Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

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STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

Government of the Northwest Territories

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STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

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1.1 General

This specification is for the removal of all material necessary for the construction of the Work as shown on the Drawings and as determined by the Department Representative. Excavation shall also include, but not be limited to, maintaining the stability of slopes, fills, or existing structures; designing, constructing and maintaining temporary access berms, cofferdams and dikes; and the protection, water management, dewatering and maintenance of excavations, and disposal of excavated materials. Any underground utilities located on the Drawings are approximate and are to be confirmed by the Contractor at the project site.

All underground utility locations shall be clearly marked and protected during the course of construction. Damages to existing utilities resulting from the Contractor's operations shall be repaired at the Contractor's expense and to the satisfaction of the Department Representative. The Contractor shall maintain the integrity and stability of excavations at all times. Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder shall be an integral part of all aspects of the Work. The Contractor shall immediately provide the Department Representative with any documentation required by the Occupational Health and Safety Regulations upon request.

Construction Site Supervisors and Relief Supervisors working in the Northwest Territories must attend an approved course that familiarizes them with occupational health and safety legislation. The approved course providers for the Supervisor Familiarization courses that meet legislative requirements are listed on the Worker's Safety & Compensation Commission (WSCC) website.

The Contractor shall provide acceptable provisions for the control and management of water and/or ice at all times.

Excavation elevations and dimensions shown on the Drawings shall be considered approximate only. The Department Representative may require changes in final elevation and/or dimensions of excavations based on actual site conditions.

For projects in which the existing asphalt concrete pavement (ACP) surfaces are to be retained, the Contractor shall provide protection acceptable to the Department Representative of the ACP during excavation, trimming, or other construction activities. Protection of the existing ACP will be considered to be incidental to the Work and no separate or additional payment will be made. Any damage to the ACP caused by the Contractor's operations shall be repaired at their expense and to the satisfaction of the Department Representative.

The Contractor shall backfill all excavations after foundation and substructure components are acceptably constructed to the design elevations shown on the Drawings and with materials acceptable to the Department Representative. Where no design elevation is shown, the excavation shall be backfilled to the original ground surface or streambed, or as determined by the Department Representative. Backfilling of excavations shall be completed and will be paid for in accordance with Section 2, Backfill. All costs associated with excavations made by the Contractor that are not shown on the Drawings or required by the Department Representative shall be backfilled at their expense to the satisfaction of the Department Representative.

1.2 Clearing

Clearing required for the completion of the Work will be considered incidental to the Work, and no separate or additional payment will be made.

1.3 Culvert and Bridge Structure Foundations

Excavated surfaces for culvert and bridge structure foundations shall be free of loose material, cleaned and cut to a surface condition acceptable to the Department Representative. Seams contained within excavated surfaces that are determined by the Department Representative to be unacceptable, shall be cleaned out, filled, and compacted with backfill material acceptable to the Department Representative.

When excavated surfaces for culvert and bridge structure foundations are determined unacceptable by the Department Representative, the Contractor shall continue the excavation to the elevation and dimensions determined by the Department Representative. The excavation shall then be backfilled to the extents determined by the Department Representative as shown on the Drawings and in accordance with Section 2, Backfill.

1.4 Temporary Access Berms, Cofferdams and Dikes

1.4.1 General

The Contractor shall design, construct, maintain and remove temporary access berms, cofferdams and dikes necessary to complete the Work.

The Contractor's design of temporary access berms, cofferdams and dikes shall include, but is not limited to, access roads, water and/or ice flows, height of temporary access berm, cofferdam and dike elevations, geometry, materials, and anticipated equipment surcharge.

Temporary access berms, cofferdams and dikes shall isolate instream construction activities and eliminate the flow of water through the construction area. The temporary access berms, cofferdams and dikes shall be installed and removed in a controlled manner to minimize the disturbance to the channel and banks.

The Contractor shall complete all Work in accordance with the conditions of all environmental approvals, permits, licenses and authorizations issued for the project and environmental requirements in the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements. The Contractor's Environmental Construction Operations Plan (ECO Plan) shall include requirements for temporary access berms, cofferdams and dikes.

The Contractor shall establish a stream flow monitoring protocol that can provide several days advance warning of impending water and/or ice flows.

The Contractor shall test all temporary access berm and dike materials to confirm assumed design material properties. The Contractor shall provide material test reports to the Department Representative upon request.

The Contractor shall submit design notes, drawings, construction sequencing, and an updated ECO Plan, of proposed temporary access berms, cofferdams, and dikes to the Department Representative for review and acceptance a minimum of 3 weeks prior to the commencement of the work. The design notes, drawings and construction sequence will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practise within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp as issued by NAPEG.

The design notes, drawings and construction sequencing will be reviewed by the Department Representative solely to ascertain general conformance with Contract requirements. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

1.4.2 Pre and Post Construction Channel Surveys

Prior to construction of temporary access berms, the Contractor shall complete a detailed elevation survey (3 m grid or finer) of the channel banks and streambed. The extent of the detailed elevation survey shall include any proposed access roads along the channel banks, footprint of the temporary access berm extending 12 m upstream and 48 m downstream for the full width of the channel.

The accuracy of the detailed elevation survey shall be ±100 mm vertically and ±250 mm horizontally.

The channel banks and streambed shall be restored in accordance with Subsection 1.4.8, Site Restoration, prior to completing the post construction channel bank and streambed survey. The Contractor shall complete a post construction survey at the same locations as the pre-construction survey within 5 days of restoration completion.

Pre and post construction survey results shall be submitted to the Department Representative within 10 days of survey completion.

1.4.3 Turbidity Monitoring and Testing

Turbidity monitoring and testing shall be carried out in accordance with the Special Provisions of the Contract.

1.4.4 Fish Salvage

Fish salvage shall be carried out in accordance with the Special Provisions of the Contract.

1.4.5 Cofferdam Dewatering

Cofferdams shall be sealed to prevent the ingress of water. The Contractor shall make every attempt necessary to obtain a dry work area prior to commencement of foundation construction. The work area will be considered dry when the seepage rate is less than 500 mm in depth per hour and the water can be controlled by pumps or other means to reduce the depth of accumulated water to 75 mm in depth or less at the time of concrete placement. Dewatering cofferdams shall be completed using means and methods acceptable to the Department Representative such that water does not flow through plastic concrete.

A water management plan to manage cofferdam seepage water shall be included in the Contractor's ECO Plan. The water management plan shall be reviewed and accepted by the Department Representative 2 weeks prior to commencement of the work.

When conditions are encountered which, in the opinion of the Department Representative, make it impracticable to dewater the cofferdam prior to placing concrete, construction of a concrete cofferdam seal below the elevation of the bottom of the foundation may be required. The concrete cofferdam seal shall be placed by tremie method such that water does not flow through plastic concrete. No separate or additional payment will be made for the concrete cofferdam seal unless it is specified on the Drawings, in which case it will be paid for at the unit price bid for the class of concrete specified.

1.4.6 Cofferdam Bracing

No cofferdam bracing shall be left in the completed Work without the written acceptance of the Department Representative.

1.4.7 Removal of Temporary Access Berms, Cofferdams and Dikes

Temporary access berms, cofferdams, and dikes shall be removed after completion of the work and in accordance with the Special Provisions of the Contract. The Contractor shall take care not to disturb or damage the completed Work in any way during removal operations. Backfill required around the completed work shall be placed prior to removal of the temporary access berms, cofferdams, and dikes.

1.4.8 Site Restoration

Upon removal of temporary access berms, cofferdams and dikes; the channel banks, streambed, and any areas disturbed from the construction of access roads shall be restored to the composition and elevation that existed at the time prior to construction and the pre-construction channel survey, in accordance with the Drawings. Site restoration will be reviewed and accepted by the Department Representative based on comparison of pre- and post- construction channel surveys and any other available information.

1.5 Disposal

Details of proposed excavated material disposal locations shall be submitted to the Department Representative for review and acceptance prior to disposing of materials.

1.6 Measurement and Payment

1.6.1 Excavation

1.6.1.1 Excavation Classification

Excavation will be classified as follows:

- Structural Excavation: Excavation related to foundations and substructure components; or
- Channel Excavation: Excavation carried out to improve the alignment or carrying capacity of the stream channel.

Payment for structural and channel excavation will be at the unit price bid per cubic metre or lump sum price basis. The prices bid shall include the cost of all labour, material, equipment, and other items of expense necessary to complete the Work.

1.6.1.2 Payment by Unit Price

Measurement for payment of excavation will be by the cubic metre of material acceptably excavated, measured to the nearest cubic metre.

The quantity of material paid for will be the actual volume of material excavated and placed or disposed of, as measured from the original ground surface or streambed to the neat lines shown on the Drawings as determined by the Department Representative.

Payment will be made at the unit prices bid for “Excavation - Structural” and/or “Excavation - Channel”, as applicable, and will be full compensation for all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

All cost associated with the control and management of water and/or ice will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with maintaining the stability of slopes, fills, or existing structures will be considered incidental to the Work, and no separate or additional payment will be made.

1.6.1.3 Payment by Lump Sum

Payment will be made at the lump sum prices bid for "Excavation - Structural" and/or "Excavation - Channel", as applicable, and will be full compensation for all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

When the required extents of excavation are greater than originally anticipated, as determined by the Department Representative, the additional quantities of excavation may be paid for through a negotiated lump sum price, or as extra expense in accordance with the General Terms and Conditions.

All cost associated with the control and management of water and/or ice will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with maintaining the stability of slopes, fills, or existing structures will be considered incidental to the Work, and no separate or additional payment will be made.

1.6.2 Temporary Access Berms, Cofferdams and Dikes

Payment will be made at the lump sum price bid for "Temporary Access Berms, Cofferdams and Dikes", and will be full compensation for the design; construction; maintenance, including the control and management of water; removal; site restoration; and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

All costs associated with pre- and post- construction channel surveys, and excavation through the depth of the berm to access the Work, including structural excavation, will be considered incidental to the Work, and no separate or additional payment will be made.

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2.1 General

This specification is for the supply and placement of backfill materials necessary to complete the Work, including, but not limited to, filling excavations; constructing approach fills, embankments and slopes, and channel banks as shown on the Drawings and as determined by the Department Representative.

All materials shall be sourced and supplied by the Contractor. The Contractor shall be responsible for royalties, processing, loading, hauling, placing, compacting, quality control testing and any other incidentals required to supply these materials in place.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

2.2 Materials

All material used for backfill, including native material, shall be of a quality acceptable to the Department Representative and shall be in a thawed state when placing and compacting and be free from rocks, large or frozen lumps, wood, or other unsuitable material. Backfill material shall not be placed on frozen substrate.

2.2.1 Compacted Non-Granular Material

Compacted non-granular material shall be inorganic soil such as clay. When reviewed and accepted by the Department Representative, non-granular material can be substituted with crushed aggregate material.

Culvert clay seals shall be highly plastic clay as defined by ASTM D2487 and have a minimum Plasticity Index of 40.

2.2.2 Crushed Aggregate Material

Where crushed aggregate material is specified, it shall consist of clean sand and gravel, complying with the requirement of Table 2-1, Crushed Aggregate Material Requirements.

Des 2 Class 25 crushed aggregate material may be used where Des 2 Class 40 has been specified. No separate or additional payment will be considered for the proposed substitution.

Table 2-1 Crushed Aggregate Material Requirements

Metric Sieve Size (CGSB 8-GP-2M) (µm)	**Des 2 Class 40 (% Passing)**	**Des 2 Class 25 (% Passing)**	**Des 2 Class 20 (% Passing)**
80 000	100	100	100
50 000	100	100	100
40 000	100	100	100
25 000	70 - 94	100	100
20 000	n/a	82 - 97	100
16 000	55 - 85	70 - 94	84 - 94
10 000	44 - 74	52 - 79	63 - 86
5 000	32 - 62	35 - 64	40 - 67
1 250	17 - 43	18 - 43	20 - 43
630	12 - 34	12 - 34	14 - 34
315	8 - 26	8 - 26	9 - 26
160	5 - 18	5 -18	5 - 18
80	2 - 10	2 - 10	2 - 10
% fractures by weight (2 faces)	50+	60+	60+
Plasticity Index	NP - 6	NP - 6	NP - 6
L.A. Abrasion Loss Percent Maximum	50	50	50

2.2.3 Backfill Material Tests

The Contractor shall be responsible for carrying out quality control testing at the frequencies specified in Table 2-2 Quality Control Testing Requirements. Testing shall be completed by an independent third-party testing agency that is experienced with the testing requirements in the Contract.

The Contractor shall submit sieve analysis, percent fracture, laboratory/proctor density, plasticity index testing for the applicable proposed backfill materials to the Department Representative for review and acceptance 2 weeks prior to commencement of the work. Sampling and testing shall have been completed no more than 90 days prior to use unless otherwise reviewed and accepted by the Department Representative.

Table 2-2 Quality Control Testing Requirements

Description	Standard	Minimum Frequency
Aggregates Tests		
Sieve Analysis		
Crushed Aggregate	ATT-25 or ATT-26	One per Source
Plasticity Index	AASHTO T 90	When requested by the Department Representative
Percent Fracture (crushed aggregate)	ATT-50	One per Source
L.A. Abrasion	AASHTO T 96	When requested by the Department Representative
Backfill Tests		
Moisture Density Tests (Laboratory/Proctor)		
Crushed Aggregate (Des 2 Class 25/Class 20)	ASTM D698	One test per source
Non Granular Material	ASTM D698	One test for each soil type
Density of Materials (Field)		
Crushed Aggregate (Des 2 Class 25/Class 20)	ASTM D6938	For culvert and bridge component backfill – 3 tests for: the first lift of backfill, every 4 lifts thereafter, and the final lift.
Crushed Aggregate (Des 2 Class 40)	ATT-58A (Control Strip Method)	Control strips shall be established for culverts and bridge components on the first lift of backfill, and at the ¼ and ½ height of the required backfill depth. For culverts, the controls strips shall be established on both sides of the pipe.
Non-Granular Material	ASTM D6938	For embankments and bridge components – 3 tests for: the first lift of backfill, every 10 lifts thereafter, and the final lift.
		For culvert clay seals – 3 tests for: the first lift of backfill, every 4 lifts thereafter, and the final lift.

Notes:

(1) The term "ATT" refers to Alberta Transportation Test method.
(2) ATT-58A, Control Strip Method may be used for field density testing of Des 2 Class 25 or Des 2 Class 20 when reviewed and accepted by the Department Representative.
(3) Location of density testing shall be reviewed and accepted by the Department Representative.
(4) Compaction monitoring shall occur on all lifts of backfill.

Results of all quality control tests shall be submitted to the Department Representative within 3 days of the test being completed.

2.3 Placement

All spaces excavated and not occupied by the permanent Work shall be backfilled and compacted with material acceptable to the Department Representative and to the design elevations shown on the Drawings or as determined by the Department Representative. Where no design elevation is shown, the excavation shall be backfilled to the original ground surface or streambed, or as determined by the Department Representative.

All backfill material, regardless of type, shall be placed in lifts not exceeding 150 mm in thickness of loose material. The rate of placing the backfill material shall be such that the specified level of compaction is achieved uniformly. Compaction of crushed aggregate and non-granular material shall be a minimum of 95% proctor density with optimum moisture content. Compaction of crushed aggregate and non-granular material below approach slabs shall be a minimum of 98% proctor density with optimum moisture content.

The compaction equipment proposed by the Contractor must be reviewed and accepted by the Department Representative prior to commencement of the work.

Compaction acceptance testing shall be completed in accordance with Table 2-2, Quality Control Testing Requirements.

Backfill material shall not be placed against any concrete component until the Department Representative has reviewed and accepted the timing of placement. Generally, backfill placement will not be permitted until 7 days after concrete placement or the compressive strength of the concrete has obtained 75% of the required 28-day strength.

Backfill material around culverts and concrete components shall be placed simultaneously on all sides of the culvert or concrete component. The elevation difference on any side shall not exceed 300 mm. Special precautions shall be taken to prevent any wedging action against the concrete and the slope bounding the excavation for abutments and wingwalls. The slope shall be stepped to prevent wedge action. Jetting of backfill material behind abutments and wingwalls will not be permitted.

The Department Representative will carry out quality assurance testing if the Contractor's compaction methods and procedures are in the Department Representative's opinion not meeting the specification requirements.

2.4 Measurement and Payment

2.4.1 Payment by Unit Price

Measurement for payment of backfill will be by the cubic metre of material acceptably placed and compacted, measured to the nearest cubic metre.

The quantity of backfill to be paid for will be the actual measured quantity of backfill acceptably placed and compacted as shown on the Drawings and to the satisfaction of the Department Representative.

Payment will be made at the unit price or prices bid for "Backfill", for the types of material specified, and will be full compensation for the supply of material; placement and compaction; sampling and testing; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

2.4.2 Payment by Lump Sum

Payment will be made at the lump sum price or prices bid for "Backfill", for the types of material specified, and will be full compensation for the supply of material; placement and compaction; sampling and testing; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

When the required extents of excavation are greater than originally anticipated, as determined by the Department Representative, the additional quantities of backfill may be paid for through a negotiated lump sum price, or as an extra expense in accordance with the General Terms and Conditions.

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This specification is for the supply and installation of plain and galvanized steel H-piles and pipe piles, and cast-in-place concrete piles. It includes driven piles, drilled cast-in-place concrete piles, drilled cast-in-place concrete/steel pipe composite piles, and associated pile capacity test methods.

3.2 Materials

3.2.1 Steel Piling

Steel "H" piling shall meet the requirements of CSA G40.21 Grade 350W or ASTM A572/A572M Grade 50.

Steel pipe piling shall meet the requirements of ASTM A252 Grade 2, except that hydrostatic testing is not required.

Where metric dimensioned piling is specified, imperial dimensioned piling may be proposed and submitted to the Department Representative for review and acceptance. At a minimum, the proposed imperial dimensioned piling shall have equivalent or greater section properties.

3.2.1.1 Mill Test Reports

Mill test reports shall be provided in English for all foundation pile components.

Mill test reports shall be submitted to the Department Representative for review and acceptance 2 weeks prior to commencement of the work.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have the mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

The Contractor shall maintain a tracking system and records for all steel piling supplied to the project site. The tracking system at a minimum shall detail the mill test report, heat number, size, length and dates received at the project site for each pile.

3.2.1.2 Galvanizing

Galvanized piling shall be galvanized in accordance with Subsection 6.2.7.3.1, Galvanizing.

3.2.1.3 Boron Content

The boron content of steel piling being welded shall not exceed 0.0008%.

3.2.2 Pile Concrete

The work shall be completed in accordance with Section 4, Cast-In-Place Concrete.

3.2.3 Reinforcing Steel

Reinforcing steel shall meet the requirements of Section 5, Reinforcing Steel.

3.3 Driven Piles

3.3.1 Pile Driving Equipment

Diesel or hydraulic hammers shall be used for the driving of piling. When hydraulic hammers are proposed, the Contractor shall ensure they are configured such that the stroke of the ram is visible and measurable during driving operations to the full satisfaction of the Department Representative. Vibratory hammers may be utilized for temporary works or initial insertion of driven piles to achieve alignment and/or support prior to driving with diesel or hydraulic hammers.

Pile driving equipment shall be sized such that piles can be driven with reasonable effort to the specified geotechnical capacity without damaging the pile, but in no case shall the total energy developed be less than 35 kilojoules (kJ) per blow.

Pile driving equipment shall consist of fixed leads. Hanging leads shall not be used.

A driving cap shall be provided to maintain alignment and orientation of the pile and hammer. The driving cap shall be of adequate dimensions to allow driving the pile without trimming or reducing the cross section of the pile.

Driving extensions will only be permitted when reviewed and accepted by the Department Representative. When driving extensions are accepted for use, one pile from each group of 10 shall be a long pile driven without extensions and used as a test pile to determine the average capacity of the group.

The use of gravity hammers will not be permitted except when the required pile capacity is less than 350 kilonewtons (kN) and the Department Representative determines that the gravity hammer and leads are acceptable. Where the use of a gravity hammer is determined to be acceptable by the Department Representative, the Contractor shall provide the Department Representative acceptable proof of its weight including the weight of the follower.

3.3.2 Pile Driving Plan

A pile driving plan shall be submitted by the Contractor to the Department Representative for review and acceptance a minimum of 3 weeks prior to commencement of pile installation. At a minimum, the following shall be provided in the pile driving plan:

- Specifications, setup and configuration of pile driving equipment including:
    - Hammer Data: Hammer type, manufacturer, model number, serial number, maximum rated energy and range in operating energy, stroke at maximum rated energy and range of operating stroke, ram weight, modifications;
    - Details of onboard equipment capable of energy monitoring;
    - Striker Plate Data: weight, diameter, thickness, composition;

    - Hammer Cushion Data: Manufacturer(s), area, thickness per plate, number of plates, total thickness, and composition;
    - Helmet Data: Weight, composition; and
    - Pile Cushion Data: Material, area, thickness per sheet, number of sheets, total thickness of cushion;
- Driving methods, procedure and driving sequence;
- Details and drawings of driving frames;
- Pile driving tools and accessories;
- Mill test reports;
- Proposed pile number convention;
- Material tracking system sample output;
- Pile lengths, splicing details, and anticipated splicing locations;
- Cold weather protection methods;
- List of welders and proof of certification;
- Weld procedures;
- ECO Plan, in compliance with the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements, including a water management plan to manage seepage water encountered during the driving of open ended pipe piles;
- When pile driving analysis (PDA) testing is specified in the Contract:
    - PDA testing procedures;
    - Identification of piles to be PDA tested;
    - Schedule of PDA testing; and
    - Contact information and qualifications of the independent testing agency.

If, during the course of the work, the required pile set criteria and tip elevations are not achieved, the Contractor shall revise their pile driving plan and resubmit it to the Department Representative for review and acceptance prior to any further pile driving.

The Department Representative's review and acceptance of the Contractor's pile driving plan will not relieve the Contractor of their sole responsibility for the methods and procedures required to achieve the pile capacity and tip elevations specified in the Contract.

A construction milestone meeting shall occur after the pile driving plan has been reviewed and accepted by the Department Representative a minimum of 1 week prior to commencement of the work. The Contractor's project manager, piling sub-contractor's project manager and field superintendents shall attend the construction milestone meeting at a date, time and location acceptable to the Department Representative.

3.3.3 Driven Pile Installation

The Contractor shall use steel driving frames for the installation of driven piles. At a minimum, soldier piles shall be used to secure the position of the driving frame and be driven to a depth sufficient to prevent displacement of the driving frame during driven pile installation. Permanent piles shall not be used for securing the position or setting of the driving frame. Alignment components of the driving frame shall be equal to or larger in size and/or stiffness than the permanent piles being driven and permit the passage of piles with splice plates when required. Soldier piles shall be removed or provided in a type, location, size and length acceptable to the Department Representative such that they may remain in the completed Work.

3.3.3.1 Pile Driving Set Criteria and Tip Elevation Requirements

The Department Representative will determine an estimated initial pile driving set criteria (blows per 250 mm) for each foundation element using Wave Equation Analysis of Pile driving (WEAP) and the theoretical pile driving hammer information provided in the Contractor's pile driving plan. Provision of the estimated initial pile driving set criteria shall not be considered as acceptance of the Contractor's pile driving equipment and will not relieve the Contractor of their sole responsibility to achieve the pile capacity and tip elevations specified in the Contract.

The first driven pile for each foundation element shall be considered a test pile. When the foundation element contains more than 15 piles the first 2 driven piles in that foundation element shall be considered test piles. When two test piles are required, they shall be located such that they are at opposite ends of the foundation element in the direction of the largest dimension. Test piles shall be driven with the same type and size of equipment to be used for the entire foundation element and completed on the same working day. Information from the test pile installation(s) will be used to confirm the pile design and acceptability of the pile driving equipment.

Test piles shall be driven to the estimated initial pile driving set criteria determined by the Department Representative, prior to driving any of the other piles within the foundation element. PDA testing shall be completed on the test piles when PDA testing is specified in the Special Provisions of the Contract. The test pile tip elevations determined by the Department Representative may vary from the tip elevations shown on the Drawings. Test piles may be up to 15% longer in length than that shown on the Drawings.

The Department Representative will review the estimated initial pile driving set criteria determined from the estimated initial WEAP analysis based on data obtained during the test pile driving, evaluation of actual hammer performance, and PDA testing, including re-strikes, if specified in the Special Provisions of the Contract. Based on this review, the Department Representative will then provide the Contractor with final pile driving set criteria and tip elevations for all piles in the associated foundation element including the test piles. The Contractor shall drive all piles to both the tip elevation and pile driving set criteria determined by the Department Representative.

Payment for test piles will be made at the same unit prices bid for driven piles, in accordance with Subsection 3.6.1, Driven Piles and no separate or additional payment will be made.

The Contractor shall have no claim against the Government of the Northwest Territories for any inconvenience or delay resulting from these requirements.

3.3.3.1.1 Bearing Formulas

When specified in the Special Provisions of the Contract, pile driving set criteria will be determined by the Department Representative using bearing formulas. For piles driven with diesel or hydraulic hammers the bearing formula will be as follows:

$P = \frac{165xExF}{S+5}$, where

- P = Pile service limit state (SLS) extreme load as defined on the Drawings (kilonewtons);
- E = Rated energy output of hammer (kilojoules) at corresponding number of blows per minute based on published hammer data sheet;
- F = Efficiency factor = 0.8 or as determined by the Department Representative; and
- S = Pile driving set criteria = the average penetration (mm per blow) for the last 10 to 20 blows.

The bearing formula for piles driven with diesel or hydraulic hammers will only be applied when:

- The head of the pile is not broomed, crushed, or deformed;
- The rate of penetration is acceptable to the Department Representative; and
- A driving extension is not used.

3.3.3.2 Transportation, Handling and Storage

Pile materials shall be transported, handled, and stored in a manner that prevents damage. Loading and unloading shall be by crane, loader or other hoisting equipment acceptable to the Department Representative.

Care shall be taken in order to prevent damage of galvanized pile surfaces. Fabric slings, wood blocking or other methods acceptable to the Department Representative, shall be used to support and separate galvanized piling when handling, hauling or storing.

3.3.3.3 Preparation of Steel Piling for Driving

Steel piles supplied with driving heads out of square shall be cut square and neat using a cutting guide prior to commencement of the work.

Sections of steel piles with holes cut into piling sections as part of the Contractor's rigging and lifting procedures shall be cut at an elevation such that the holes are not incorporated into the work or sized and installed in a location acceptable to the Department Representative. Plug welding of holes will not be permitted.

When specified in the Contract documents, pile tip reinforcement shall be installed in accordance with Alberta Transportation Standard Drawing S-1850, Standard Steel Pile Details.

When pipe piles are to be driven closed ended, pipe pile tips shall have welded end plates installed in accordance with Alberta Transportation Standard Drawing S-1850, Standard Steel Pile Details.

The Contractor shall apply permanent markings on each pile at 0.25 m intervals with a numbered label at each 1 m interval starting from the toe of the pile. Soap stone, paint sticks or other methods acceptable to the Department Representative shall be used to apply markings to the piles. Aerosol spray paint will not be permitted.

Prior to the commencement of driving each pile the Contractor shall submit to the Department Representative, the material tracking record for the pile to be driven.

3.3.3.4 Steel Piling Splices

The Contractor shall locate steel piling splices such that the final location of the splice is below the elevation specified on the Drawings, or a minimum of 1 m below the specified final ground elevation, or at an elevation acceptable to the Department Representative.

All welding, cutting and preparation of steel piling shall be completed in accordance with the AASHTO/AWS Bridge Welding Code D1.5M/D1.5 and this Subsection. In the case of conflicting requirements, the requirements of this Subsection shall govern.

Steel pile splices shall be in accordance with Alberta Transportation Standard Drawing S-1850, Standard Steel Pile Details.

Cutting of steel piles in preparation for splicing shall be completed using a cutting guide. Cuts shall be square and neat. For steel pipe piling, methods acceptable to the Department Representative shall be used to match out-of-round piling. Weld procedures shall be developed by the Contractor and submitted to the Department Representative for review and acceptance for steel pipe pile splices where out-of-round conditions are present.

Shielded metal arc welding (SMAW) shall be used for pile splicing. Low hydrogen filler, fluxes and welding practices shall be in accordance with Subsection 6.2.5.1, Filler Metals & Welding Processes.

When the ambient air temperature is below 10°C, all material to be welded shall be preheated to 100°C for a distance of 80 mm beyond the weld and shall be sheltered from the wind. When the ambient air temperature is below 0°C, welding will not be permitted unless hoarding and heating acceptable to the Department Representative is provided.

Welding procedures, including welding procedure datasheets, shall be submitted to the Department Representative for review and acceptance a minimum of 3 weeks prior to commencement of the work for each type of weld proposed. All weld procedure datasheets shall be approved by the CWB and include the heat input provided for each size of weld in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5. Only weld procedure data sheets that will be used shall be submitted. Weld procedures and weld procedure datasheets will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut. The Professional Engineer shall be a welding engineer with extensive experience in welding procedures for this type of work.

Tack and temporary welds will not be permitted unless they are incorporated within the final weld. Tack welds to be incorporated into final welds shall be completed using consumables compatible with the final weld. Tack welds shall have a minimum weld length at least 4 times the nominal weld size and a maximum weld length of 15 times the nominal weld size. Tack welds shall be equivalent in quality to the final weld and will be subject to the same inspection and testing requirements as final welds. Tack welds with any cracking shall be removed and the location tested using magnetic particle non-destructive testing methods to confirm that the crack has been completely removed prior to final welding.

Welders shall be CWB approved in the applicable category. Their qualifications shall be included in the pile driving plan and available for examination by the Department Representative upon request.

Where the upper portions of piling are specified to be galvanized, excess piling shall be removed from the ungalvanized portion of the piling to ensure that the galvanized portion extends to the elevation shown on the Drawings. Splicing within the galvanized portion of the piling shall be avoided. If splicing within the galvanized portion becomes necessary, the galvanizing shall be removed to the extent required to complete the splice in a manner acceptable to the Department Representative. The spliced areas and any other damaged galvanized areas shall be metallized in accordance with ASTM A780/A780M Method A3, Metallizing, to a thickness of 180 µm and tested for adhesion. All costs associated with metallizing and testing will be considered incidental to the Work, and no separate or additional payment will be made.

3.3.3.4.1 Testing of Steel Piling Splices

The Contractor shall have all steel piling splice welds visually inspected by an independent welding inspector certified to CSA W178.2 Level II.

For each bridge component, the Contractor shall also perform ultrasonic testing for a minimum of 20% of all full penetration welded splices in compression.

The Contractor shall perform ultrasonic testing for 100% of full penetration welded splices in tension as specified on the Drawings.

If visual inspection of the weld reveals the presence of potential defects, the Department Representative will require the Contractor to complete additional ultrasonic testing to that already specified to confirm the acceptability of the weld. The Department Representative will determine the scope of additional ultrasonic testing to be completed and the acceptability of the weld. If welds are determined unacceptable by the Department Representative, the Contractor shall repair the weld at their expense to the full satisfaction of the Department Representative.

All ultrasonic testing shall be completed by an independent testing company certified to CSA W178.1. Ultrasonic testing technicians shall be certified to Level 2 of CAN/CGSB-48.9712.

A copy of inspection and test reports shall be provided to the Department Representative for review and acceptance within 3 days of the inspection and testing.

All costs associated with inspection and testing of splices will be considered incidental to the Work and no separate or additional payment will be made.

3.3.3.5 Steel Pipe Piles

At the completion of driving open-ended pipe piles the thickness of accumulated material in the pipe pile shall be measured and recorded by the Contractor. Upon completion of the measurements and review and acceptance of the Department Representative, the interiors shall be cleaned out to the specified elevation. All material, either loose or adhering to the walls of the pipe piles shall be removed to the satisfaction of the Department Representative prior to installing reinforcing steel or placing concrete. Driving of any type of piles within 3 m of a pipe pile or integral pile that contains concrete shall not be undertaken until the concrete has been placed and cured for a minimum of 3 days.

The Contractor shall cover all open pipe piles until concrete or backfill is placed. Coverings shall be designed, supplied, installed, secured and maintained by the Contractor, in a manner acceptable to the Department Representative.

3.3.3.5.1 Reinforcing Steel

Reinforcing steel shall be fabricated, shipped, handled, stored, placed, fastened and spliced in accordance with these specifications, Section 5, Reinforcing Steel, and as shown on the Drawings.

Reinforcing steel shall be positioned and braced to achieve placement tolerances specified in Section 5, Reinforcing Steel. Shoes or spacers shall be firmly attached to the reinforcement to ensure the reinforcement is kept in position during concrete placement and cover requirements are met.

Projecting reinforcing steel shall be located such that it is within a tolerance of ± 10 mm or as determined by the Department Representative.

3.3.3.5.2 Pile Concrete

The work shall be completed in accordance with Section 4, Cast-In-Place Concrete, Subsection 3.4.3.3, Pile Concrete, and this Subsection.

Pipe pile concrete shall not be placed until the pipe pile has been reviewed and accepted by the Department Representative. Any reinforcing required projecting from the pipe pile shall be installed and secured prior to concrete placement.

3.3.3.6 Driven Pile Installation Tolerances

Piles shall not be driven with a variation of more than 150 mm from the horizontal position shown on the Drawings, except for fully integral abutments for which the piles shall not be driven with a variation of more than 50 mm from the horizontal position. In addition, for fully integral abutments, the variation in position between the centre of the pile casing and centre of the pile shall not be more than 25 mm from the horizontal position shown on the Drawings.

Piles shall be driven with a variation not exceeding more than 20 mm per metre from the vertical alignment shown on the Drawings. Piles in exposed bents shall not be out of position by more than 50 mm at the ground line and 25 mm in the pier cap.

At the completion of driving of each pile within a foundation element, a control elevation shall be established on the pile by the Contractor to determine if heave has occurred after all piles for the foundation element have been driven. Piles that heave shall be re-driven to the depth and capacity required by the Contract or as determined by the Department Representative.

If tolerances are not met, the Contractor shall make immediate changes to their piling procedures. Any pile out of the specified tolerance shall be corrected at the Contractor's expense to the full satisfaction of the Department Representative.

3.3.3.7 Driven Pile Cut Off Elevation

After all piles have been driven and the set criteria and tip elevation have been reviewed and accepted by the Department Representative, driven piles shall be cut off level and neat using a cutting guide and at the elevation specified on the Drawings.

3.3.4 Defective Piles

The equipment and methods used to drive piles shall not result in deformation of the steel, crushing and spalling of the concrete, or any other damage determined by the Department Representative.

When damage at the driving end of the pile or buckling at any location occurs, the Contractor shall immediately stop pile driving and revise and resubmit their pile driving plan to the Department Representative. The Contractor shall not continue pile driving until the revised pile driving plan has been reviewed and accepted by the Department Representative. All costs and schedule impacts associated with the required modifications to the pile driving plan will be considered incidental to the Work and no additional or separate payment nor completion date adjustments will be made. Modifications may include, but are not limited to, reinforcing the driving end of the piling or utilizing different pile driving equipment or procedures.

Manipulation of piles to adjust position, considered by the Department Representative to be harmful, will not be permitted.

Piles damaged by driving, or driven out of specified tolerance, orientation, or driven below the cut off elevation, shall be repaired by the Contractor at their expense. The Contractor shall submit a repair procedure to the Department Representative for review and acceptance before any further piling is installed. The Contractor's repair procedures, as a minimum, shall include one of the following:

- The defective piling shall be withdrawn and replaced with new, and if necessary, longer piles;
- Replacement piling shall be driven adjacent to the defective pile(s);
- The defective pile(s) shall be spliced or built up; or
- A sufficient portion of the pile cap extended and reinforced.

Piling on which the galvanized coating has been damaged, as determined by the Department Representative, shall be replaced or repaired by the Contractor at their expense. Where repair of damaged galvanizing is required, it shall be completed in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

3.4 Drilled Cast-In-Place Concrete Piles

3.4.1 Pile Drilling Equipment

Only screw rotary type augers shall be used.

Hydraulic oscillating equipment will be permitted for the installation of temporary or permanent casings.

Continuous flight auger equipment shall not be used.

3.4.2 Pile Drilling Plan

The Contractor shall have demonstrated experience related to the successful completion of previous projects with similar scopes of work and ensure that the equipment used is adequate in quantity, quality and operating condition.

A pile drilling plan shall be submitted by the Contractor to the Department Representative for review and acceptance a minimum of 3 weeks prior to the commencement of pile installation. At a minimum, the following information shall be provided in the pile drilling plan:

- Summary of Contractor's experience related to the project scope of work;
    - Project personnel resumes; and
    - Client contact information;
- Specifications, setup and configuration of piling equipment;
- Drilling methods, installation sequence and timing, drilling procedure (including methodology to address the presence of boulders, hard rock stringers, or occurrences of pile wall sloughing and/or ingress of water);
- List of drilling tools and attachments for belling and cleaning;
- List of proposed casing lengths and diameters to be available on site;
- Proposed use of drilling fluids and associated drilling fluid management considerations;
- Method of gas detection;
- Methods to install and remove temporary casing;
- Availability of borehole video inspection equipment and associated specifications;
- Concrete mix design review letter and applicable trial batch information in accordance with Section 4, Cast-In-Place Concrete;
- Reinforcing steel mill test reports in accordance with Section 5, Reinforcing Steel;
- Reinforcing steel cage lift design drawings;
- Tremie method plan, if applicable;
- Crosshole sonic logging (CSL) testing details; CSL independent testing agency qualifications; and CSL tube grout mixing, placing and testing procedures, if applicable;

- Cold weather protection methods;
- ECO Plan including a water management plan to manage seepage water encountered; and
- Sample piling monitoring records.

If during the course of the work, the required pile capacities and tip elevations are not achieved, or the work is not being completed in accordance with the Contract requirements, the Contractor shall revise their pile drilling plan and resubmit it to the Department Representative for review and acceptance before any further piling Work occurs.

The Department Representative's review and acceptance of the Contractor's pile drilling plan will not relieve the Contractor of their full responsibility for the methods and procedures required to achieve the pile capacity and tip elevations specified in the Contract.

A construction milestone meeting shall occur after the pile drilling plan has been reviewed and accepted by the Department Representative and a minimum of 1 week prior to commencement of the work. The Contractor's project manager, piling sub-contractor's project manager and field superintendent(s) shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

3.4.3 Drilled Pile Installation

Drilled pile holes shall be stabilized and sealed by means of temporary casings to prevent the possible collapse of the pile holes or ingress of water. The Contractor shall make every attempt necessary to obtain dry pile holes prior to placing pile concrete. At a minimum, the Contractor shall have on site casings of appropriate size and lengths, bailing buckets, final cleanout buckets and water pumps ready for use in the work. A drilled pile hole will be considered dry when the seepage rate into the drilled pile hole is less than 300 mm per hour (25 mm in 5 minutes) and the water can be controlled by pumps or other means to reduce the depth of accumulated water to 75 mm or less at the bottom of the pile hole at the time of concrete placement. Dewatering will not be permitted after concrete placement commences. No accumulation of water will be permitted on the top of previously placed concrete.

Seepage water removed from pile holes shall be managed in compliance with all environmental regulations and requirements by discharging it into settlement tanks or ponds, hauling and disposing offsite, or other methods acceptable to the Department Representative. A seepage water management strategy shall be included in the Contractor's ECO Plan and submitted with the pile drilling plan. Further, environmental requirements shall be in accordance with the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements.

Temporary casings, if used in drilling operations, shall be removed from the hole by vibration or hydraulic oscillation and of sufficient strength to withstand repeated use and any forces required to install or retrieve it. The internal diameter of casings shall be the same size as the specified pile diameter and of sufficient length to permit drilling operations to proceed unimpeded. The bottom of the casing shall be maintained sufficiently below the top of the concrete during withdrawal and placing operations.

Drilling fluids will not be permitted unless otherwise reviewed and accepted by the Department Representative. Drilling fluids and drilling fluid management, as a minimum, shall meet the requirements of Federal Highway Administration (FHWA) NHI-18-024 GEC 10, Appendix D, Subsections X3.4 – X3.6.

Pile hole tip elevations shown on the Drawings shall be considered approximate only, and the Department Representative may determine further drilling is necessary to achieve satisfactory capacity of the piles. For dry holes, the Contractor shall provide pile hole video inspection equipment when determined necessary by the Department Representative. The pile hole video inspection equipment shall be installed with lighting and resolution acceptable to the Department Representative. Pile hole video inspection equipment shall be equipped with recording data logging capability and the electronic files provided to the Department Representative immediately upon request.

Where belling of the piles is specified, belling shall proceed only after the pile hole has been drilled to an elevation acceptable to the Department Representative.

The walls and bottoms of the pile holes shall be cleaned to remove all loose and extraneous material. The Contractor shall determine if any noxious or explosive gas is present in the pile holes and shall provide whatever means and equipment necessary to ensure a safe work site.

Pile reinforcement and pile concrete shall not be placed without the Department Representative's review and acceptance of the pile holes. The Department Representative shall be permitted full and safe access to the drill hole to allow for the inspection of drilling operations, evaluation of soil or rock cuttings, presence of water ingress or wall sloughing, tip elevations, or any other reasons determined necessary by the Department Representative. The time elapsed between the completion of the pile hole, reinforcement installation and concrete placement shall be minimized and acceptable to the Department Representative.

3.4.3.1 Open Drilled Holes

The Contractor shall cover all open drilled holes until concrete or backfill is placed. Coverings shall be highly visible, designed, supplied, installed, secured and maintained by the Contractor, in a manner acceptable to the Department Representative.

3.4.3.2 Reinforcing Steel

Reinforcing steel shall be fabricated, shipped, handled, stored, placed, fastened and spliced in accordance with these specifications, Section 5, Reinforcing Steel and as shown on the Drawings.

Reinforcing steel cage lifts shall be designed by a Professional Engineer registered in the Northwest Territories and Nunavut and lift drawings submitted to the Department Representative for review and acceptance. The lift drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Reinforcing steel shall be positioned and braced to achieve placement tolerances specified in Section 5, Reinforcing Steel. Shoes and spacers shall be firmly attached to the reinforcement to ensure the reinforcement is kept in position during concrete placement and cover requirements are met.

Projecting reinforcing steel shall be located such that it is within a tolerance of ±10 mm or as determined by the Department Representative.

3.4.3.3 Pile Concrete

The work shall be completed in accordance with Section 4, Cast-In-Place Concrete and these specifications.

Suitable forms shall be used to maintain the specified dimensions of concrete piles above ground level. When the reinforcement has been acceptably placed, concrete shall be immediately deposited in the pile hole.

3.4.3.3.1 Pile Concrete Placed in the Dry

Pile concrete shall be placed by means of a hopper equipped with a centre pipe drop tube. The pipe drop tube shall be a minimum of 200 mm in diameter and 2 m long. Concrete may be placed free fall, providing the fall is vertically down the centre of the casing or drilled hole and there are no transverse ties or spacers. Pile concrete shall have a slump range of 130 ±30 mm at time of discharge. Concrete in the upper 3 m of the piles shall be consolidated by the use of an acceptable concrete vibrator.

3.4.3.3.2 Pile Concrete Placed under Water

If, in the opinion of the Department Representative, all attempts to achieve a dry pile hole have been taken and proven unsuccessful, the pile hole shall be immediately filled with clean water from an external source to an elevation that results in a positive hydraulic head and seepage into the pile hole has stopped. Placement of pile concrete under water will be required and shall be completed in accordance with Subsection 4.21, Placing Concrete under Water and these specifications.

The integrity of the pile shall be tested and verified using Crosshole Sonic Logging (CSL) as described in Subsection 3.4.3.3.3, Crosshole Sonic Logging.

3.4.3.3.3 Crosshole Sonic Logging

All piles with concrete placed under water shall have CSL completed to confirm pile integrity. The Contractor shall complete CSL testing in accordance with ASTM D6760 and these specifications.

The Contractor shall hire an independent CSL testing agency that has a minimum of 5 years' experience in CSL testing. A Professional Engineer employed by the independent CSL testing agency and registered in the Northwest Territories and Nunavut shall supervise the independent CSL testing and prepare a CSL testing report. The CSL testing report will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp as issued by NAPEG.

CSL testing shall be completed within 3 to 21 days after concrete placement as determined by the independent CSL testing agency.

The Contractor shall supply and install one 50 mm inside diameter tube for each 0.3 m of pile diameter with a minimum of 4 tubes per pile. CSL tubes shall be Schedule 40 steel pipe meeting the requirements of ASTM A53/A53M or an equivalent acceptable to the Department Representative. If required, CSL tubes shall be extended with watertight mechanical threaded steel couplers that have a wall thickness equivalent to the CSL tubes and have the ability to resist all loads. Coupler locations shall be recorded and provided to the CSL testing agency prior to installing the reinforcing steel cage within the pile hole. The CSL tubes shall be clean, watertight, of uniform internal diameter, free of defects, obstructions, corrosion and discontinuities. CSL tubes shall be installed by the Contractor in a manner that permits the CSL probes to pass through the entire length of the tube without binding.

The Contractor shall fit the CSL tubes with watertight mechanical threaded steel shoes on the bottom and caps on the top. CSL tubes shall be secured to the interior of the reinforcement stirrups a minimum of every 1 m along the length of the pile. CSL tubes shall be installed parallel to each other and equidistant around the circumference of the pile. CSL tubes shall be installed a minimum of 40 mm away from the vertical reinforcing steel bars and care taken to ensure the verticality of CSL tubes along the full length of the reinforcing steel cage. CSL tubes shall extend a minimum of 600 mm above ground elevation, or to an elevation acceptable to the Department Representative. CSL tubes shall also extend as close to the bottom of drilled pile holes as possible and in no case be more than 150 mm from the bottom. CSL tubes shall be capped to prevent debris from entering the access tubes.

The Contractor shall ensure that CSL tubes are not damaged during the installation of the reinforcement cage. CSL tubes shall be filled with water to prevent damage during concrete placement. The water shall be a minimum of 4°C immediately prior to concrete placement. Special care shall be taken to avoid debonding between the concrete and the tubes. If CSL tube debonding occurs or test equipment does not pass through the entire length of the CSL tube, the Contractor shall core drill a 50 mm diameter hole to the depth of debonding or blockage for each affected CSL tube at a location acceptable to the Department Representative.

The Contractor shall take and record CSL measurements at depth intervals of 50 mm from the bottom of the tubes to the top of each pile.

The Contractor shall submit the CSL testing report to the Department Representative within 5 days of CSL testing completion. The CSL testing report shall include test summaries, results in graphical and tabular form, analyses, and an opinion of the pile concrete's integrity and suitability for the intended use. Test summaries shall be in accordance with the criteria listed in Table 3-1, CSL Condition Ratings.

Table 3-1 CSL Condition Ratings

Condition Rating	Velocity Reduction	CSL Results
Good (G)	≤ 10%	Good quality concrete.
Questionable (Q)	>10% & <20%	Minor contamination or intrusion. Questionable quality concrete.
Poor/Flaw (P/F)	≥ 20% & <30%	Flaws exists, possible water/slurry contamination, soil intrusion and/or poor quality concrete.
Poor/Defect (P/D)	≥ 30%	Defects exists, possible water/slurry contamination, soil intrusion and/or poor quality concrete.
No Signal (NS)	No Signal Received	Soil intrusion or other severe defect absorbed the signal.

Velocity reduction criteria outlined in Table 3-1, CSL Condition Ratings, shall be from the highest measured signal velocity in the comparable zone.

Piles with condition ratings other than "G" will be considered unacceptable and will result in rejection. If the Contractor elects to carry out further investigation to provide supplemental information of the pile's integrity, the flawed and/or defective zones shall be evaluated using cross-hole tomography, concrete coring, and any other testing required by the Department Representative. Low strain impact integrity testing/pile integrity test (PIT), encompassing the pulse echo method and the transient response method, may only be used in addition to cross-hole tomography, and concrete coring. The Department Representative in consultation with the independent CSL testing agency's Engineer will determine the depth, location, diameter and number of cores to be extracted. If the Department Representative determines the use of a borehole video inspection equipment for inspection is also required, large diameter cores may be required. A minimum of 2 cores will be required to intercept the suspected flaw or defect zones.

When the Department Representative determines a drilled pile is unacceptable, the Contractor shall submit a repair procedure with supporting design calculations and drawings to the Department Representative for review and acceptance a minimum of 2 weeks prior to commencement of the repair work. The repair procedure, supporting design calculations and drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The pile will not be considered acceptable until all repair work has been completed, reviewed and accepted by the Department Representative.

Upon completion of CSL testing by the Contractor and acceptance of the pile concrete by the Department Representative, the CSL tubes shall be filled with grout. The grout shall have the equivalent compressive strength and durability properties as the pile concrete. The grout mix design shall be submitted to the Department Representative for review and acceptance a minimum of 2 weeks prior to commencement of the work. The Contractor shall not grout the CSL tubes or perform any further work on the CSL tested drilled piles until the Department Representative has reviewed and accepted the drilled pile.

3.4.3.4 Cold Weather Conditions

When the ground temperature against which pile concrete is placed is below -5°C, the pile hole shall be hoarded and heated until the ground temperature is warmer than 10°C or oversized by 100 mm. Immediately after placing and finishing the pile concrete, the top exposed surface shall be protected with insulated tarps or other means to adequately cure the concrete for a period of 7 days. If the top of the pile extends above the ground surface it shall be protected in accordance with Section 4, Cast-In-Place Concrete.

3.4.3.5 Drilled Pile Installation Tolerances

Piles shall be installed with a variation not exceeding more than 50 mm from the horizontal position shown on the Drawings.

Piles shall be installed with a variation not exceeding more than 20 mm per metre from the vertical alignment shown on the Drawings.

Projecting reinforcing steel shall be installed with a variation not exceeding more than 10 mm in any direction from the position shown on the Drawings.

If tolerances are not met, the Contractor shall make immediate changes to their piling procedures. Any pile out of the specified tolerance shall be corrected at the Contractor's expense to the satisfaction of the Department Representative.

3.4.3.6 Drilled Pile Cut-Off Elevation

After all drilled piles have been constructed, reviewed and accepted by the Department Representative, the Contractor shall remove all laitance, unsound concrete, or other deleterious material from concrete surfaces as determined by the Department Representative and in accordance with Subsection 4.22, Concrete Removal and Surface Preparation, to elevation specified on the Drawings.

3.4.4 Defective Piles

Manipulation of reinforcement to adjust position, considered by the Department Representative to have the potential to damage the pile integrity, will not be permitted.

A decrease in concrete elevation at the top of a completed pile of more than 2% of the pile diameter between the time of initial pour and set will be considered a damaged pile.

Piles damaged during drilling, reinforcing steel cage installation, or concrete placement shall be repaired by the Contractor at their expense. The Contractor shall submit a repair procedure to the Department Representative for review and acceptance before any further piling is installed. The Contractor's repair procedures, as a minimum, shall include one of the following:

- The defective pile(s) shall be re-drilled and replaced by new, and if necessary, longer piles;
- Concrete removal and replacement;
- The defective piles shall be built up; or
- The pile cap extended and reinforced to the satisfaction of the Department Representative.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

3.5 Pile Capacity Testing and Reporting

3.5.1 Static Load Testing

When specified in the Contract, Static Load testing shall be completed by an independent testing agency specializing in this type of Work. The independent testing agency shall be engaged by the Contractor and supply and install all testing equipment and analyze the test results in accordance with these specifications. The Contractor shall be responsible to coordinate and manage all associated static load testing activities.

Static load testing and reporting shall be completed in accordance with ASTM D1143/D1143M for piles subjected to axial compressive loads and ASTM D3689/D3689M for piles subjected to axial tensile loads and as outlined in the Contract documents.

As a minimum, the report shall include the following:

- Site plan showing locations of test pile and nearest test holes;
- Test hole logs and summary of subsurface conditions;
- Type and dimensions of test and reaction piles;
- Test pile material including basic specifications;
- Pile installation details;
- Final pile top and tip elevations;
- Ground surface elevation;

- Date and type of load test;
- Temperature and weather conditions during the test;
- Description of instrumentation used to monitor pile performance during testing including their locations;
- Description of test setup and testing procedures;
- Tabulation of time, load, and displacement readings;
- Interpretation and analyses of test results including failure load and the criterion used to estimate it, shaft friction, and end bearing resistance (as applicable);
- Pile load-movement curve; and
- Pile time-load and time-movement curves.

The static load test report shall be submitted to the Department Representative for review and acceptance within 7 days of completion of testing.

Bi-directional static load (osterberg) or rapid load (statnamic) tests may be proposed by the Contractor in substitution for conventional static load testing. Osterberg tests shall conform to ASTM D1143/D1143M using the Quick Load Test Method for Individual Piles. Statnamic tests shall conform to ASTM D7383. The Contractor shall submit details of all proposed testing measures in their piling plan to the Department Representative for review and acceptance.

The Contractor shall have no claim against the Government of the Northwest Territories for any inconvenience or delay resulting from these requirements.

3.5.2 High Strain Dynamic Load Testing - Pile Driving Analysis (PDA Testing)

When specified in the Contract, PDA testing shall be completed by an independent testing agency that has specialized in this type of Work for a minimum of 5 years. The independent testing agency shall be engaged by the Contractor and supply and install all testing equipment and analyze the test results in accordance with these specifications. The Contractor shall be responsible to coordinate and manage all associated PDA testing activities.

The Contractor shall provide the Department Representative a minimum of 1 week advance notice of any scheduled PDA testing. PDA testing of re-strikes shall be completed at date and time acceptable to the Department Representative.

The Department Representative will evaluate and may revise set criteria and tip elevation requirements of the remaining piles based on information obtained by the PDA testing completed.

3.5.2.1 Testing Requirements

PDA testing shall be completed in accordance with ASTM D4945.

The impact device used for PDA testing shall be acceptable to the Department Representative and capable of mobilizing the ultimate pile capacity in a single blow without additional data interpretation.

Unless otherwise specified in the Contract, the number of PDA tests to be completed for each foundation element shall be the greater of 2 piles or 15% of the total piles. For pile walls with more than 40 piles, the greater of 6 piles or 10% of the total piles in each wall shall be PDA tested.

PDA testing shall occur on the test piles and the remaining piles as identified by the Department Representative for each foundation element. PDA testing shall be completed at the end of initial driving and upon re-strike when re-striking is specified in the Special Provisions of the Contract. The required pile set-up time until re-strike occurs, and all associated details will also be outlined in the Special Provisions of the Contract.

The Contractor shall include any costs associated with re-striking in the unit price bid and shall have no claim against Government of the Northwest Territories resulting from any delays caused by these requirements. If re-striking test results do not meet the specified requirements, the Contractor shall continue pile driving until results acceptable to the Department Representative are achieved.

Additional PDA testing may be required when driven piles exhibit lower capacity and/or shorter penetrations than specified or cast-in-place piles encounter ground water, or piling equipment or procedures change. The Department Representative will determine the scope and number of additional PDA tests to be completed and this additional testing will be paid for at the unit price bid.

If the Contractor demobilizes from the foundation element before the Department Representative's acceptance is received, all remobilization and associated costs will be at the Contractor's expense.

The Contractor shall have no claim against the Government of the Northwest Territories for any inconvenience or delay resulting from these requirements.

3.5.2.2 Reporting Requirements

The independent testing agency shall provide a daily field log and electronic PDA test data in a format acceptable to the Department Representative within 24 hours of testing. The daily field log shall summarize preliminary test results including driving stresses, transferred energy and estimated pile capacity. Upon review of the electronic PDA data and daily field log(s), set criteria and tip elevations may be revised by the Department Representative.

The independent testing agency shall also provide a summary letter report that includes complete PDA test results and analysis for each foundation element tested. The summary letter report(s) shall be prepared in accordance with the requirements of ASTM D4945 and these specifications. As a minimum, the summary letter report shall include the following:

- Pile and driving system information;
- Pile installation data;
- PDA testing equipment and procedure;
- Energy imparted;
- Maximum driving stresses;
- Hammer blow rate;
- Signal matching input parameters including quake and damping factors; and
- Shaft friction, end bearing and total pile capacity.

The PDA summary letter report(s) will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut employed by the independent testing agency and validated by a Responsible Member, in accordance with NAPEG requirements. The summary letter report(s) shall be submitted to the Department Representative for review and acceptance within 3 days of PDA testing completion for each foundation element. The Department Representative will provide the Contractor written acceptance and/or a list of items requiring revision and resubmission of the summary letter report(s) within 3 business days of its receipt.

3.6 Measurement and Payment

3.6.1 Driven Piles

3.6.1.1 Supply of Piling

Measurement for payment of supply of piling will be by the metre of piling acceptably supplied, measured to the nearest 0.1 m.

The quantity to be paid will be the length of piling acceptably driven and remaining in the completed structure. Where portions of steel piling are specified to be galvanized, only the specified lengths requiring galvanizing will be included in the quantity to be paid.

Payment will be made at the unit prices bid for "Supply of Piling", for each type and size of piling specified, and will be full compensation for the supply of the piling; loading; delivery; and unloading of the material to the project site; and all labour, equipment, tools and incidentals necessary to complete the Work.

All costs associated with the supply, fabrication and installation of welded end plates for closed-ended pipe piles will be considered incidental to the Work, and no separate or additional payment will be made.

3.6.1.2 Pile Set-up

Payment will be made at the unit prices bid per pile for "Pile Set-up", for each specified type and size of piling, and will be full compensation for the supply, fabrication and installation of driving frames; pile set-up including setting the equipment over the pile ready to commence pile driving; and all labour, equipment, tools and incidentals necessary to complete the Work.

Payment will be made only once for each acceptably driven pile. All costs associated with pile set-up for pile restrikes, as determined necessary by the Department Representative, will be considered incidental to the Work, and no separate or additional payment will be made.

3.6.1.3 Pile Driving

Measurement for payment of pile driving will be by the metre of piling acceptably driven and remaining in the completed structure, measured to the nearest 0.1 m.

The quantity to be paid will be the actual measured length of piling acceptably driven and remaining in the completed structure.

Payment will be made at the unit prices bid for "Pile Driving", for each specified type and size of piling, and will be full compensation for handling; driving; splicing; cutting; and all labour, equipment, tools, and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

3.6.1.4 Pile Tip Reinforcement

Payment will be made at the unit price bid per pile for "Pile Tip Reinforcement" and will be full compensation for the supply and installation of pile tip reinforcements, including all labour, equipment, tools and incidentals necessary to complete the Work.

3.6.1.5 Pile Splicing

Where piles penetrate 20% deeper than the design pile tip elevation shown on the Drawings, splicing will be paid for at the assigned unit price for pile splicing and will include all labour, materials, equipment, tools and incidentals necessary to complete the work. Only one splice will be paid for each pile.

The unit price assigned for pile splicing shall be as follows:

- H-Piles: $1,000 per splice;
- Pipe Piles: $1,200 per splice.

3.6.1.6 Restocking of Piling

When the total Contract quantity of steel piling is reduced by 20% or more, the Government of the Northwest Territories will make payment for verifiable re-stocking costs for each 12 m or longer length of piling incurred by the Contractor.

The Contractor shall present project material tracking system records, dates, quantities, supplier invoices, and all other supporting documentation requested by the Department Representative. Payment will only be made for piles supplied to the project site and at industry standard re-stocking rates acceptable to the Department Representative.

3.6.1.7 Pile Concrete

Payment for pile concrete will be made in accordance with Section 4, Cast-In-Place Concrete.

3.6.1.8 Reinforcing Steel

Payment for reinforcing steel will be made in accordance with Section 5, Reinforcing Steel.

3.6.2 Drilled Cast-In-Place Concrete Piles

3.6.2.1 Drill Rig Set-up

Payment will be made at the unit prices bid per pile for “Drill Rig Set-up”, for each specified type and size of the drilled pile and will be full compensation for setting the equipment over the pile ready to commence drilling; supply, installation and removal of temporary casings; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

3.6.2.2 Pile Installation

Measurement for payment of pile installation will be by the metre of drilled piles acceptably installed, measured to the nearest 0.1 m.

The quantity paid for will be the actual measured length from the pile tip to the underside elevation of the pile cap or abutment seat, as applicable.

Payment will be made at unit prices bid for "Pile Installation", for each specified type and size of the drilled pile, and will be full compensation for drilling pile holes to the elevations and dimensions shown on the Drawings; supply and installation of composite H-pile steel sections, if specified; removal and disposal of pile hole tailings; detection and purging of hazardous gases; borehole video inspection; dewatering and cleaning of pile holes as required; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

All costs associated with crosshole sonic logging and any associated repair work required will be considered incidental to the Work, and no separate or additional payment will be made.

No payment will be made for CSL tested drilled cast-in-place concrete piles until the pile tested has been reviewed and accepted by the Department Representative.

3.6.2.3 Pile Concrete

Payment for pile concrete will be made in accordance with Section 4, Cast-In-Place Concrete.

No payment will be made for CSL tested drilled cast-in-place concrete piles until the pile tested has been reviewed and accepted by the Department Representative.

3.6.2.4 Reinforcing Steel

Payment for reinforcing steel will be made in accordance with Section 5, Reinforcing Steel.

No payment will be made for CSL tested drilled cast-in-place concrete piles until the pile tested has been reviewed and accepted by the Department Representative.

3.6.3 Static Load Testing

Payment for static load testing will be made at the unit price bid per test for "Static Load Testing", and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the testing to the satisfaction of the Department Representative.

3.6.4 PDA Testing

Payment for PDA testing will be made at the unit price bid per test for "PDA Testing", and will be full compensation for testing, re-striking, electronic data, reporting; and all labour, materials, equipment, tools and incidentals necessary to complete the testing to the satisfaction of the Department Representative.

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4.1 General

This specification includes requirements for the production, handling, sampling and testing, transporting, placing, curing, finishing and quality of cast-in-place concrete. Pre-bagged concrete shall not be used unless specifically allowed for in these specifications or in the contract documents. if pre-bagged concrete is approved, all work shall be in accordance with Sections 20.5.6.1, Pre-bagging for Site Batching, and 20.5.6.2, Concrete Mixer Trucks and Water Supply for Site Batching.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

4.2 Materials

Materials originating from outside Canada or the United States of America intended for use in the production of concrete shall be tested by a certified laboratory in Canada or the United States of America by testing the material to the specified material standards. The testing laboratory shall be certified to CSA A283 or AASHTO Accreditation Program (AAP) for the tests required. Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable material test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

4.2.1 Hydraulic Cement

Hydraulic cement shall conform to the requirements of CSA A3001. General Use (Normal) Type GU, or High Sulphate Resistant Type HS, or HSb shall be supplied unless otherwise specified.

As an alternative to Type HSb cement, concrete intended for placement in sulphate environments may be produced with combinations of Type GU cement and supplementary cementing materials provided current CSA A3004-C8 test data demonstrating compliance with CSA A3001 requirements for high sulfate resistance.

The use of Type GUL cement is forbidden, unless otherwise specified or specifically allowed for by the Department Representative.

4.2.2 Supplementary Cementing Materials

4.2.2.1 Silica Fume

Silica fume shall conform to the requirements of CSA A3001 for a Type SF supplementary cementing material, with a minimum SiO_2 content of 85%, a maximum loss on ignition of 10% and maximum SO_3 content of 1%.

4.2.2.2 Fly Ash

Fly ash shall conform to the requirements of CSA A3001 for Type F fly ash with a maximum calcium oxide (CaO) content of 15%.

4.2.3 Water

Water to be used for mixing concrete, approved concrete patching materials, or concrete finishing materials, shall conform to the requirements of CSA A23.1 and shall be free from harmful amounts of alkali, organic materials or deleterious substances. The Contractor shall not use slurry water, treated wash water or water from shallow, stagnant or marshy sources.

4.2.4 Aggregates

Fine and coarse aggregates shall conform to the requirements of CSA A23.1.

4.2.5 Admixtures

Admixtures shall be compatible with all mix constituents. Water reducing agents and superplasticizers shall conform to ASTM C494/C494M. The addition of calcium chloride, air reducing/detraining agents or accelerators will not be permitted. Air entraining agents shall conform to ASTM C260/C260M.

The use of hydration stabilizing admixtures requires prior written acceptance of the Department Representative and their usage is limited to those projects where haul times are expected to exceed the specified times and/or projects which require hydration stabilization due to mass concrete or pile concrete placement considerations. Hydration stabilizing admixtures shall meet the requirements of ASTM C494/C494M Type B and/or Type D.

Anti-washout admixtures shall conform to the US Army Corps of Engineers CRD-C 661.

The use of workability retaining admixtures requires prior written acceptance of the Department Representative. Workability retaining admixtures shall meet the requirements of ASTM C494 Type A and/or S and be listed on the Ministry of Ontario's Designated Source of Materials (DSM) List # 9.25.10 Concrete Admixtures, Chemical and Superplasticizing - Workability Retaining Admixture.

4.2.6 Steel Fibres

When specified, steel fibres shall conform to ASTM A820/A820M Type 1 or 5 and be 50 mm in length with the aluminum content no more than 0.020% by mass, when tested in accordance with the United States Environmental Protection Agency (USEPA) Test Method 3050B.

Steel fibres shall be free from balls and clumps at all times during their use in the work.

4.3 Storage of Materials

Cement, silica fume, fly ash and steel fibres shall be stored separately in a suitable weather tight building which shall protect these materials from moisture. Cement, silica fume and fly ash shall be free from lumps at all times during their use in the work.

Fine and coarse aggregates shall be stored separately. Aggregates secured from different sources shall be stored in separate stockpiles. The site of the stockpiles shall be cleaned of all foreign materials and shall be level and firm. If aggregates are placed directly on the ground, material within 150 mm of the ground level shall not be used and this material shall remain undisturbed to avoid contaminating the aggregate being used with the ground material.

All aggregates shall be handled in a manner that prevents segregation.

4.4 Class and Composition of Concrete

4.4.1 Class of Concrete

Table 4-1 Classes of Concrete

Class of Concrete[9]	Minimum Specified Compressive Strength at 28 Days (MPa)	Nominal Maximum Aggregate Size(mm)	Range of Slump [6] (mm)	Total Air Content [5] (%)	Max. Water/ Cementing Materials Ratio
C [4]	35	20 to 5 [1]	100 ±30	5 - 8	0.40
HPC [3,7,8]	45	20 to 5 [2]	120 ±30	5 - 8	0.38
D [4]	30	14 to 5	100 ±30	5 - 8	0.42
S [4]	20	20 to 5 [1]	100 ±30	5 - 8	0.50
Pile [4,10]	30	20 to 5 [1]	130 ±30	5 - 8	0.42

Notes:

(1) 28 to 5 mm nominal maximum coarse aggregate size may be considered for Class C, Class S, and elements considered mass concrete.
(2) When the thickness of deck overlay concrete is specified as 50 mm or less, the nominal maximum top size of aggregate shall be 14 mm.
(3) Class HPC concrete shall be used for all decks, deck overlays with internal reinforcement, curbs, barriers, medians, roof slabs, deck joint blockouts, approach slabs and MSE wall coping. Deck overlay concrete shall be Class HPC with steel fibres when no internal reinforcement exists.
(4) Fly ash shall not exceed 30% by mass of cementing materials.
(5) Range in air content shall be in accordance with CSA A23.1-19 Table 4 Category 1 based on the nominal maximum aggregate size of the concrete mix design.
(6) Modification to slump ranges may be proposed by the Contractor and shall be included in the mix design review letter submitted to the Department Representative for review and acceptance.
(7) For MSE Wall panels a smaller nominal maximum size aggregate may be considered.
(8) Class HPC and Class HPC with Steel Fibres shall also meet the requirements specified in Subsection 4.4.1.2, Class HPC and Class HPC with Steel Fibres.
(9) Sulphate resistance and/or other required project specific performance properties will be outlined on the Drawings and/or Special Provisions of the Contract.
(10) The proposed used of hydration stabilizing admixtures will be acceptable; however, the design time period of hydration stabilization shall be proposed by the Contractor and included in the concrete mix design review letter submitted to the Department Representative for review and acceptance.

4.4.1.2 Class HPC and Class HPC with Steel Fibres

Class HPC and Class HPC with Steel Fibres shall meet the following requirements:

- Mix shall include silica fume and fly ash as supplementary cementing materials in combination with compatible air entraining, water reducing and/or superplasticizing admixtures, as required;

- The gradation limits for fine aggregate shall conform to CSA A23.1 FA1 except that the material finer than 160 µm shall not exceed 7%. For fine aggregate FA1 with 5 to 7% material finer than 160 µm, the shrinkage after 28 days of drying and concrete age of 35 days shall not be greater than 0.060% in prisms with a cross-section of 75 x 75 mm. For fine aggregate FA1 with less than 5% material finer than 160 µm, shrinkage testing shall be reported for prisms with a cross-section of 75 x 75 mm;
- Coarse aggregate shall conform to CSA A23.1 and the maximum combination of flat and elongated particles (4:1 ratio), as determined by CSA A23.2-13A Procedure A, shall not exceed 10% of the mass of coarse aggregate;
- Minimum type GU hydraulic cement content (excluding supplementary cementing materials) shall be 335 kg/m^3. The C_3A content of hydraulic cements shall be greater than or equal to 4.0%;
- Sum of silica fume and fly ash by mass of cementing materials shall be within the range of 17 to 20%;
- Silica fume by mass of cementing materials shall be within the range of 6 to 8%;
- Fly ash by mass of cementing materials shall within the range of 11 to 15%;
- Resistance to chloride ion penetration shall be determined in accordance with ASTM C1202 on duplicate laboratory moist cured samples at 28 days. The average of all tests shall not exceed 1000 coulombs with no single test greater than 1250 coulombs. When only 2 test values are used to calculate the average coulomb rating, no test shall exceed 1000 coulombs. For Class HPC with steel fibres, testing shall be done without the presence of steel fibres;
- An air-void spacing factor shall be determined in accordance with ASTM C457/C457M, modified point-count method at 100 times magnification. The average of all tests shall not exceed 230 µm with no single test greater than 260 µm. When only 2 test values are used to calculate the average air-void spacing factor, no test shall exceed 230 µm. The minimum hardened air content shall be 3.0%; and
- When Class HPC with steel fibres is specified, it shall contain 60 kg of 50 mm long steel fibres, per m^3. The Contractor shall submit test results of the aluminum content in the steel fibres to the Department Representative for review and acceptance, a minimum of 2 weeks prior to placing concrete at site. The dosage rate of the proposed steel fibres shall be determined in accordance with ASTM C1609/C1609M. The toughness (T^D_{600}) shall be greater than or equal to that determined for the specified fibre type and dosage rate.

4.4.1.3 Mass Concrete

If in the Special Provisions of the Contract a concrete element has been designated as mass concrete, the Contractor shall develop and submit a mass concrete thermal control plan, including thermal mitigation measures, to the Department Representative for review and acceptance. The mass concrete thermal control plan shall be submitted a minimum of 4 weeks prior to the commencement of mass concrete placement. The mass concrete thermal control plan will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The mass concrete thermal control plan shall be in accordance with CSA A23.1 Subsection 7.6.3.4, Thermal Control Plan. Thermal control mitigation measures shall be developed and consistent with the technical requirements outlined in the CSA A23.1 Annex T, Subsection T.5 Thermal Control Planning and the American Concrete Institute (ACI) 207.4R, Cooling and Insulating Systems for Mass Concrete. The mass concrete thermal control plan shall also describe the performance monitoring requirements and on-site response strategies to address varying thermal conditions.

Trial batch testing shall be completed in accordance with Subsection 4.4.4, Trial Batches and results summarized and included on the concrete mix design review letter.

4.4.2 Concrete Temperature at Discharge

The concrete temperature shall be between 10°C and 20°C, at discharge for Class HPC and Class HPC with steel fibres. The concrete temperature at discharge shall be between 10°C and 25°C for all other classes of concrete. The concrete temperature at discharge for mass concrete shall be as indicated in the mass concrete thermal control plan reviewed and accepted by the Department Representative.

4.4.3 Concrete Mix Design Submission Requirements

The Contractor shall submit a concrete mix design review letter for each class of concrete specified in the Contract for the Department Representative's review and acceptance a minimum of 2 weeks prior to concrete placement. For concrete mix designs that require a trial batch, the mix design review letter shall be submitted a minimum of 7 weeks prior to concrete placement.

A concrete mix design review letter is not required for concrete used in the construction of culvert collars or cut-off walls when culverts are less than 3000 mm in diameter.

Concrete mix design review letters shall document compliance with all specification requirements for the associated class of concrete including an evaluation and summary of all mix constituents, material test reports, mix proportion quantities, and if applicable, mass concrete design considerations, and portable batch plant batching procedures.

The concrete mix design review letter will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut who is employed by an independent concrete testing laboratory certified to CSA A283 and validated with the firm's Permit to Practice stamp, issued by NAPEG.

Alternatively, the concrete mix design review letter may be authenticated by both a concrete mix design engineer and concrete mix design check engineer who are both Professional Engineers licensed to practice in the Northwest Territories and employed by a concrete supplier that maintains a concrete testing laboratory certified to CSA A283. The concrete supplier's design engineer and check engineer shall maintain separate signed and sealed design notes and check notes. The design and check notes shall be in a legible and logical format, clearly identifying material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used, if required. The design notes and check notes will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. Design and check notes shall be provided to the Department Representative upon request.

When concrete suppliers request confidentiality of mix proportion quantities, the reviewing Professional Engineer, subject to a mutually agreeable confidentiality agreement with the concrete supplier, shall be granted full disclosure of mix proportion quantities such that a general mix proportioning discussion can be provided in the mix design review letter.

Material test reports shall be current and fully represent materials to be used in production.

For each mix design submission, the source(s) of proposed aggregate(s) and aggregate analysis shall be provided as required in Table 4-2, Aggregate Analysis.

Table 4-2 Aggregate Analysis

Aggregate Analysis	Standard	Required Frequency of Analysis (max. days prior to & during production)
Fine and Coarse Aggregate Sieve	(CSA A23.2-2A) (2)	90
Amount of material finer than 80 µm in aggregate	(CSA A23.2-5A) (2)	90
Organic Impurities in Sands for Concrete	(CSA A23.2-7A) (2)	90
Results of deleterious substances and physical properties of aggregates	(CSA A23.1-19 Table 12, CSA A23.1; CSA A23.2-3A, CSA A23.2-4A, CSA A23.2-13A Procedure A, CSA A23.2-23A, CSA A23.2-24A, CSA A23.2-29A) (1)	180
Potential expansivity of aggregates	(CSA A23.2-14A) (1)	24 months
Detection of alkali-silica reactive aggregate by accelerated expansion of mortar bars	(CSA A23.2-25A) (1)	12 months
Petrographic Examination of Coarse and Fine Aggregate for Concrete	(CSA A23.2-15A) (1)	180

Notes:

(1) Sampling and testing of aggregates shall be completed by a concrete testing laboratory certified to CSA A283.
(2) Sampling and testing of aggregates may be completed by a concrete testing laboratory certified to CSA A283 or by the aggregate supplier.

A break in production of a particular class of concrete shall not constitute the need for additional testing when the Contractor provides aggregate sieve analysis, organic impurities in sands for concrete, petrographic examination of aggregates, and letter of evaluation from the mix design review letter professional indicating that the material initially tested is still representative. Additional analyses shall be provided by the Contractor when requested by the Department Representative to confirm that the mix constituents continue to meet specification requirements.

If the fine aggregate consists of a blend from more than one source, the fine aggregate sieve analysis shall show the gradation of the blended fine aggregates. Similarly, in the case of blended coarse aggregates, the coarse aggregate sieve analysis shall indicate the gradation of the blended coarse aggregates.

Fine aggregate, tested in accordance with CSA A23.2-7A, shall produce a colour not darker than the Standard colour (Organic Plate Number 3). Aggregate producing a colour darker than the Standard colour will be rejected in the absence of a satisfactory record of performance of a similar CSA exposure class of concrete (minimum 30 tests over the last 12 months); CSA A23.1-19 Provisions 4.2.3.3.3.2 (a) & (b) shall not apply. When testing in accordance with CSA A23.2-2A and CSA A23.2-5A fine aggregate shall not have more than 3.0% passing 80 µm sieve.

The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-27A. Test data less than 24 months after date of sampling shall be used to evaluate the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-14A or CSA A23.2-25A. Testing in accordance with CSA A23.2-28A may be utilized as part of the alkali-aggregate reactivity assessment. In the absence of test data, the aggregate shall be presumed to be highly reactive. The level of risk for alkali-aggregate reactivity assessment shall be for concrete exposed to humid air and the design service life shall be greater than or equal to 75 years (St4).

When assessing mitigation in accordance CSA A23.2-27A, fly ash with a CaO content within the range of 12 to 15% shall be considered a Type CI fly ash unless supported by 2 year concrete prism data tested in accordance with CSA A23.2-14A using coarse and fine aggregate representative of the intended sources for use in the project and proportioned in accordance with the concrete mix design review letter.

Petrographic analysis on the proposed fine and coarse aggregates shall be performed in accordance with CSA A23.2-15A by experienced personnel employed by a laboratory certified to CSA A283. The weighted petrographic number of the coarse aggregate shall not exceed 130, and the ironstone content shall not exceed 0.8%. Ironstone content in fine aggregate (material retained on the 2.5 mm sieve) shall not exceed 1.5% by total dry mass of fine aggregate for all classes of concrete except pile concrete. The petrographic analysis report will be considered a Professional Work Product and shall be authenticated by a Professional Engineer, or a Professional Geoscientist licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

4.4.4 Trial Batches

The Contractor is required to complete a trial batch for Class HPC, Class HPC with Steel Fibres, any class of concrete containing hydration stabilizing admixtures, mass concrete, and/or any class of concrete produced from a portable batch plant.

The trial batch shall only occur after the mix design review letter has been reviewed and accepted by the Department Representative. The trial batch shall be performed a minimum of 35 days prior to placement of concrete at site. Written notification of the trial batch schedule shall be provided to the Department Representative a minimum of 1 week prior to commencement of the trial batch.

Each trial batch shall be a minimum of 3 m^3 or 50% of the rated mixer capacity (whichever is greater). The Contractor's quality representative and superintendent shall attend all trial batches. The Contractor's ACI certified concrete finisher/journeyman concrete finisher shall also attend Class HPC or Class HPC with Steel Fibres trial batches to assess workability and finishability.

Sampling and testing of concrete completed for trial batches shall be completed in accordance with Subsection 4.9, Inspection and Testing. An independent testing laboratory certified to CSA A283 shall complete all hardened concrete testing in accordance with the specified material reference standards.

The Contractor shall submit all trial batch test results to the Department Representative and the mix design review professional within 3 business days of being completed. If changes to the concrete mix design are required due to unsatisfactory performance of the trial batch, as determined by the Department Representative, the mix design review letter shall be updated and resubmitted to the Department Representative for review and acceptance and trial batch testing completed again.

For projects with a duration longer than 12 months, all trial batch testing shall be repeated annually except for mass concrete which will not be required to be repeated every 12 months.

4.4.4.1 Class HPC and Class HPC with Steel Fibres

Trial batch testing for slump, air content, and temperature shall be recorded at 15, 30, 50, and 70 minutes after batching. The slump, air content, and temperatures of the trial batch concrete shall be within the specified range at the anticipated time of haul. Slump retention after 50 minutes shall be at least 50% of that measured at 15 minutes.

At 70 minutes from the time of batching, samples shall be cast to determine compressive strength at 7 and 28 days, resistance to chloride ion penetration, and hardened air void system in accordance with the requirements of Subsection 4.4.1.2, Class HPC and Class HPC with Steel Fibres.

Shrinkage of the trial batch concrete shall be measured in accordance with CSA A23.2-21C. Shrinkage test results shall be submitted to the Department Representative within 7 days of test completion.

The trial batch concrete shall be placed into a 4.5 m x 4.5 m x 0.15 m thick formwork on grade for constructing of a trial batch slab. For MSE wall precast concrete fascial panels the trial batch may be used to produce a trial panel in the production formwork. Concrete shall be placed into the formwork after 70 minutes from the time of batching or the design length of hydration stabilization, if applicable. The Contractor shall consolidate, screed and finish the trial batch concrete such that the workability and finishability of the concrete can be assessed in accordance with the specified requirements. The specified concrete surface finish shall be completed by the Contractor's finishers in the presence of the Department Representative for review and acceptance. For projects with a duration longer than 12 months, construction of a trial batch concrete slab to assess the concrete mix's workability and finishability may not be required in each of the following years, as determined by the Department Representative.

4.4.4.2 Hydration Stabilized Concrete Mixes

The design length of hydration stabilization shall be the difference of the project haul time and the specified allowable haul time (not exceeding 90 minutes) or that required by mass concrete or pile concrete placement considerations. The hydration stabilized mix design, including a detailed concrete batching procedure, shall be submitted and reviewed in accordance with Subsection 4.4.3, Concrete Mix Design Submission Requirements. Hydration stabilized concrete mixes demonstrating significant inconsistencies, as determined by the Department Representative, shall require additional trial batch testing to demonstrate compliance.

The Contractor shall also submit a summary of the estimated time for hauling, placing, finishing, and implement of curing measures for deck and deck overlay concrete to the Department Representative for review and acceptance. The estimated time periods shall be consistent with the trial batch concrete's setting characteristics and acceptable to the Department Representative.

Workability including, slump and air content, shall be assessed at 30 minutes after batching, quarter points of the design hydration stabilization period and at the design period. Testing to determine setting characteristics, compressive strength at 3, 7, and 28 days and hardened air void system shall be completed. Setting characteristics shall be determined in accordance with ASTM C403/C403M and the time required to achieve penetration resistances of 0.5 MPa, 1.0 MPa and 3 MPa reported. Hardened air void systems shall meet the requirements of Subsection 4.4.1.2, Class HPC and Class HPC with Steel Fibres. Class HPC and Class HPC with steel fibres trial batches shall also meet the requirements for rapid chloride permeability. Shrinkage results shall be provided to the Department Representative within 7 days of test completion.

4.4.4.3 Mass Concrete Mixes

The predicted adiabatic temperature rise of the class of concrete shall be reported in the concrete mix design review letter. The method used to determine the predicted adiabatic temperature rise shall be in accordance with CSA A23.1 Annex T, Subsection T.3.2.2, Adiabatic Testing, or CSA A23.1 Annex T, Subsection T.3.2.3, Semi-Adiabatic Testing and conducted during the trial batch.

Workability retention including, slump and air content, shall be assessed at 15 minutes after batching, quarter points of the time of haul and at the end of time of haul. Testing to determine setting characteristics, and compressive strength at 3, 7, and 28 days shall be completed. If the mass concrete mix has a hydration stabilizing admixture, trial batching to assess workability retention shall be in accordance with Subsection 4.4.4.2, Hydration Stabilized Concrete Mixes.

4.4.5 Mix Adjustments

Only the addition of air entrainment and/or superplasticiser admixtures to the concrete batch will be permitted on site and when reviewed and accepted by the Department Representative. The sequence of addition and quantities shall be in accordance with the requirements of the reviewed and accepted concrete mix design review letter.

If during the progress of the work the concrete produced in accordance with the reviewed and accepted mix design is modified or found to be unsatisfactory on the basis of specification requirements or performance concerns identified by the Department Representative, the Contractor shall resubmit a revised mix design review letter, in accordance with the requirements of Subsection 4.4.3, Concrete Mix Design Submission Requirements, to the Department Representative for review and acceptance prior to continuing concrete operations. Discussion on the requirement for a new trial batch to address the issues identified shall be included in the revised mix design review letter.

4.5 Measurement of Materials

Coarse aggregates, fine aggregates, and each cementitious material shall be separated and weighed individually. The accuracy of measuring devices shall be such that successive quantities can be measured within ±1.0%.

Mixing water shall be measured by volume or by weight using a device accurate to within ±0.5%. Air entraining agent and other admixtures shall be added to the batch in a water diluted solution. The solution concentration shall be acceptable to the mix design review professional and the Department Representative.

4.6 Mixing Concrete

4.6.1 General

Mobile continuous mixers or other such volumetric concrete supply equipment shall not be used.

Portable batch plants may only be used when reviewed and accepted by the Department Representative. A comprehensive batching procedure shall be submitted to and reviewed by the mix design review professional in accordance with Subsection 4.4.3, Concrete Mix Design Submission Requirements. The concrete production rate shall be provided with the batching procedure.

Concrete shall be mixed thoroughly until it is uniform in appearance, with all ingredients uniformly distributed. The Department Representative may require that the uniformity of the mixed concrete be tested for conformance with CSA A23.1-19 Clause 5.2.4.5. The "Batch" will be considered the quantity of concrete inside the mixer regardless of the size of the mixer. The mixing period shall be measured from the time materials enter the mixing drum.

The Contractor shall in no case load the mixer above its rated capacity. The Contractor shall maintain the mixer in good condition. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar. Mixer blades which are bent or worn down so as to affect the mixing efficiency shall be renewed. Any mixer, leaking mortar or causing waste of materials through faulty charging shall be taken out of service until repaired. The Contractor shall, at all times, operate the mixer at the speed recommended by the manufacturer and shall, if requested, supply the manufacturer's certification of the mixing capacity of the machine in use.

The mixer shall be fitted with an accurate and dependable means for measuring the water added, which is not affected by variation in pressure in the water supply line. All joints, valves and other parts shall be maintained so that there is no leakage of water into the mixer drum. Failure of the Contractor to have an accurately working and dependable water gauge on a mixer shall be cause for the Department Representative to prohibit the mixer to be used.

Water shall be released first and continue to flow while other materials are entering the mixer. The water discharge pipe shall be so arranged and be of such size that the flow into the mixer is completed within the first quarter of the mixing time, and the water is delivered well within the mixer where it will be quickly mixed with the entire batch.

Air entraining agents and admixtures shall be placed in the mixer after the initial water is in the mixer drum and before the remaining materials are added. Superplasticizer shall be added after initial mixing and in accordance with the manufacturer's recommendation.

4.6.2 Truck Mixing

Truck mixers, unless otherwise authorized by the Department Representative, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure uniform distribution of materials throughout the batch. All materials for the concrete shall be accurately measured in accordance with Subsection 4.5, Measurement of Materials and charged concurrently into the drum at the production plant, at the proportions satisfying the accepted mix design. Increases in the water to cementitious materials ratio will not be permitted.

Maximum size of the batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped on the mixer. Truck mixing shall commence immediately upon introduction of ingredients into the drum and be continued for at least 70 revolutions with the mixing rate being in accordance with the manufacturer's recommended rate and shall be such as to thoroughly mix the concrete.

When adjustment to the mix by adding air entraining agent or superplasticizer at the site is authorized by the Department Representative, the mixer shall rotate for a minimum of 70 additional revolutions to ensure homogeneity of the concrete before discharge. Discharge chutes shall be kept clean and free from hardened concrete and shall be wet prior to use.

4.6.3 Time of Hauling

The maximum time allowed for all classes of concrete other than Class HPC and Class HPC with steel fibres including delivery to the site of the work and discharge shall not exceed 90 minutes after batching. For Class HPC and Class HPC with steel fibres this requirement is reduced to 70 minutes. In hot weather, or under conditions that accelerate setting of the concrete, these haul times may be reduced as determined by the Department Representative. Batching of all classes of concrete is considered to occur when any of the mix ingredients are introduced into the mixer drum, regardless of whether or not the drum is revolved.

4.7 Delivery

The Concrete supplier shall have sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that cold joints do not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of re-handling, and without damage to the structure or the concrete.

4.8 Pour Schedules

The Contractor shall inform to the Department Representative of the proposed pour schedule and production rates for all concrete pours a minimum of 3 days prior to commencement of the work. If, in the opinion of the Department Representative, the pour size is such that potential adverse effects could occur with the methods proposed, the Contractor shall:

- Limit the amount to be poured at any time (using construction joints at a location and in a manner acceptable to the Department Representative); or
- Revise the methods proposed to the satisfaction of the Department Representative.

4.9 Inspection and Testing

The Department Representative shall be afforded full facilities for the random quality assurance inspection and testing that may be carried out relative to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete wherever this may be situated. The facilities shall be adequate in the opinion of the Department Representative to permit proper sampling of concrete, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete test cylinders in accordance with the referenced standards is the responsibility of the Contractor.

The results of the quality assurance testing carried out by the Department Representative will serve to monitor and review the quality control program of the Contractor.

The Contractor shall utilize American Concrete Institute (ACI) or Canadian Council of Independent Laboratories (CCIL)/CSA certified field concrete testers independent of the concrete supplier with extensive related experience to test at site, the air content, density, slump and temperature of each batch. Results of all such tests shall be provided to the Department Representative. Additional tests will be required if the results are marginal or widely variable, as determined by the Department Representative. In case of an unacceptable result, one check test will be permitted. The certified testers shall also cast the concrete test cylinders as specified in Subsection 4.9.3, Test Cylinders.

The certified testers shall utilize the “Concrete Test Results” form contained at the end of this Section 4, Cast-In-Place Concrete. The completed forms shall accompany the concrete test cylinders to the testing laboratory.

The certification of the testers shall be current and available for examination by the Department Representative.

The Contractor shall be responsible for all costs for concrete inspection and testing, including but not limited to making and curing test cylinders, transporting cylinders to an independent certified testing laboratory of their choice, storage, curing, strength testing, and providing written reports of the concrete test results to the Department Representative.

4.9.1 Compressive Strength Tests

A compressive strength test shall consist of the four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standards and as modified herewith. One cylinder shall be tested at 7 days. The 28 day test result shall be the average of the strengths of the remaining three specimens, except that if any specimen in a test showing distinct evidence of improper sampling, moulding or testing, shall be discarded and the remaining strengths averaged. Additional cylinders may be cast, at the discretion of the Department Representative or Contractor.

For Class HPC the Contractor shall take a compressive strength test to represent each approximate 20 m^3 portion of the concrete pour, to a minimum of one compressive strength test for every 2 batches of concrete. For Class HPC with steel fibres the Contractor shall take a compressive strength test to represent each approximate 5 m^3 portion of the concrete pour or one compressive strength test for every batch of concrete, whichever is less. For all other concrete, the Contractor shall take a compressive strength test to represent each bridge element or portion of the element (i.e. foundation pile, abutment seat, abutment backwall, pier footing, pier cap etc.). On larger pours, a compressive strength test will be taken to represent each approximately 30 m^3 portion of the concrete pour, to a minimum of one compressive strength test for every three batches of concrete. Such tests shall be taken from representative batches as determined by the Department Representative.

4.9.2 Sampling

Sampling of concrete shall be carried out in accordance with CSA A23.2-1C, Sampling Plastic Concrete. When a concrete pump is used to place concrete, sampling shall be at the end of the discharge hose with the exception that when concrete is being deposited underwater by tremie methods, sampling may occur at the pump's hopper.

4.9.3 Test Cylinders

Making and curing concrete test cylinders shall be carried out in accordance with CSA A23.2-3C, Making and Curing Concrete Compression and Flexural Test Specimens, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor in standard CSA approved heavy duty steel or plastic moulds. Plastic moulds shall have a wall thickness of at least 6 mm. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in CSA A23.2-3C Subsection 9.3.2.1, Initial curing conditions in the mould, for a period of not less than 24 hours, and fully protected from damage at all times. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a portable building which will be used by Contractor's personnel or the Department Representative during the first 24 hour storage period will not be permitted. Storage facilities shall be provided, installed, and accepted by the Department Representative before any concrete is placed.

The Contractor shall deliver concrete test cylinders to an independent testing laboratory certified to CSA A283 for testing. Handling and transporting of the cylinders shall be in accordance with CSA A23.2-3C. No extra laboratory curing time shall be allowed for cylinders that are delivered late to the laboratory. For Class HPC and Class HPC with steel fibres, the ends of cylinders shall be ground flat prior to testing. A copy of the test results shall be forwarded to the Department Representative and Concrete Producer within 2 days of the break date.

If the test cylinders exhibit frost etchings or were stored at temperatures below 10°C or above 25°C or are otherwise mishandled resulting in unreliable compressive strength test results, the Department Representative may reject these portions of the work, unless core testing, at the Contractor's expense confirms the in situ strength of the concrete.

The Contractor shall also be responsible for supplying CSA approved heavy duty steel or plastic moulds, curing and delivering test cylinders cast by the Department Representative, for quality assurance purposes to the same independent certified testing laboratory. Quality assurance testing may be carried out by the Department Representative and costs for testing and provision of concrete test cylinder reports will be paid for by the Government of the Northwest Territories.

4.9.4 Slump Testing

Slump tests shall be carried out in accordance with CSA A23.2-5C.

4.9.5 Air Content and Density Testing

Air content and density testing shall be carried out in accordance with CSA A23.2-4C and CSA A23.2-6C respectively.

4.9.6 Compressive Strength Testing

Compressive strength testing shall be carried out in accordance with CSA A23.2-9C by an independent CSA certified engineering laboratory engaged by the Contractor.

4.9.7 Failure to Meet Slump or Air Content Specifications

In the event that slump and/or air content exceed the specified tolerance range, as determined by the Contractor's or the Department Representative's testing, the Department Representative may, accept adjustments of the deficient condition as an alternate to rejection provided adjustments are made within the maximum time allowed as specified in Subsection 4.6.3, Time of Hauling. Concrete that does not meet the specifications will be rejected after the maximum time is exceeded.

The Contractor will be allowed to adjust only the quantities of superplasticizer or air entraining agents. In no case shall an accepted batch adjustment relieve the Contractor of their responsibility for the eventual durability, strength, and acceptability of the concrete. The Department Representative reserves the right to reject any batch in the event of confirmed unacceptability, and to require immediate removal of any rejected concrete which might have already been placed in the structure.

4.9.8 Portable Batch Plants

The Contractor shall provide full time experienced and competent personnel to operate, maintain and continuously monitor portable batch plant operations.

The Contractor shall provide the qualifications of the portable batch plant supervisor to the Department Representative for review and acceptance. The portable batch plant supervisor shall monitor concrete production at the portable batch plant at all times.

4.10 Falsework and Formwork

4.10.1 General

Detailed falsework and formwork drawings shall be submitted to the Department Representative for review and acceptance a minimum of 3 weeks prior to commencement of the work. The falsework and formwork drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The falsework and formwork drawings will be reviewed by the Department Representative solely to ascertain general conformance with the Contract requirements. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the sole responsibility for completing the Work in accordance with the Contract requirements.

Falsework and formwork shall be fabricated and installed in accordance with the reviewed and accepted drawings. The Contractor shall submit a letter of conformance to the Department Representative indicating that the falsework and formwork has been installed in accordance with the reviewed and accepted Drawings prior to the placement of concrete. The letter of conformance will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The Contractor shall make every effort to accurately position formwork against hardened concrete so as to avoid form lines and discontinuities at the construction joint. Construction tolerances for formwork misalignments are outlined in Subsection 4.24.1, Honeycomb, Cavities, and Casting Defects.

Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder, shall be an integral part of all aspects of the Work. The Contractor shall immediately provide the Department Representative_with any documentation required by the Occupational Health and Safety Regulations upon request.

4.10.2 Design

For the design of falsework and formwork, the density of fresh concrete shall be assumed to be 2400 kg/m^3. Pour rates and methods of consolidation shall be such that fluting, or misalignment of formwork does not occur.

All forms shall be of wood, metal or other materials that have been reviewed and accepted by the Department Representative. Formwork shall be designed and constructed mortar tight and of sufficient rigidity to prevent deflection due to the pressure of concrete and other loads incidental to the work. The forms shall be substantial and unyielding, and shall be designed so that hardened concrete will conform to the design dimensions and alignments. The shape, strength, rigidity, water tightness and surface smoothness of reused forms shall be maintained at all times. Any warped or bulged formwork must be repaired or replaced before being used. Forms which are unsatisfactory in any respect, as determined by the Department Representative, shall not be used.

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without settlement or deformation. Falsework which cannot be founded on footings shall be supported on piling spaced, driven and removed in a manner acceptable to the Department Representative.

For timber formwork, drawings shall specify the type and grade of lumber and show the size and spacing of all members. The formwork drawings shall also show the type, size and spacing of all ties or other hardware, and the type, size and spacing of all bracing.

When forms appear to be unsatisfactory in the opinion of the Department Representative, either before or during the placing of concrete, the Department Representative will order the work stopped until the defects have been corrected.

For formwork in which the bottom is inaccessible, as determined by the Department Representative, removable panels or access hatches shall be provided in the bottom form panel to enable cleaning and removal of dirt, debris, or unsuitable material prior to concrete placement.

4.10.3 Formwork for Exposed Surfaces

Formwork for exposed surfaces which require a Class 1, Ordinary Surface Finish, shall be made of good quality plywood, or an acceptable equivalent, of uniform thickness and with or without a form liner.

Formwork for exposed surfaces requiring a Class 2, Rubbed Surface Finish or Class 3, Bonded Concrete Surface Finish, shall be all new material, made of coated formply, consisting of Douglas Fir substrate with resin-impregnated paper overlay and factory treated chemically active release agent. Formwork proposed for reuse shall be free of holes or patched holes in plywood or form liner surfaces, bulging, delamination, damage, or other imperfections that affect the trueness of the formed concrete surfaces.

All steel pre-engineered modular formwork systems with recessed panels between their supports proposed to construct concrete elements that will receive Class 2, Rubbed Surface Finish or Class 3, Bonded Concrete Surface Finish, shall be sheeted with a minimum of one layer of 18 mm plywood and one layer of 18 mm coated formply for a total thickness of 36 mm.

Any proposed reuse of formwork shall be reviewed and accepted by the Department Representative prior to use.

All formwork material for exposed surfaces shall be full sized sheets, as practical.

All formwork for exposed surfaces shall be mortar tight, filleted at all sharp corners, and given a bevel or draft in the case of all projections. At the top edges of exposed surfaces, the chamfers are to be formed by chamfer strips.

For exposed concrete elements where the pour height is 1.5 m or less, the minimum formwork requirements shall be 18 mm approved plywood supported at 300 mm maximum on centres. Where the pour height is greater than 1.5 m, minimum formwork requirements shall be 18 mm approved plywood, “Coated Formply”, supported at 200 mm maximum on centres. The support spacing specified here assumes the use of new material. Closer spacing may be required in case of reused material. Strong backs or walers placed perpendicularly to the supports shall be used to ensure straightness of the form.

Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 50 mm from the concrete surface. Break back type form ties shall have all spacing washers removed and the tie shall be broken back a distance of at least 50 mm from the concrete surface. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size. Torch cutting of steel formwork hardware at concrete surfaces will not be permitted. All cavities created from ties or associated hardware removal shall be filled with an approved concrete patching material from Alberta Transportation's Products List in the Vertical/Overhead (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and placed in accordance with the manufacturer's published product data sheet.

When plastic sleeves and removable inner rods are used, the plastic sleeve shall be removed for a distance of 100 mm from the face of the concrete except for curbs, barriers and medians where the entire plastic sleeve shall be removed. The cavity shall be filled with an approved non-shrink grout to 75 mm from the concrete surface and cured a minimum 24 hours. The remaining 75 mm of the cavity shall then be filled with an approved concrete patching material. When fibre reinforced polymer rods are used they shall be removed a distance of 75 mm back from the face of the concrete and filled with an approved concrete patching material from the Alberta Transportation's Products List in the Vertical/Overhead (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and placed in accordance with the manufacturer's published product data sheet.

If the Contractor proposes to secure barrier, curb, or median formwork with an anchorage system installed into hardened concrete deck surfaces, the anchorage system shall be fully removable or comprised of stainless steel inserts recessed to a minimum depth of the specified concrete cover. The anchorage system shall be submitted to the Department Representative for review and acceptance a minimum of 2 weeks prior to commencement of the work. Anchorage system components shall have a diameter between 9 mm and 20 mm and the deck reinforcing steel located to avoid installation conflicts and/or damage. All cavities created from the anchorage system shall be filled with an approved concrete patching material from the Alberta Transportation's Products List in the Vertical/Overhead (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and placed in accordance with the manufacturer's published product data sheet and wet cured a minimum of 72 hours.

Anchor rod assemblies shall be accurately and securely positioned as shown on the Drawings with rigid templates. The projection of anchor rods shall be reviewed and accepted by the Department Representative prior to concrete placement.

The use of nails, screws or other fasteners to secure formwork to previously hardened concrete surfaces will not be permitted.

4.10.4 Formwork for Unexposed Surfaces

The minimum acceptable formwork for unexposed concrete shall have 18 mm plywood supported at 400 mm maximum on centres.

4.10.5 Deck Formwork

A deck formwork construction milestone meeting shall occur a minimum of 3 weeks prior to commencement of the work. The Contractor's project manager, field superintendent, and representatives directly involved in the supervision of the work, shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

Where construction loads or loading conditions proposed by the Contractor vary from those shown on the Drawings, the Contractor shall be responsible for all temporary measures required to maintain girder stability and alignment. Drawings and the design notes of the temporary measures required to maintain girder stability and alignment shall be submitted to the Department Representative for review and acceptance 1 week prior to the deck formwork construction milestone meeting. The drawings and design notes of temporary measures required for girder stability will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

After girder elevations at the abutments, piers and splice locations have been reviewed and accepted by the Department Representative, the Contractor shall survey all girders at locations corresponding with those detailed on the camber diagram and determine girder haunch dimensions required to achieve design grades. The survey data, calculated deck thickness, grades, and haunch dimensions shall be submitted to the Department Representative for review and acceptance a minimum of 1 week prior to the commencement of deck reinforcing steel placement. If the design haunch dimensions vary more than allowable girder fabrication tolerances, the Department Representative may revise gradelines.

The Contractor shall design and install support brackets such that no damage to girder flanges and webs will result. Where required, deck formwork design shall include any additional bracing system to those shown on the Drawings. Effects of concentrated loads on webs shall be checked, and where necessary, sufficient means shall be provided to distribute or carry such concentrated loads to the supporting flanges or stiffeners. Where support brackets bear against girder webs, the Contractor shall protect the contact surface with timber or neoprene softeners. No drilling of additional holes, or any other modifications including field welding, shall be made to the superstructure elements. The proposed use of embedded girder web dowels or Nelson studs for deck formwork support will only be permitted when reviewed and accepted by the Department Representative.

Screed guide rails and their supports, including the supporting system required beyond the end of the bridge for the deck placing/finishing machine and work bridges, shall be detailed on the deck formwork drawings and submitted to the Department Representative for review and acceptance.

Formwork for decks, curbs, sidewalks and parapets shall be fabricated so that the lines and grades shown on the drawing are achieved, with adjustments made where necessary, as determined by the Department Representative, to compensate for variances in girder dimensions, positioning, alignment and sweep.

Formwork hangers or ties for exposed surfaces of decks, including underside surfaces, shall be removable threaded type and permit their removal to a minimum depth of 20 mm from the concrete surface. Flange J-hooks for deck formwork will not permitted. All cavities resulting from threaded rod removal along the underside of deck overhangs shall be adequately prepared and filled with an approved concrete patching material from the Alberta Transportation’s Products List in the Vertical/Overhead (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List. Deck overhang patches shall be placed level with adjacent surfaces and be similar in colour and texture. For interior bays, all cavities resulting from threaded rod removal shall be filled with Sikaflex 15LM or an approved equivalent. The caulked surface shall be placed level with adjacent surfaces and be similar in colour.

4.11 Protection of “Weathering” Steel Girders

Where steel girders are fabricated of “weathering” steel, it is essential that the uniformity of rust formation is not adversely affected by the Contractor's work.

The Contractor shall exercise utmost care and provide the necessary protection to prevent marking or staining of the girders. All joints between deck formwork and steel members (including interior girders, and diaphragms) shall be sealed to prevent leakage of cement paste or concrete. Polyurethane sealant or approved equivalent materials shall be used to achieve the seal.

If foreign material spills onto the girders despite the protection provided, the Contractor shall clean off, wash, and lightly abrasive blast the contaminated areas, to the satisfaction of the Department Representative.

If the exterior fascia web and flanges of an exterior girder becomes contaminated with foreign material, stained or marked, the Contractor shall clean off, wash and abrasive blast the exterior fascia web and flanges and weather the surfaces such that uniformity of girder colour is achieved. Weathering shall be achieved by repeatedly fogging the exterior girder faces with clean water and then, allowing to dry. Fog misting shall leave girder surfaces wet but not running wet, and be repeated when the girders are completely dry and until a finish acceptable to the Department Representative is achieved.

The cost of sealing and stain prevention shall be included in the unit price bid for the deck concrete; no separate or additional payment will be made for the cost of protecting the girders, nor for any cleaning, sandblasting or "weathering" made necessary by the Contractor's work.

4.12 Protection of Concrete Work and Bridge Elements from Staining

The Contractor shall take precautions to protect all concrete work and bridge elements from staining. If staining occurs, it shall be removed to the full satisfaction of the Department Representative. Stained concrete surfaces that have received a Class 3 finish shall have the entire surface face of the component sandblasted and the Class 3 finish reapplied. Stained concrete surfaces that have received a Class 2 finish shall have the entire surface face of the component refinished. There shall be no trace of staining after the specified concrete finishing is completed.

4.13 Removal of Falsework and Formwork

Falsework, formwork, and their supports shall only be removed at a time and in a manner that will not result in damage to the concrete or surrounding components in any way. Removal methods shall result in a uniform and gradual loading of the component and structure. Falsework and formwork shall not be removed without the review and acceptance of the Department Representative.

The following requirements for removal of forms and supports may be used if the temperature of the concrete is maintained at no less than 15°C and review and acceptance of the Department Representative is received:

Component	Age or Minimum Strength
Cast-in-place concrete girders	14 days or 80% of 28 day strength
Abutment seats and pier caps	5 days or 50% of 28 day strength
Pier shafts/columns	1 to 3 days
Decks and slabs	5 days or 50% of 28 day strength
Wingwalls and backwalls (less than or equal to 3 m in height)	12 to 24 hours
Wingwalls and backwalls	2 days (greater than 3 m in height)

Falsework and formwork may be removed earlier than the above requirements if reviewed and accepted by the Department Representative. The Contractor shall, at their expense, furnish evidence satisfactory to the Department Representative that the concrete placed has attained the specified compressive strength before the commencement of falsework or formwork removal.

All formwork shall be removed from the completed structure.

4.14 Handling and Placing Concrete

4.14.1 General

The Contractor shall provide the Department Representative with a minimum of 2 days advance notice of a scheduled concrete pour date or a change to a pour date.

The method of concrete placement shall have no adverse effects on the concrete properties. All equipment proposed for use in mixing, conveying, placing and consolidating the concrete shall be reviewed and accepted by the Department Representative prior to its use. All the necessary equipment for any particular pour shall be on site and proven to be in working condition before the pour commences, with backup equipment on site. The equipment shall be well maintained, suitable for the intended purpose and adequate in capacity for the work.

In preparation for the placing of concrete, all sawdust, wood chips and other construction debris and foreign materials shall be removed from the interior of forms. Struts, spreaders, stays, and braces, serving temporarily to secure the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. When depositing concrete by mixer truck chute, concrete pump or crane and bucket, the free fall of the concrete shall not exceed 1 metre. Concrete placement in elements containing multiple layers of reinforcing steel shall be completed such that the concrete is not deposited on upper layers of reinforcing steel.

Concrete shall be deposited in the forms in the order indicated on the Drawings, and each portion placed between construction joints shall be placed in one continuous operation. No other order of pouring shall be done unless otherwise accepted by the Department Representative.

Concrete placing operations shall not work off, or transport concrete directly over concrete previously placed.

Concrete shall not be placed when construction activities adjacent to the work will impart vibration on the concrete that could in the opinion of the Department Representative cause damage to the concrete.

4.14.2 Consolidation

Concrete, during and immediately after depositing, shall be thoroughly consolidated. The consolidation shall be done by mechanical vibration, and subject to the following provisions:

- The vibration shall be internal unless special authorization of other methods is given by the Department Representative, or the Department Representative requests the use of other method(s);
- Vibrators shall be of a type and design acceptable to the Department Representative. Vibrators shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4500 impulses per minute;

- The intensity of vibration shall be such as to visibly affect a mass of concrete of 25 mm slump over a radius of at least 0.5 m;
- The Contractor shall provide a sufficient number of vibrators to properly consolidate each batch, immediately after placement in the forms;
- Vibrator operators shall be suitably instructed in the use of vibrators, and the importance of adequate and thorough consolidation of the concrete;
- Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly acceptably consolidate the concrete without causing segregation. Application of vibrators shall be at points uniformly spaced and not farther apart than the radius over which the vibration is visibly effective;
- Vibration shall not be applied directly or through the reinforcement of sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration;
- Vibrators shall not be used to transport concrete within forms or made to flow over distances resulting in segregation; Vibration shall be supplemented by spading as is necessary to ensure smooth and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators; and
- Once vibrated the Contractor shall not disturb the concrete, step into the concrete or add additional concrete after vibration.

4.14.3 Additional Requirements

Accumulation of concrete on reinforcing steel shall be removed with brushes or other means acceptable to the Department Representative prior to it developing initial set or losing workability. Care shall be taken during cleaning such that the reinforcing steel bond is not affected or concrete damaged.

Concrete shall be placed while fresh and before it has taken its initial set. Partially hardened concrete shall not be tempered. Concrete that does not reach its final position in the forms within the time limits specified shall not be used.

After initial set of the concrete, the forms shall not be jarred or any strain placed on the ends of projecting reinforcing bars.

Concrete which would be adversely affected by the presence of freestanding water shall be protected to prevent its occurrence, and the Contractor shall take whatever steps may be necessary to prevent free water build up in the event of unexpected rainfall or similar occurrences for the first 24 hours.

Water used to keep equipment clean during the pour or to clean equipment at the end of the pour shall be discharged in a designated area acceptable to the Department Representative.

4.14.4 Pumping

The operation of the pump shall produce a continuous flow of concrete without air pockets. The equipment shall be so arranged such that the freshly placed concrete is not damaged by pump vibration. When pumping is complete, the concrete remaining in the line, if it is to be used, shall be ejected in such a manner that there will be no contamination or segregation of the concrete.

4.15 Placing Pile Concrete

Pile concrete shall be placed in accordance with Section 3, Foundation Piles.

4.16 Placing Class HPC Concrete and Class HPC Concrete with Steel Fibres

4.16.1 General

The Contractor shall submit a deck or deck overlay concrete placement procedure to the Department Representative for review and acceptance a minimum of 2 weeks prior to the construction milestone meeting. The deck pour placement procedure shall include, but not be limited to, documentation outlining compliance with all specification requirements. Review comments shall be incorporated into the deck or deck overlay concrete placement procedure to the satisfaction of the Department Representative and resubmitted prior to the commencement of the work.

A construction milestone meeting shall occur a minimum of 1 week prior to the placement of deck or deck overlay concrete. The Contractor's project manager, field superintendent, concrete quality control testing supervisor, concrete finishing supervisor, and the concrete supplier's representative shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

Class HPC concrete and Class HPC concrete with steel fibres shall not be placed when the air temperature is below 5°C, or is expected to fall below 5°C, during the curing period, or when the air temperature is above 25°C, or in the event of rain or excessive wind or dust, or when there are other conditions detrimental to the work as determined by the Department Representative.

Class HPC concrete and Class HPC concrete with steel fibres shall be placed between the hours of 6:00 pm and 10:00 am of the following day, unless otherwise reviewed and accepted by the Department Representative. Class HPC concrete and Class HPC concrete with steel fibres shall not be placed when the evaporation rate exceeds 0.5 $kg/m^2/hr$. The evaporation rate shall be determined using Figure D.1, of CSA A23.1-19 Annex D. The rate of evaporation shall be recorded as concrete placing operations progress and the Contractor shall make all necessary adjustments to ensure the evaporation rate does not exceed the specified limit.

The temperature of the concrete during discharge shall be between 10°C and 20°C unless reviewed and accepted by the Department Representative. The temperature of the mix shall be maintained below the 20°C maximum temperature by the inclusion of ice to the mix which shall not alter the design water cementing materials ratio.

Lighting shall be provided in front and behind the placing/finishing machine and along the length of each curb and/or barrier. Additional portable tower light plants shall be placed at each end of the bridge and at the concrete testing area. Details of all proposed lighting and associated equipment shall be provided in the Contractor's deck or deck overlay concrete placement procedure.

All projecting reinforcing steel and anchor rod assemblies shall be covered during concrete placement, consolidation, screeding, and testing operations such that it is not contaminated with concrete or concrete paste.

Prior to placing concrete, substrate surfaces shall be brought to a saturated surface dry condition with clean water meeting the requirements of Subsection 4.2.3, Water. Saturation with water shall not be less than 3 hours prior to concrete placement. Substrate surfaces shall be surface dry and free of water immediately prior to concrete placement.

Deck and deck overlay concrete shall be screeded using one of the following concrete placing/finishing machines or an equivalent acceptable to the Department Representative:

- Terex Bidwell Models: 2450, 3600, 4800;
- Gomaco Models: C450, C750; or
- Allen Models: 4836 B, 6036 B, 6048 B.

The Contractor shall provide 2 work bridges, separate from the placing/finishing machine, of adequate length to completely span the width of the pour. The work bridges shall facilitate the operations of concrete finishing and placement of the filter fabric for wet curing. Work bridges shall be made available to the Department Representative for straight edge checking, upon request. The work bridges shall be supported parallel to the concrete surface, between 250 mm and 600 mm above the concrete surface, and shall provide an unobstructed working surface that is wide enough to permit diverse uses concurrently and rigid enough that dynamic deflections are negligible and do not adversely affect the work. Work bridges shall include specialized work platforms to facilitate concrete finishing in front of curbs, barriers or medians.

All deck concrete and deck overlay concrete shall be consolidated in accordance with Subsection 4.14.2, Consolidation, even when vibratory drum type placing/finishing machines are used. Consolidated deck concrete and deck overlay concrete shall not be walked in or otherwise damaged.

4.16.2 Screed Guide Rails and Supports

Steel screed guide rails and supports shall be installed to suit the profile of the required surface and to ensure a smooth and continuous surface from end to end of the bridge. Guide rails shall extend beyond the end of the bridge and the entire deck surface shall be screeded with the deck placing/finishing machine. Details of the screed guide rail supports, including extensions beyond the end of the bridge, shall be included in the deck formwork submission.

Screed guide rails and guide rail supports shall not be located within any concrete pour.

4.16.3 Dry-Run

The finishing machine shall be set-up to match the skew angle of the bridge, when the skew angle exceeds 15°. For skewed bridge structures on vertical curves this requirement may be modified to suit site constraints, as determined by the Department Representative.

The deck finishing machine shall be dry-run and measurements taken to determine expected deck thickness and reinforcing steel concrete clear cover at locations corresponding with those detailed on the girder camber diagram(s). Measurements shall also be taken at other locations on the deck, including at deck edges, front face of barrier lines, deck joints, and bulkheads. Adjustment of the deck finishing machine and/or guide rails shall be completed such that the design grades, specified deck thickness, and reinforcing steel concrete clear cover are achieved. The deck finishing machine, guide rails or their supports shall not be adjusted after the dry-run has been completed and the results have been reviewed and accepted by the Department Representative. If the finishing machine is adjusted for any reason after acceptance, the dry-run, including all checks, shall be repeated.

Where screed rails are supported on cantilevered formwork that may deflect under the weight of the fresh concrete and the deck finishing machine, the Contractor shall pre-load a test section of the cantilevered formwork on each side of the bridge to determine deflections occurring during concrete placement. The formwork, machine and/or screed rails shall be adjusted to compensate for the expected formwork deflection.

The dry run shall be completed, reviewed and accepted by the Department Representative a minimum of 24 hours prior to the commencement of concrete placement.

4.16.4 Screeding Concrete

Concrete shall be placed as close as practical ahead of the finishing machine, and at no time more than 3 m in front of the trailing end of the finishing machine's roller.

The screed shall be moved slowly and at a uniform rate. The direction of concrete placement shall be from the low end of the bridge to the high end. A roll of concrete shall be maintained along the entire front of the screed at all times to ensure the filling and consolidation of the concrete surface. The Contractor shall continually measure and record the concrete thickness being placed behind the deck finishing machine at the corresponding locations on the camber diagram and measured during the dry-run.

Screeding shall be completed in no more than 2 passes.

Consolidated deck concrete and deck overlay concrete surfaces shall not be walked in or otherwise damaged.

The Contractor shall ensure that the required concrete deck thickness and concrete clear cover is being achieved by probing the plastic concrete behind the finishing machine at locations consistent with the dry-run measurements.

4.16.5 Bull Floating/Surface Texturing

The concrete surface produced behind the finishing machine shall be manually bull floated with a magnesium bull float to ensure that the surface is free from open texturing, plucked aggregate and local projections or depressions. Bull floating and surface texturing shall follow as close as practical behind the screed. Concrete finishing shall be completed under the direct supervision of an individual who has completed the ACI Concrete Flatwork Finisher Certification Program or under the direct supervision of a certified journeyman concrete finisher. Copies of certifications shall be provided to the Department Representative upon request.

Evaporation reducer or water shall not be finished into the concrete surface at any time during finishing operations.

The Contractor shall check the concrete surface with a 3 m long expanded polystyrene straight edge immediately after final bull floating and before texturing or application of evaporation reducer to ensure the required surface tolerances are met. Concrete surfaces that do not meet the surface tolerances described in Subsection 4.16.6, Surface Defects and Tolerances shall be corrected while the concrete is still plastic and before curing procedures are implemented.

4.16.6 Surface Defects and Tolerances

The finished surface of the concrete shall conform to the design gradeline indicated on the Drawings. The details of any proposed gradeline modification shall be submitted to the Department Representative for review and acceptance. For any required corrective work the Contractor shall submit a repair procedure for review and acceptance by the Department Representative 1 week prior to commencement of the repair work.

The surface shall be free from open texturing, plucked aggregate and local projections.

Except across the crown, when checked with a 3 m long straight edge placed in any direction on the concrete surface, the gap between the bottom of the straight edge and the concrete surface shall not exceed 3 mm. Areas with surface defects or do not meet the required surface tolerances will be clearly marked out by the Department Representative and the Contractor shall at their expense, without reducing the specified concrete cover:

- Remove and replace areas where the deviation exceeds 10 mm from the correct surface. As a minimum, the Contractor's repair procedure shall include saw cuts 25 mm deep in neat perpendicular lines and concrete removed to a depth of 35 mm below the top layer of reinforcing steel. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing steel shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water for a period of 24 hours prior to concrete placement. Repair areas shall be free of standing water and saturated surface dry immediately prior to placing class HPC concrete. Curing shall be in accordance with the requirements for class HPC concrete;
- Grind down any areas higher than 3 mm but not higher than 10 mm above the correct surface; or
- Correct any areas lower than 3 mm but not lower than 10 mm below the correct surface, by grinding down the adjacent high areas.

Concrete surfaces that are damaged in any way by construction operations, or show signs of distress, scaling, dusting, or delamination shall be repaired or replaced by the Contractor at their expense to the satisfaction of the Department Representative.

4.17 Placing Mass Concrete

A mass concrete construction milestone meeting shall occur a minimum of 3 weeks prior to scheduled concrete placement. The Contractor's project manager, field superintendent, and representatives directly involved in the supervision of the work, shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

Concrete temperature control and monitoring requirements shall be in accordance with Subsection 4.23.1, General.

Cooling tubes, if used as thermal control measures shall be grouted after all thermal records have been reviewed and the concrete accepted by the Department Representative. Grout materials shall meet the requirements of Subsection 7.3.3.5.5, Grout. Cooling tube grouting details shall be included in the mass concrete thermal control plan.

4.18 Concreting Shear Keys and Diaphragms

Form work for shear keys and diaphragms shall be designed to accommodate variations in girder dimensions, positioning, alignment, camber and sweep. Girder keyways and diaphragms shall be brought to a saturated surface dry condition prior to concrete placement. Saturation with water shall not be less than 3 hours. Substrate surfaces shall be saturated surface dry and free of water immediately prior to concrete placement.

Concrete placed in the keyways shall be fully consolidated and trowelled smooth and level with the top surfaces of the precast girders. Curing shall be in accordance with Subsection 4.23, Curing Concrete for the class of concrete specified. For Alberta Transportation SLW precast concrete girder shear keys, the specified pre-bagged concrete patching material shall be cured in accordance with the manufacturer's recommendations. The use of curing compounds will not be permitted.

4.19 Construction Joints

4.19.1 General

Construction joints shall be made only where specified on the Drawings unless otherwise reviewed and accepted by the Department Representative.

If not detailed on the Drawings, or in the case of emergency, construction joints shall be installed in accordance with CSA A23.1 or as determined by the Department Representative. Shear keys or inclined reinforcement shall be used where necessary to transmit shear, or to bond the two sections together. Construction joints shall be located to allow a minimum of 60 mm concrete cover on reinforcing steel running parallel to the joint.

4.19.2 Bonding

Prior to depositing new concrete on/or against concrete which has hardened, the hardened concrete surfaces shall be thoroughly prepared by abrasive blast cleaning to remove laitance or other foreign materials to the satisfaction of the Department Representative. Projecting reinforcing steel contaminated with concrete shall also be abrasive blast cleaned. Formwork shall be protected from damage during surface preparation operations. After surface preparation and reinforcing steel has been cleaned, formwork shall be retightened against hardened concrete surfaces they are in contact with. Hardened concrete surfaces shall be blown clean with compressed air and saturated with clean water meeting the requirements of Subsection 4.2.3, Water. Saturation with water shall not be less than 3 hours. Hardened concrete surfaces shall be surface dry and free of water immediately prior to concrete placement.

The placing of concrete shall be carried out continuously from joint to joint. The face edges of all joints which are exposed shall be carefully finished true to line and elevation.

4.20 Concreting in Cold Weather

In addition to the requirements of Subsection 4.23, Curing Concrete, when the air temperature is, or is expected to be below 5°C as forecasted by the closest Environment Canada Meteorological Station or a meteorological station specified in the Special Provisions of the Contract during the placing and curing period, a cold weather concreting plan shall be implemented. The Contractor shall submit details of their proposed cold weather concreting plan to the Department Representative for review and acceptance a minimum of 2 weeks prior to concrete placement. The Contractor's cold weather concreting plan shall include the following requirements:

- All aggregate and mixing water shall be heated to a temperature of at least 20°C but not more than 65°C. The aggregates may be heated by either dry heat or steam. When heating by steam the quantity of mixing water shall be adjusted such that the reviewed and accepted concrete mix design water cementing materials ratio is achieved. The temperature of the concrete shall be in accordance with Subsection 4.4.2, Concrete Temperature at Discharge, at the time of placing in the forms. In the case of mass pours, the Department Representative may alter the temperature requirements in accordance with the recommendations of the concrete mix design review;
- Before placing concrete, pre-heat shall be provided to raise the temperature of formwork, reinforcing steel, previously placed concrete, substrate surfaces, air within the formwork enclosure, and/or soil to between 10°C and 20°C. For mass concrete placements the preheat temperature range may be modified if required by the mass concrete thermal control plan but in no case shall be less than 5°C;
- The Contractor shall enclose the structure in such a way that the formwork, concrete and air within the enclosure can be kept at or above 15°C for a protection period of 7 days after placing the concrete. Enclosures shall be constructed with a minimum of 300 mm clearance between the enclosure and the concrete;

- For Class HPC or Class HPC with steel fibres the 7 day protection period shall be increased to 17 days (14 days wet curing and 3 days of air drying). The enclosure for Class HPC or Class HPC with steel fibres shall be constructed large enough to comfortably accommodate workers and equipment necessary to place, finish and cure the concrete. The underside of bridge decks shall be suitably enclosed and heated;
- The Contractor shall supply and install two thermocouples, one in the centre and one at the surface of the concrete, for every 100 m^2 of deck, at locations determined by the Department Representative;
- The relative humidity within the enclosure shall be maintained at not less than 85%. Heaters must be kept well clear of the formwork housing. Adequate ventilation is required to provide air for combustion, and to prevent the accumulation of carbon dioxide. The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat will not be permitted;
- The system of heating, and positioning of steam outlets, heaters, and fans, shall be designed to provide uniform distribution of heat;
- When reviewed and accepted by the Department Representative, fully insulated formwork may be considered as an alternative to providing heat during the curing period. The Contractor shall design and insulate the formwork such that the initial heat of the mix and the heat generated during hydration processes will maintain the specified curing conditions throughout the curing period. If the insulated formwork fails to maintain the specified conditions, the Contractor shall immediately implement measures to restore them;
- Concrete curing shall be in accordance with the requirements of Subsection 4.23, Curing Concrete;
- The adequacy of protection shall be monitored and recorded a minimum of every 4 hours for the first 72 hours and every 8 hours for the remainder of the curing period, including measurement of internal and surface concrete temperatures. The protective measures shall be modified as necessary to maintain the specified conditions;
- Repairing concrete defects and concrete surface finishing shall be in accordance with Subsection 4.24, Repairing Concrete Defects and Subsection 4.25, Concrete Surface Finish respectively;
- Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced. The temperature differential between the core of the element and the surface of the element shall not exceed 20°C. In addition, the temperature differential between the surface of the element and the ambient air shall not exceed 15°C. Ambient air temperature is defined as the temperature at mid-height and 300 mm from the surface of the element. The Contractor shall measure the temperature of internal concrete, surface of the concrete and ambient air temperatures a minimum of every 4 hours and shall make adjustments as necessary to keep the rate of cooling within the specified parameters.

The Contractor shall demonstrate to the satisfaction of the Department Representative that the requirements of the cold weather concreting plan are met.

4.21 Placing Concrete under Water

Concrete shall not be placed underwater without the review and acceptance of the Department Representative.

All Work shall be completed in accordance with Section 4, Cast-In-Place Concrete and this Subsection. In the case of conflicting requirements, the requirements of this Subsection shall govern.

Concrete placed under water shall be completed in the presence of the Department Representative.

The concrete temperature at discharge shall be between 10°C and 25°C.

Concrete shall not be placed in water which is below 4°C or flowing.

Underwater formwork shall be watertight.

The placement of concrete underwater shall be continuous until the work is complete. The surface of the concrete shall be kept as horizontal as is practicable at all times.

4.21.1 Concrete Mix Design

Concrete to be placed underwater shall meet the requirements of Table 4-3, Tremie Concrete and a concrete mix design completed in accordance with Subsection 4.4.3, Concrete Mix Design Submission Requirements. The concrete mix design review letter and associated trial batch test results shall be submitted to the Department Representative for review and acceptance a minimum of 3 weeks prior to commencement of the work.

Table 4-3 Tremie Concrete

Class of Concrete	**Minimum Specified Compressive Strength at 28 Days (MPa)**	**Nominal Maximum Aggregate Size(mm)**	**Slump Flow (mm)**	**Visual Stability Index Rating**	**Hardened Visual Stability Index Rating**	**Total Air Content (%)**
Tremie (2,4,5,6,7)	30	20 to 5 (1)	400 - 550	0	≤ 1	5 – 8 (3)

Notes:

(1) Nominal maximum coarse aggregate size may be reduced to 14 mm.
(2) Fly ash content shall be determined by the concrete mix design review Professional Engineer.
(3) Range in air content shall be in accordance with CSA A23.1-19 Table 4 Category 1 based on the nominal maximum aggregate size of the concrete mix design.
(4) Hydration stabilizing admixtures will be permitted. The design time period of hydration stabilization shall be proposed by the Contractor and included in the concrete mix design review letter submitted to the Department Representative for review and acceptance.
(5) Anti-washout admixtures incorporating viscosity modifiers will be permitted.
(6) Sulphate resistance and/or other required project specific performance properties will be outlined in the Special Provisions of the Contract.
(7) Trial batch testing shall be completed.

4.21.2 Trial Batches

Trial batches shall be completed in accordance with Subsection 4.4.4, Trial Batches and this Subsection. In the case of conflicting requirements, the requirements of this Subsection shall govern.

The trial batch shall be performed a minimum of 28 days prior to placement of concrete at site and written notification of the trial batch schedule provided to the Department Representative 1 week prior to commencement of the trial batch.

Workability retention including, slump flow, visual stability index, and air content, shall be assessed at 30 minutes after batching, quarter points of the time of haul and at the end of time of haul. Testing to determine setting characteristics, compressive strength at 3, 7, and 28 days shall be completed. If the tremie concrete mix has a hydration stabilizing admixture, trial batching to assess workability retention shall be in accordance with Subsection 4.4.4.2, Hydration Stabilized Concrete Mixes. Hardened visual stability index shall be completed in accordance with AASHTO R81, Standard Specification for Static Segregation of Hardened Self-Consolidating Concrete (SCC) Cylinders.

4.21.3 Inspection and Testing

Inspection and testing shall be completed in accordance with Subsection 4.9, Inspection and Testing.

Slump flow and visual stability index (VSI) testing shall be completed when slump testing is specified in Subsection 4.9, Inspection and Testing. Slump flow and VSI testing shall be completed in accordance with CSA A23.2-19C, Slump Flow of Concrete.

4.21.4 Tremie Method

Concrete placed under water shall be completed by means of tremie method (concrete pump line system or gravity tremie system) and such that it is placed in its final position in a compact mass without segregation. A tremie method plan shall be submitted to the Department Representative for review and acceptance a minimum of 2 weeks prior to commencement of the work. The tremie method plan will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The following information, at a minimum, shall be contained in the tremie method plan:

- Tremie equipment (concrete pump line sizes, hopper dimensions and line sizes, line lengths, connection details, etc.);
- Number of tremies and spacing, if applicable;
- Initial concrete placement details;
- Tremie embedment depth;
- Tremie embedment monitoring details;
- Concrete elevation monitoring details;
- Concrete over pour elevation; and
- Concrete over pour removal procedure details and associated vibration monitoring plan if applicable.

Details of the tremie method plan shall comply with the methodology outlined in the Federal Highway Administration (FHWA) NHI-18-024 GEC 10, Appendix D, Subsections X3.4 – X3.6, the European Federation of Foundation Contractors Guide to Tremie Concrete for Deep Foundation, and this Subsection. In the case of conflicting requirements, the requirements of this Subsection shall govern.

Tremie lines shall be constructed of steel pipe. If tremie lines are segmental, connections shall be waterproof and fitted with watertight gaskets.

The embedment depth of the tremie line shall not be less than 3 m or exceed 7.5 m at any time after initial concrete placement.

Tremie plugs for either dry or wet initial concrete placement shall be suitable for the intended purpose and be demonstrated to be effective to the satisfaction of the Department Representative before the commencement of the work.

4.22 Concrete Removal and Surface Preparation

The Contractor shall remove surface laitance and any unsatisfactory material as determined by the Department Representative.

A 25 mm deep saw cut shall be made around the perimeter of the removal area prior to the commencement of removal operations. The depth of the saw cut shall be modified if required such that the saw blade does not come within 6 mm of the reinforcing steel. Removal of material within 100 mm of concrete that will remain in the completed Work shall be completed using chipping hammers less than nominal 7 kg class. Jack hammers up to a nominal 27 kg class may be used to remove material within 100 mm and 300 mm of concrete that will remain in the completed Work.

Compact hydraulic excavators, skid steers and other similar compact construction equipment will only be considered for use to remove material that is further than 300 mm away from concrete that will remain in the completed Work. If compact hydraulic excavators, skid steers and other similar construction equipment are proposed to remove material further than 300 mm away a vibration monitoring plan shall be submitted to the Department Representative for review and acceptance. The vibration monitoring plan shall, at a minimum, include demolition equipment details, hammer/breaker attachment rated energies, vibration monitoring equipment details and setup. Hammer/breaker attachments, if proposed, shall not have a rated energy greater than 550 Joules. Vibrations measured at the top of the concrete remaining in the completed Work shall not exceed 25 mm/sec (1 in/sec).

Concrete construction joint surfaces and projecting reinforcing steel contaminated with concrete shall be abrasive blast cleaned. The prepared concrete surfaces and projecting reinforcing steel shall be reviewed and accepted by the Department Representative prior to commencement of the next sequence of Work.

The Contractor shall repair damage caused by removal operations to the satisfaction of the Department Representative.

4.23 Curing Concrete

4.23.1 General

Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, water damage and moisture loss for the curing period.

All concrete surfaces consisting of Class C or D concrete shall be wet cured. The Contractor shall cover the concrete surface(s) with two layers of clean Nilex 4504 white coloured filter fabric or an approved equivalent as soon as the surface will not be marred by so doing. The filter fabric shall be kept continuously wet for 72 hours. Where the formwork is left in place for 72 hours or more, no additional curing will be required. Curing compounds shall not be used on any concrete surface except as specified for concrete slope protection.

During the curing period the Contractor shall provide protection such that the temperature of the centre of the in-situ concrete does not fall below 10°C or exceed 70°C and the temperature differential between the centre and any surface does not exceed 20°C. In addition, the requirements of CSA A23.1-19 Table 20 shall apply.

When a concrete element has a width, depth, and length greater than 1.5 m, the Contractor shall supply and install two thermocouples, one in the centre and one between 25 mm and 75 mm of the concrete surface for every 50 m^3 of concrete, at locations determined by the Department Representative. The Contractor shall monitor and record the temperatures every 4 hours for the first 72 hours after concrete placement and every 8 hours thereafter for the specified cure period and until 24 hours after the maximum temperature has occurred. Daily temperature records shall be forwarded to the Department Representative.

Concrete shall be cured for the specified time period and achieve a compressive strength acceptable to the Department Representative, prior to being exposed to construction or traffic loads.

4.23.2 Curing Requirements for Concrete Slope Protection

Concrete slope protection shall receive 2 coats of a Type 2 curing compound meeting the requirements of ASTM C309 or ASTM C1315. The first coat is to be applied immediately after the concrete has been finished, and the second coat is to be applied within 3 hours after the application of the first coat. Each application shall be at a rate specified by the manufacturer and provide uniform coverage without streaking, runs, or sags after application.

4.23.3 Curing Requirements for Class HPC and Class HPC with Steel Fibres

The Contractor shall prepare and submit details for their proposed curing procedure to the Department Representative for review and acceptance a minimum of 2 weeks prior to the scheduled pour date. At a minimum, the curing procedure shall include a description of equipment, materials, and work methods/techniques proposed to complete the work.

Immediately after final bull floating and/or surface texturing, an evaporation reducer shall be applied to the finished concrete surface by a hand sprayer with a misting nozzle at the manufacturer's recommended concentration and application rate. The evaporation reducer shall be a monomolecular film forming compound intended for application to fresh concrete for temporary protection against moisture loss, such as MasterKure ER 50 manufactured by BASF or an equivalent acceptable to the Department Representative.

Two layers of white filter fabric, Nilex 4504 or an approved equivalent, shall be placed on the concrete surface as soon as the surface will not be marred by its installation. The fabric shall be pre-wet, or a fine spray of clean water immediately applied once placed. Edges of the filter fabric shall overlap a minimum of 150 mm and be held in place without marring the surface of the concrete. The filter fabric shall be kept in a continuously wet condition throughout the curing period by means of soaker hoses or other means reviewed and accepted by the Department Representative. The use of polyethylene sheeting above the two layers of filter fabric to reduce moisture loss will only be permitted if the sheeting is manufactured with regular perforations to permit the adequate application of curing water from above and reduce the heat generated by greenhouse effects.

Wet curing shall be maintained for a minimum of 7 days for rehabilitation projects and 14 days for new bridge construction. When concreting in cold weather, curing with filter fabric and water shall be maintained for a minimum of 14 days followed by 3 days of air drying for both rehabilitation and new bridge construction projects.

When formwork is removed prior to the completion of the specified curing period, the resulting exposed concrete surfaces shall be wet cured for the remaining days.

Curb and barrier formwork shall be carefully removed such that the concrete is not damaged by removal operations. Formwork removal shall occur no later than 72 hours after concrete placement. Wet curing of the concrete surfaces exposed after formwork removal shall commence immediately after formwork removal.

In the event that curing is determined unacceptable by the Department Representative, or any portion of the Class HPC or Class HPC with steel fibres becomes surface dry during the curing period, the Department Representative will have cause to reject the concrete.

4.24 Repairing Concrete Defects

Honeycomb, cavities, spalls, chips, cracking and other casting or construction defects shall be immediately reported to the Department Representative. The Contractor shall submit a repair procedure for honeycomb, cavities, spalls, chips, cracking and other casting or construction defects to the Department Representative for review and acceptance and any review comments incorporated into the repair procedure prior to commencement of the repair work.

Damaged concrete shall be repaired by the Contractor to the satisfaction of the Department Representative.

4.24.1 Honeycomb, Cavities, and Casting Defects

Honeycomb, cavities and other deficiencies are defined as those areas that are greater than 30 mm in depth or 0.05 m^2 in area. Defects less than 30 mm in depth and 0.05 m^2 in area shall be repaired in accordance with Subsection 4.25.3, Class 2 Rubbed Surface Finish.

As a minimum, the Contractor's repair procedure shall include removing and replacing the defective concrete with the originally specified class of concrete. Repair extents shall be saw cut 25 mm deep in neat perpendicular lines and concrete removed to a depth of 35 mm below reinforcing steel. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing steel shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water for a period of 24 hours prior to concrete placement. Repair areas shall be free of standing water and given sufficient time to become saturated surface dry, immediately prior to concrete placement. Curing shall be in accordance with the requirements for the specified class of concrete.

Formwork alignment of highly visible elements, including medians, curbs, barriers, exterior deck fascia, pier shafts, and exterior fascia of wingwalls shall be such that when checked with a 1.2 m long straight edge placed in any direction on the concrete surface, the gap between the bottom of the straight edge and the concrete surface does not exceed 3 mm. The formwork alignment of all other elements shall not be greater than 5 mm when checked with a 1.2 m long straight edge. Concrete elements with formwork alignment exceeding the specified tolerances shall be repaired or replaced as determined by the Department Representative.

4.24.2 Cracks

For Class HPC and Class HPC with steel fibres the Contractor and the Department Representative shall jointly inspect and identify all cracks after the curing period and before opening to traffic. The Department Representative will plot the width in millimeters and length in linear meters of cracks and report the findings to the Government of the Northwest Territories. Cracks that are determined by the Department Representative to be design related shall be repaired by the Contractor as extra expense. The Contractor shall complete all required crack repairs prior to opening to traffic. Cracks that develop after opening to traffic will not require repair.

The Contractor shall repair cracks with widths greater than or equal to 0.2 mm using the following procedure:

(1) Clean and dry cracks with oil-free compressed air.

(2) Seal cracks with a gravity flow concrete crack filler in accordance with the manufacturer's recommendations. The crack filler shall maximize the penetration by taking into consideration the ambient temperature, substrate temperature, viscosity and pot life of the material. The crack filler shall be chosen from Alberta Transportation's Products List in the Concrete Crack filler/Proven Products category and have a viscosity less than 105 centipoises (cP). Gravity flow crack repairs shall be completed in accordance with the methodology outlined in the American Concrete Institute (ACI) RAP 2, Crack Repair by Gravity Feed with Resin.

(3) When cracks extend the full depth of the deck slab, barriers or curbs or extend partial depth of decks that are cast to grade, epoxy injection will be required. The epoxy resin shall meet the requirements of ASTM C881/C881M Type IV, Grade 1, Class B or C and have a viscosity less than 500 cP.

For all other classes of concrete, cracks 0.2 mm or greater in width identified prior to issuance of the Construction Completion Certificate, shall be repaired by epoxy injection in accordance with the manufacturer's recommendations. The epoxy for crack injection shall meet the requirements of ASTM C881/C881M Type IV, Grade 1, Class B or C. The viscosity shall not exceed 500 cP.

When epoxy injection is required, an injection procedure shall be submitted to the Department Representative for review and acceptance prior to commencing repairs. The injection procedure shall be in accordance with the methodology outlined in the American Concrete Institute (ACI) RAP 1, Structural Crack Repair by Epoxy Injection.

All costs associated with crack repairs will be considered incidental to the Work and no separate or additional payment will be made.

4.25 Concrete Surface Finish

4.25.1 General

Wood or magnesium tools shall be used for finishing concrete and be of a type and quality acceptable to the Department Representative.

Evaporation reducer, finishing aids or water shall not be used during any stage of concrete finishing.

On exposed concrete surfaces to 600 mm below grade or, in the case of river piers, 600 mm below lowest water level, surface finishes shall be applied as follows:

Class 1 Ordinary Surface Finish

- All concrete surfaces unless other finishes are specified; and
- Top surfaces of pile caps, abutment seats, pier caps, curbs, and barriers.

Class 2 Rubbed Surface Finish

- Piers except grade separation piers (all surfaces except top surfaces of pier caps);
- Traffic side surfaces of curbs, barriers, medians and sidewalks; and
- Cast-in-place concrete girders except exterior fascia.

Class 3 Bonded Surface Finish

- Exposed faces of abutment seats except top surface;

- Exposed faces of curtain walls/wingwalls;
- Cast-in-place walls, MSE wall panels, and coping caps;
- Grade separation piers except top surfaces;
- Exterior concrete girder faces;
- Exposed faces of cast in place concrete diaphragms;
- Underside of the deck overhang extending to top flange of girder; and
- Exterior surfaces of deck slabs, curbs, barriers and sidewalk.

Class 3 bonded surface finishes shall only be applied to the above listed elements when specified in the Special Provisions of the Contract. When a Class 3 bonded surface finish is not specified in the Special Provisions of the Contract, all above listed elements shall receive a Class 2 rubbed surface finish. When specified in the Special Provisions of the Contract the extents of the Class 3 bonded surface finishes shall be in accordance with Standard Drawings S-1851, Standard Concrete Sealer Surface Treatment for Major Bridges and/or S-1852, Standard Concrete Sealer Surface Treatment for Standard Bridges.

Class 4 Floated Surface Finish

- Top surfaces of concrete deck, roof slabs, and approach slabs which are to receive waterproofing membranes and wearing surfaces

Class 5 Floated Surface Finish, Broomed Texture

- Top surfaces of sidewalks, medians, and pedestrian bridge decks;
- Approach slab concrete which will be covered by a wearing surface only (without waterproofing membrane);
- Concrete slope protection; and
- Deck joint blockout concrete top surfaces.

Class 6 Floated Surface Finish, Surface Textured

- Top surfaces of deck, deck overlay, roof and approach slabs which will not be covered with either waterproofing membrane or wearing surface.

4.25.2 Class 1 Ordinary Surface Finish

4.25.2.1 Unformed Surfaces

Immediately following placing and consolidation, the concrete shall be screeded to conform to the required surface elevations, and then floated to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions.

When checked with a 1.2 m long straight edge placed in any direction on the concrete surface, the gap between the bottom of the straight edge and the concrete surface shall not exceed 3 mm unless specified otherwise.

4.25.2.2 Formed Surfaces

Immediately following the removal of forms, all fins and irregular projections shall be removed from concrete surfaces. On all surfaces the cavities produced by form ties, and all other holes, shall be thoroughly chipped out, cleaned, and filled with an approved concrete patching material listed on the Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List. The repair material shall be appropriate for the intended application and be placed in accordance with the manufacturer's published product data sheet. All repairs shall be wet cured for a minimum of 72 hours. Curing compounds may be used for curing repair areas on formed vertical surfaces that do not require Class 2 rubbed surface finish or Class 3 bonded surface finish.

4.25.3 Class 2 Rubbed Surface Finish

Immediately following the removal of forms, all concrete fins and irregular projections shall be removed and concrete surfaces inspected for compliance with Subsection 4.24.1, Honeycomb, Cavities, and Casting Defects. After review and acceptance of the Department Representative, all concrete surfaces shall be prepared by abrasive blast cleaning. Abrasive blast cleaning shall be completed to a concrete surface profile 3 in accordance with the International Concrete Repair Institute (ICRI) Guideline No. 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair and expose the full extent of surface air voids and other concrete defects. Concrete surfaces of piers within a watercourse may be prepared by diamond grinding wheels or other methods reviewed and accepted by the Department Representative.

After surface preparation has been reviewed and accepted by the Department Representative, surface voids greater than 19 mm diameter but less than 0.05 m^2 in area and less than or equal to 30 mm deep shall be filled with an approved concrete patching material listed on the Alberta Transportation's Products List in the Overhead/Vertical (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and placed in accordance with the manufacturer's published product data sheet. Surface voids less than 19 mm in diameter and less than or equal to 30 mm deep may be filled with a pre-bagged sack rub material. Sack rub materials shall be mixed and placed in accordance with the manufacturer's recommendations over the entire prepared surface. Sack rub and patching materials shall be cured in accordance with the manufacturer's recommendation. The use of curing compounds will not be permitted. When the patching and sack rub materials have adequately cured, a carborundum stone or method acceptable to the Department Representative shall be used to finish the surface to a smooth, uniform and closed texture. Any voids or cavities opened during the stone rubbing process shall be refilled. Parging or surface patching to correct irregularities will not be permitted.

When checked with a 1.2 m long straight edge placed in any direction on the concrete surface, the gap between the bottom of the straight edge and the concrete surface shall not exceed 3 mm unless specified otherwise.

All prepared concrete surfaces, including all patching and sack rubbing shall be uniform in colour and texture. After the surface preparation has been completed to the satisfaction of the Department Representative, the Contractor shall apply sealer as required in Subsection 4.26, Type 1c Sealer. If application of the Type 1c sealer is applied in a uniform and manner acceptable to the Department Representative, any subsequent change in the uniformity of concrete surface colour will be considered acceptable.

4.25.4 Class 3 Bonded Surface Finish

Concrete surface finish shall be completed in accordance with Subsection 4.25.3, Class 2 Rubbed Surface Finish, except that uniformity in colour and Type 1c Sealer is not required.

After the surface finish has been completed to the satisfaction of the Department Representative, the concrete surface shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours and before becoming contaminated with dust or other bond breaking materials, the Contractor shall apply an approved pigmented concrete sealer that meets the requirements for a Type 3 sealer of the Alberta Transportation Material Testing Specifications for Concrete Sealers B388.

The pigmented concrete sealer shall be applied in accordance with the manufacturer's specifications and as a minimum two applications totaling the Alberta Transportation's approved application rate of the pigmented sealer are required. The colour(s) of the proposed coating scheme, which typically shall be similar to the natural colour of cured concrete, must be acceptable to the Department Representative before application of the coating. If a colour scheme has been designed for the site it will be specified in the Special Provisions. When spray application is used the surface shall be back rolled. The Contractor shall ensure that no colour variation is visible and shall match the colour of any previously sealed adjoining surfaces. Acceptance of the pigmented sealer used will not be considered to relieve the Contractor of the sole responsibility for its acceptable performance and appearance.

4.25.5 Class 4 Floated Surface Finish

Unless otherwise noted on the Drawings, concrete surfaces receiving a waterproofing membrane and a final wearing surface, shall be manually bull floated and float finished as necessary to provide a smooth surface.

Concrete surfaces shall meet the requirements of Subsection 4.16.6, Surface Defects and Tolerances.

4.25.6 Class 5 Floated Surface Finish, Broomed Texture

The concrete surface shall be float finished as necessary to produce a smooth surface. After the concrete has set sufficiently, the surface shall be given a transversely broomed finish using a coarse broom to produce regular corrugations to a maximum depth of 2 mm. A bronze edging tool shall be used at all edges and control joints.

Sidewalk and median control joints shall be installed at the same locations of curb/barrier control joints using a bronze grooving tool of sufficient gauge to produce control joints to a depth of a minimum of one quarter of the slab thickness.

When checked with a 3 m long straight edge placed in any direction on the concrete surface, the gap between the bottom of the straight edge and the concrete surface shall not exceed 3 mm unless specified otherwise.

4.25.7 Class 6 Floated Surface Finish, Surface Textured

After the concrete has been manually bull floated, the surface shall be textured with a "flat wire" texturing tool having a single row of tines. The texture shall be transverse grooving which may vary from 1.5 mm width at 10 mm centres to 5 mm width at 20 mm centres, with a groove depth of 3 mm to 5 mm. This work shall be done at such time and in such manner that the texture is achieved while minimizing the displacement of coarse aggregates or steel fibres. The textured surface shall be uniform over the entire concrete surface.

Following surface texturing, a 300 mm width of concrete surface adjacent to the curb, barrier or median shall be trowelled smooth and the surface left closed.

Concrete surfaces shall meet the requirements of Subsection 4.16.6, Surface Defects and Tolerances.

4.25.8 Surface Finish under Bearings and Baseplates

Concrete surfaces within grout pad recesses shall be bush hammered to a depth of 3 mm including all air voids prior to the installation of bearings, bridgerail posts, luminaire, overhead sign structure or other baseplates. Bush hammering shall not occur within 25 mm of anchor rods. Anchor rods shall be protected from damage during the work.

Concrete surfaces on which bearing baseplate pintels or shim stacks will be placed shall be ground to a level, smooth, solid and even surface after bush hammering.

When checked with a 1.2 m long straight edge placed in any direction on concrete surfaces to receive plain elastomeric bearings, the gap between the bottom of the straight edge and the concrete surfaces shall not exceed 1 mm.

4.26 Type 1c Sealer

An approved Type 1c concrete sealer selected from the Alberta Transportation's Products List shall be applied to all concrete surfaces which are to receive a Class 2, Class 5 and Class 6 surface finish. This shall include all concrete surfaces to 600 mm below grade or in the case of river piers 600 mm below lowest water level. Surfaces that are to receive a waterproofing membrane shall not have sealer applied. Sealer will not be required on the underside of bridge decks or on concrete diaphragms in the interior bay areas, however, the faces of the end diaphragms nearest the abutment backwalls, inside face of backwall and top surface of abutment seat, excluding bearing recess pockets, shall be sealed.

The sealer shall be applied in accordance with the manufacturer's recommendations; however, the application rate shall be increased by 30% from that indicated on the Alberta Transportation’s Products List and the substrate temperature shall be a minimum of 5°C. Before applying the sealer, the concrete shall be cured for at least 28 days. The concrete surface shall be dry, and air blasted to remove all dust and accepted by the Department Representative prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of 2 coats. Asphalt concrete pavement surfaces and other elements shall be adequately protected from overspray and runoff during sealer application.

4.27 Measurement and Payment

Measurement for payment of cast-in-place concrete will by the cubic metre of concrete acceptably placed, measured to the nearest 0.01 m^3.

The quantity of concrete paid for will be the volume of concrete remaining within the neat lines as shown on the Drawings, less the volume of concrete displaced by steel pipe piles, concrete piles, ducts and voids, and girder flanges and webs. The volume of concrete displaced by H-Piles, reinforcing steel, deck joint anchorages, and anchor rods will not be deducted from the quantity to be paid for.

When calculating the volume of pile concrete for drilled piles at locations where the pile holes are drilled larger than specified, the additional volume of concrete required to fill the oversize pile hole will not be included in the quantity of material to be paid for.

Payment will be made at the unit prices bid for "Concrete – Supply and Place" for the class of concrete specified less any applicable payment adjustments for compressive strength, and will be full compensation for falsework and formwork; curing; concrete surface finishing; the supply and application of concrete sealers; testing and inspection; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

All costs associated with concreting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Department Representative, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the concrete. The remaining 20% of the unit price bid will be made once concrete surface finishing has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Department Representative.

For Class HPC deck concrete, 80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Department Representative, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the concrete. 20% of the unit price bid will be made once concrete surface finishing, the condition of weathering steel girders, concrete work and other bridge components, and 28 day concrete compressive strength test results have been reviewed and accepted by the Department Representative.

The Department Representative reserves the right to reject concrete that does not meet the specified requirements. The Department Representative may, at its sole discretion, accept concrete that does not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Subsection 4.27.1, Compressive Strength Test Result Payment Adjustment. Compressive strengths at higher concrete ages will not be accepted as replacement unless specifically specified in the Contract.

4.27.1 Compressive Strength Test Result Payment Adjustment

Payment adjustment may be applied to the volume of concrete represented by the concrete compressive strength test results in accordance with Subsection 4.9.1, Compressive Strength Tests.

Class C Concrete

- 35 MPa and over, full bid price
- 34 MPa to 35 MPa, bid price less $30 per cubic metre
- 33 MPa to 34 MPa, bid price less $60 per cubic metre
- 32 MPa to 33 MPa, bid price less $90 per cubic metre
- 31 MPa to 32 MPa, bid price less $120 per cubic metre
- 30 MPa to 31 MPa, bid price less $160 per cubic metre
- 29 MPa to 30 MPa, bid price less $220 per cubic metre
- 28 MPa to 29 MPa, bid price less $300 per cubic metre
- 27 MPa to 28 MPa, bid price less $400 per cubic metre
- Less than 27 MPa, rejected

Class HPC and Class HPC with Steel Fibres Concrete

- 45 MPa and over, full bid price
- 44 MPa to 45 MPa, bid price less $40 per cubic metre

- 43 MPa to 44 MPa, bid price less $100 per cubic metre
- 42 MPa to 43 MPa, bid price less $180 per cubic metre
- 41 MPa to 42 MPa, bid price less $280 per cubic metre
- 40 MPa to 41 MPa, bid price less $400 per cubic metre
- Less than 40 MPa, rejected

Class D, Class Pile, Class Tremie Concrete

- 30 MPa and over, full bid price
- 29 MPa to 30 MPa, bid price less $30 per cubic metre
- 28 MPa to 29 MPa, bid price less $60 per cubic metre
- 27 MPa to 28 MPa, bid price less $90 per cubic metre
- 26 MPa to 27 MPa, bid price less $120 per cubic metre
- 25 MPa to 26 MPa, bid price less $160 per cubic metre
- 24 MPa to 25 MPa, bid price less $220 per cubic metre
- Less than 24 MPa, rejected

Class S Concrete

- 20 MPa and over, full bid price
- 18 MPa to 20 MPa, bid price less $30 per cubic metre
- 16 MPa to 18 MPa, bid price less $70 per cubic metre
- Less than 16 MPa, rejected

SECTION 5 REINFORCING STEEL

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5.1 General

This Specification is for the supply, fabrication, handling and placing of plain reinforcing steel, epoxy coated reinforcing steel, corrosion resistant reinforcing steel (CRR), and stainless reinforcing steel. All reinforcing steel shall be supplied and installed in the lengths and shapes shown on the Drawings. No substitution of bars or changes to bar details will be permitted without prior approval of the Department Representative.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

5.2 Supply and Fabrication

5.2.1 Prefabrication Submissions

5.2.1.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications, as applicable. The Contractor shall also submit proof of qualification and certifications of all fabricators and their sub-contractors.

5.2.1.2 Mill Test Reports

Mill test reports shall be submitted to the Department Representative a minimum of 2 weeks prior to the commencement of fabrication for each heat number and reinforcing steel type. Mill test reports shall be legible and provided in English. Mill test reports shall include, at a minimum, the heat number, date, and location of production, compliance with material reference standards, chemical analysis, and mechanical properties. Details of the pickling process for stainless reinforcing steel shall also be provided. Mill test reports shall be certified by the producing mill. The yield strength shall be determined using the offset method (0.2%).

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

5.2.1.3 Shop Drawings

The Contractor shall prepare and submit reinforcing steel shop drawings to the Department Representative for review and acceptance a minimum of 2 weeks prior to the commencement of fabrication.

Shop drawings shall be provided in electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- Material reference standards;
- Bar list and marks (bar marks shall be consistent with the shop drawings);
- Bar quantities;
- Bar sizes, lengths, and shapes;
- Bar bending and cutting schedules;
- Mechanical splices, if specified;
- Bar spacing and locations; and
- Reinforcing steel mass in kilograms.

Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work.

The shop drawings will be reviewed by the Department Representative solely to determine general conformance with the Contract. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

All costs associated with the preparation and submission of shop drawings will be considered incidental to the Work, and no separate or additional payment will be made.

5.2.1.4 Fabrication Schedule

The Contractor shall maintain a fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors. The fabrication schedule shall be provided to the Department Representative upon request.

5.2.2 Materials

5.2.2.1 Plain Reinforcing Steel

Plain reinforcing steel shall be Grade 400W, meeting the requirements of CSA G30.18.

5.2.2.2 Corrosion Resistant Reinforcing Steel

Corrosion resistant reinforcing steel (CRR) shall consist of either low carbon/chromium reinforcing steel or stainless reinforcing steel.

Low carbon/chromium reinforcing steel shall conform to the requirements of ASTM A1035/A1035M. The alloy type shall be CS and the minimum yield strength based on the 0.2% offset method shall be equal to 690 MPa.

Stainless reinforcing steel, if used, shall conform to the requirements of Subsection 5.2.2.3, Stainless Reinforcing Steel.

Unless otherwise specified, only one type of CRR shall be supplied for use throughout the project.

5.2.2.3 Stainless Reinforcing Steel

Stainless reinforcing steel shall be of the following designations as defined by the Unified Numbering System (UNS):

- S31653
- S31803
- S32304

Stainless reinforcing steel shall conform to the requirements of ASTM A276/A276M and ASTM A955/A955M (including Annex 1.2 or 1.3). The minimum yield strength shall be 420 MPa.

Austenitic grades shall meet the requirements of ASTM A262 Practice E. Duplex grades shall meet the requirements of ASTM A1084 Method C by demonstrating no presence of detrimental phases.

Stainless reinforcing steel shall be shotblasted and pickled at the production mill to remove all mill scale and surface oxidation.

Unless otherwise specified, only one type of stainless reinforcing steel shall be supplied for use throughout the project.

5.2.2.4 Plain and Deformed Welded Wire Reinforcing

Plain and deformed welded wire reinforcement shall conform to the requirements of ASTM A1064/A1064M Grade 70 (Fy = 485 MPa) with a minimum yield strength of 485 MPa based on 0.2% offset. Welded wire reinforcement shall be able to attain a minimum elongation of 4% at ultimate strength. Testing for elongation shall be in accordance with the tension test specified in ASTM A1064/A1064M with the following modifications:

- The minimum test gage length shall be 100 mm;
- 100% of the tests shall be across the welds; and
- The extensometer shall not be removed until 4% elongation has been attained.

The boron content shall not exceed 0.0008%.

5.2.3 Fabrication

The Contractor shall maintain a tracking system, including heat numbers, and quality control records for all reinforcing steel fabricated. Tracking system records shall be provided to the Department Representative upon request.

Reinforcing steel shall be fabricated to the dimensions and shape shown on the Drawings. Modifications proposed by the Contractor shall be submitted to the Department Representative for review and acceptance.

All bars requiring bends shall be cold bent at the fabrication facility. Heating of bars to facilitate bending will not be permitted.

Bars shall be cut by shearing or with fluid cooled saws. Torch cutting will not be permitted. Bars showing evidence of torch cutting will be rejected.

Unless otherwise specified, all hooks and bends shall be fabricated using the pin diameters and dimensions recommended in the Reinforcing Steel Institute of Canada (RSIC) Manual of Standard Practice. Bars shall conform accurately to the dimensions shown on the Drawings and be within the fabricating tolerances detailed in the RSIC Manual of Standard Practice.

Fabrication of stainless reinforcing steel shall be carried out such that bar surfaces are not contaminated with deposits of iron or other non stainless steels; or suffer damage due to straightening or bending. Stainless reinforcing steel fabrication facilities shall be exclusive to the fabrication of stainless reinforcing steel bars or in a facility that provides a permanent fixed physical barrier which fully isolates fabrication processes. Fabrication shall occur only on equipment dedicated solely to fabrication of stainless reinforcing steel bars. All machinery points that come into contact with stainless reinforcing steel bars shall consist of hardened steel to a minimum of 35 Rockwell, stainless steel, or nylon. All racking shall be protected with hardened steel to a minimum of 35 Rockwell, stainless steel, nylon or wood.

Reinforcing steel bars shall be fabricated without the presence of laminations or burrs.

5.3 Shipping, Handling and Storage

Reinforcing steel shall be covered and protected at all times during transportation.

Lifting of stainless steel reinforcing shall be completed with nylon strapping dedicated to stainless steel reinforcing bars. Fork trucks used in the handling of coil or straight stainless reinforcing steel shall have their forks covered with hardened steel to a minimum of 35 Rockwell, stainless steel, or nylon. Stainless steel reinforcing bar bundles shall be tied with plastic strapping or stainless steel tie wire and not with carbon steel or epoxy coated carbon steel strapping.

Polyethylene wrap shall be used to fully cover all stainless reinforcing steel bars and bundled for shipping. Stainless steel reinforcing bars shall also be tarped at all times during shipping with tarps dedicated for stainless steel reinforcing bars.

Reinforcing steel of differing material types shall be stored separately. Bar tags identifying the material type shall be clearly visible and shall be maintained in-place until installation of the material.

The Contractor shall store all reinforcing steel on platforms, skids, or other suitable means of support able to keep the material above the ground surface while protecting it from mechanical damage or deterioration.

Special care shall be taken when handling epoxy coated reinforcing steel to prevent damage to the epoxy coating. Epoxy coated reinforcing bars shall not be dropped or dragged and shall be lifted with non-metallic slings. Protective measure shall be implemented to prevent bar to bar abrasion and excessive sagging of bundles.

On-site storage of epoxy coated reinforcing steel shall not exceed 120 days, and exposure to daylight shall not exceed 30 days. If the daylight exposure time is expected to exceed 30 days, the Contractor shall protect the reinforcing steel by covering with opaque polyethylene sheeting or equivalent protective material acceptable to the Department Representative.

On-site storage of all other types of reinforcing steel shall not exceed 120 days unless protected with polyethylene sheeting or equivalent protective material acceptable to the Department Representative.

The Contractor shall take all precautions necessary to prevent damage to the material during handling operations. Bundles shall be handled with spreaders and non-metallic slings, or by other methods acceptable to the Department Representative. Damaged materials shall be replaced by the Contractor at their expense.

5.4 Placing and Fastening

The Contractor shall maintain a tracking system, including heat numbers, and quality control records for all reinforcing steel installed. Tracking system records shall be provided to the Department Representative upon request.

Reinforcing steel shall be accurately placed and fastened in the positions shown on the Drawings and securely tied and chaired before placing concrete.

When reinforcing steel is pre-fastened and lifted into place, the Contractor shall submit lift drawings to the Department Representative for review and acceptance a minimum of 2 weeks prior to commencement of the work. The lift drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder shall be an integral part of the Work. The Contractor shall immediately provide the Department Representative with any documentation required by the Occupational Health and Safety Regulations upon request.

Reinforcing steel containing any loose rust, scale, dirt, paint, oil, concrete, concrete paste or other foreign materials shall be cleaned or replaced to the satisfaction of the Department Representative, prior to being incorporated into the work.

Bars shall be tied at all intersections except when the bar spacing is less than 250 mm in each direction, alternate intersections shall be tied. Specified distances from forms shall be maintained by supports, spacers, or other proposed means that have been reviewed and accepted by the Department Representative.

Except as noted herein, tie-wire shall be manufactured from the same material type as the reinforcing steel being tied. Plastic coated tie wire may be used where low carbon/chromium reinforcing steel is being placed. Where stainless reinforcing steel is being placed, tie-wire shall be stainless steel of any grade listed in Subsection 5.2.2.3, Stainless Reinforcing Steel.

Isolation of stainless reinforcing steel from low carbon/chromium reinforcing steel or plain reinforcing steel is not required. Where stainless steel is lapped with other reinforcing steel materials the tie-wire used shall be stainless steel tie-wire as specified.

Welding of reinforcing steel will not be permitted.

5.4.1 Supports

Supports used to maintain the specified reinforcing steel concrete cover or for separation between layers of bars shall be of adequate strength, shape and dimension, and accepted for use by the Department Representative. Supports shall be either plastic or precast concrete. Where additional reinforcing support bars are proposed by the Contractor they shall be of the same material type and grade used in the work and installed meeting concrete cover requirements. Proposed supports and spacers fabricated from alternate material types may be used upon review and acceptance by the Department Representative.

Plastic bolster slab supports shall be Aztec Strong Back Slab / Beam Bolster - PSBB manufactured by Dayton Superior or an equivalent acceptable to the Department Representative. Bolster slab supports shall be staggered and configured to facilitate full concrete consolidation.

Supports for barriers, curbs, and medians shall be Plastic Stackable Chair with Single Clip type manufactured by Art Mould or plastic bolster slab Aztec PSBB type with a segment length not exceeding 100 mm or other equivalent supports acceptable to the Department Representative.

Concrete reinforcing steel supports may only be used to support the bottom layer of reinforcing steel of pile caps, abutment seats and approach slabs. Concrete supports shall be precast and have the compressive strength, rapid chloride permeability, and air content equivalent or better than the specification requirements for the class of concrete being placed. Concrete supports shall be of a geometric configuration that minimizes dimensions and does not adversely affect concrete placement and/or consolidation processes. Brick or mortar chairs will not be permitted.

Reinforcing steel cage side supports for drilled cast-in-place concrete piles shall be ShaftSpacer or CageCaster manufactured by Foundation Technologies Inc., or an equivalent acceptable to the Department Representative. Reinforcing steel cage bottom supports for drilled cast-in-place concrete piles shall be BarBoot manufactured by Foundation Technologies Inc., or an equivalent acceptable to the Department Representative. Additional reinforcing steel cage bottom support systems shall be proposed by the Contractor and submitted to the Department Representative for review and acceptance when warranted by the geotechnical conditions and reinforcing cage size.

The use of nails or other fasteners, and tie-wire to position and/or secure reinforcing steel to formwork will not be permitted.

5.4.2 Field Modifications

Field bending and splicing of reinforcing steel bars, regardless of circumstance, will not be permitted unless specified on the Drawings, or reviewed and accepted by the Department Representative. Splices, where permitted, shall be staggered.

Any proposed field cutting of epoxy coated reinforcing steel shall be carried out only where necessary and reviewed and accepted by the Department Representative. Cuts shall be made by shearing or saw cutting only.

5.4.3 Lap Splices

Reinforcing steel bars at lap splice locations shall be placed in direct contact with each other and fastened securely together. Reinforcing steel bars at lap splice locations shall maintain the placement tolerances specified in Subsection 5.4.4, Tolerances for Cast-In-Place Concrete.

5.4.4 Tolerances for Cast-In-Place Concrete

Reinforcing steel for cast-in-place concrete shall be placed in conformance with the following tolerances:

- Concrete cover: ±10 mm, except concrete placed in contact with soil: ±25 mm;
- Location, where the smallest dimension of the element is:
    - 200 mm or less: ±8 mm;
    - Larger than 200 mm but less than 600 mm: ±10 mm;
    - 600 mm or larger: ±20 mm;
- Lateral spacing: ±30 mm;

- Longitudinal location of bends and ends of bars: ±50 mm;
- Longitudinal location of bends and ends of bars at discontinuous ends: ±20 mm; and
- The clear distance between reinforcement shall not be less than:
    - 1.5 times the nominal diameter of the reinforcement;
    - 1.5 times the maximum coarse aggregate size; or
    - 40 mm.

5.5 Repair of Reinforcing Steel

5.5.1 Repair of Stainless Reinforcing Steel

Individual stainless reinforcing steel bars exhibiting any of the following defects shall be repaired or replaced by the Contractor at their expense:

- Any location of contamination from grinding or cutting slag;
- Any location of iron contamination greater than 100 mm in length;
- More than 10 discrete points(1) of iron contamination on bar deformations within any 1000 mm of bar length;
- More than 20 discrete points(1) of iron contamination on bar deformations per bar; or
- More than 5 discrete points(1) of iron contamination that are not located on bar deformations per bar.

Notes:

(1) A discrete point is defined as an area of contamination less than or equal to 5 mm^2. If any area of contamination is larger than 5 mm^2, the area shall be divided by 5 to determine the number of discrete points.

Bars exhibiting excessive staining, as determined by the Department Representative, shall have the contaminants identified by energy dispersive x-ray analysis (EDXA). Contaminant identification shall be carried out by the Contractor at their expense.

Methods proposed for the repair of stainless reinforcing steel bars shall be reviewed and accepted by the Department Representative prior to implementation.

Stainless reinforcing steel bars exhibiting signs of mechanical damage shall be replaced.

5.6 Measurement and Payment

5.6.1 Measurement

Measurement for payment of reinforcing steel will be by the kilograms of reinforcing steel acceptably supplied and placed, measured to the nearest kilogram.

The quantity to be paid for will be based on the total computed mass for the size and length of bars as shown on the Drawings or reviewed and accepted by the Department Representative.

Any proposed substitution of imperial reinforcing steel for metric reinforcing steel shall be reviewed and accepted by the Department Representative prior to commencement of the work. The nominal cross sectional area of metric and imperial bar sizes used for evaluating substitutions will be in accordance with ASTM A1035/A1035M, ASTM A955/A955M and CSA G30.18, respectively.

The mass for all reinforcing steel will be calculated as follows:

Table 5-2 Reinforcing Bar Mass Calculations

Metric Bar Designation	**10M**	**15M**	**20M**	**25M**	**30M**	**35M**	**45M**	**55M**
Imperial Bar Designation	4	5	6	8	9	11	14	18
Mass (kg/m)	0.785	1.570	2.355	3.925	5.495	7.850	11.775	19.625

5.6.2 Payment

5.6.2.1 Supply

Payment will be made at the unit prices bid for "Plain Reinforcing Steel – Supply", "Corrosion Resistant Reinforcing Steel – Supply", "Stainless Reinforcing Steel – Supply", or "Plain and Deformed Welded Wire Reinforcing – Supply", as applicable, and will be full compensation for the supply and fabrication of reinforcing steel; delivery to the project site; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

When stainless steel is supplied for use where CRR is specified, payment will be made at the unit price bid for "Corrosion Resistant Reinforcing Steel - Supply" and no separate or additional payment will be made.

90% of the unit price bid will be paid once the reinforcing steel has been acceptably supplied and delivered to the project site. The remaining 10% of the unit price bid will be made as the reinforcing steel is acceptably placed and tied in the design position within the specified tolerances.

All costs associated with reinforcing steel shop drawings will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with the handling, storage and protection of reinforcing steel will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with the supply and installation of copper sulfate electrical (CSE) grounds including continuity testing before and after concrete placement will be considered incidental to the Work, and no separate or additional payment will be made.

5.6.2.2 Placement

Payment for the placement of reinforcing steel will be made at the unit price bid for "Reinforcing Steel - Place", regardless of type, and will be full compensation for all labour, equipment, tools and incidental necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

Payment for the placement of reinforcing steel will only be made once the concrete of the component containing the reinforcing steel has been acceptably placed.

All costs associated with the supply and installation of tie wire, chairs or other materials used for supporting, placing and fastening the reinforcing steel in place will be considered incidental to the Work, and no separate or additional payment will be made.

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6.1 General

This specification is for the supply, fabrication, delivery and erection of structural steel. Structural steel shall include steel girders, trusses, diaphragms, bracing, fasteners, splice plates, deck drains, anchor rods, dowels, deck joint assemblies (extrusions), buffer angles, connector angles, anchor rod sleeves, curb, barrier, and median cover plates, trough plates, pier nose plates, steel caps, capitals, pier bracing, miscellaneous components and associated materials.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

6.2 Supply and Fabrication

The Contractor shall be responsible for the work of fabricators and their sub-contractors. Qualification and Contract requirements shall apply to all fabricators and their sub-contractors.

Fabrication of structural steel shall conform to AASHTO LRFD Bridge Construction Specifications and the AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5.

All welding, cutting and preparation shall be in accordance with the AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5. The fabrication of steel structures composed of structural steel tubing shall be in accordance with the American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M.

The Contractor shall submit a supply and fabrication inspection and test plan (ITP) for structural steel girders, trusses, diaphragms, bracing, splice plates, deck joint assemblies (extrusions), and any other structural steel components identified in the Special Provisions of the Contract, to the Department Representative a minimum of 6 weeks prior to commencement of the work. The Contractor's supply and fabrication ITP shall include, but not be limited to, all specified witness points, hold points, inspection and testing requirements, and the associated acceptance criteria for each component being fabricated. The Contractor's supply and fabrication ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, quality control inspection and testing, and reporting requirements.

Fabrication shall not commence until the Contractor's supply and fabrication ITP has been reviewed and accepted in writing by the Department Representative.

6.2.1 Qualifications

Structural steel shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with CSA W47.1 as follows:

Steel girders, trusses, diaphragms, bracing, splice plates, stiffeners, connector plates, abutment and pier caps, and associated materials ..... Division 1

All other bridge components ..... Division 1 or Division 2

Field welding/repairs ..... Division 1 or Division 2

Fabricators of steel girders, trusses, splice plates, stiffeners, connector plates, abutment and pier caps, and associated materials shall also be certified by the Canadian Institute of Steel Construction (CISC) in the category of complex steel bridges. Fabricators of steel diaphragms, bracing, and associated materials shall also be certified by the Canadian Institute of Steel Construction (CISC) in the category of complex steel bridges or simple steel bridges.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Department Representative upon request.

The fabricator and/or their sub-Contractor completing metalizing shall be certified by the SSPC to QP-6, Thermal Spray (Metalizing) Contractor Certification Program or ISO9001. These certification requirements will not be required for fabricators or sub-contractors completing repair of galvanized and metallized material in accordance Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

6.2.2 Prefabrication Submissions

The Contractor shall submit the following information to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of fabrication unless noted otherwise:

- List of fabricators and qualifications;
- Fabrication sequence and equipment;
- Mill test reports and product data sheets;
- Review of plate arrangement for welded girders;
- Shop drawings;
- Welding procedures; and
- Fabrication schedule.

Prefabrication submissions will be considered hold points and shall be included in the Contractor's supply and fabrication ITP. The Contractor and the Department Representative shall provide written acceptance of the prefabrication submission hold points in the supply and fabrication ITP prior to the commencement of fabrication.

6.2.2.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications. The Contractor shall also submit the quality control plans, proof of qualification and certifications of all fabricators and their sub-contractors.

6.2.2.2 Fabrication Sequence and Equipment

The Contractor shall submit details of the fabrication sequence and equipment that will be used to complete the work. The fabrication sequence shall include the order of fabrication, details of shop assembly, and surface preparation and coating. The details of shop assembly shall also include the method of assembly, support point locations, dimensional checks, methods of trimming to length, and drilling and marking of splices.

6.2.2.3 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided in English for all structural steel materials and welding consumables a minimum of 1 week prior to the commencement of fabrication.

Re-classification of steel using a mill test report or mill test report verification testing data will not be permitted.

Mill test reports and rotational capacity testing for fasteners shall be submitted to the Department Representative for review and acceptance 6 weeks prior to the commencement of erection, field assembly or installation.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory and include laboratory accreditation documentation, applicable mill test reports, testing standards, date of verification testing, verification testing results, and declaration of compliance with the specified material reference standards. The results of verification testing shall meet all requirements of the specified material reference standard. The verification letter shall be signed by an authorized officer of the testing laboratory.

6.2.2.4 Modifications to Welded Girders

If modification to the bolted field splice locations or details specified on the Drawings are proposed, the Contractor shall submit design notes, independent check notes, and shop drawings a minimum of 6 weeks prior to commencement of the work. The design notes, independent check notes, and shop drawings will be reviewed by the Department Representative for conformance with the Government of the Northwest Territories' design requirements and the Contract requirements. Review comments provided by the Department Representative shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work. The design notes, independent check notes and shop drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The design engineer of record and independent checker shall submit separate authenticated design notes and check notes. The design notes and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement of fabrication.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in the designs.

6.2.2.5 Shop Drawings

Shop drawings shall be provided in electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- All dimensions shall be correct at 20°C unless otherwise noted;
- Weld procedure identification in the tail of the weld symbols;
- Material properties, material reference standards, and product data sheets for each component;

- All material splice locations;
- Match markings of splice plates and girders as well as truss members and connection points;
- Shop assembly drawings shall indicate camber and splice joint offsets measured to the top of top flange at a maximum spacing of 4 m;
- Sizes of hardware, shear stud connectors, and any other material shown on the shop drawings shall be in the actual units (imperial or metric) of the material being supplied; and Bearings shall be centred at -5°C.

Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work.

The shop drawings will be reviewed by the Department Representative solely to determine general conformance with the Contract. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate final as-built details into the shop drawings, including the actual mill test report heat numbers for each component. One unlocked electronic copy (PDF format) of as-built shop drawings shall be submitted to the Department Representative within 3 weeks of construction completion.

6.2.2.6 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. All weld procedures and weld procedure datasheets shall be accepted by the CWB. Welding procedures shall reference CSA W47.1 and either CSA W59 or AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5. The preheat and interpass temperature, and heat input shall be in accordance with AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 except as required in Subsection 6.2.5.5, Preheat and Interpass Temperatures. Only weld procedure data sheets referenced on the shop drawings shall be submitted. Weld procedures and weld procedure datasheets will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut. The Professional Engineer shall be a welding engineer with extensive experience in welding procedures for this type of work.

6.2.2.7 Fabrication Schedule

The Contractor shall provide and maintain a current and complete fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors.

6.2.3 Prefabrication Meeting

A prefabrication meeting shall be held for the supply and fabrication of structural steel girders, trusses, deck joint assemblies (extrusions), or other structural steel components identified in the Special Provisions of the Contract.

The prefabrication meeting shall not occur until the prefabrication submission hold points have been completed, reviewed and written acceptance provided by both the Contractor and the Department Representative.

The prefabrication meeting shall be coordinated by the Contractor and held at the fabricator's facility on a date and time acceptable to the Department Representative. A minimum of 2 weeks advance notice shall be provided to the Department Representative prior to the date of the proposed prefabrication meeting.

The Contractor, fabricator and their sub-contractors shall be in attendance at the prefabrication meeting including project manager(s), fabrication superintendent(s), independent testing agency representatives, and all employees involved in supervision of the work.

The Department Representative will prepare the prefabrication meeting agenda and chair the meeting.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representatives (up to 3 representatives from the Government of the Northwest Territories and consultant) to attend the prefabrication meeting(s) for structural steel being fabricated outside the Northwest Territories.

6.2.4 Materials

6.2.4.1 Structural Steel

Structural steel shall conform to the standards specified on the Drawings.

The boron content of structural steel to be welded shall not exceed 0.0008%. The boron content of the structural steel to be welded shall be tested and results included with mill test reports.

Repair of steel plates or rolled shapes by welding at the producing mill is not permitted.

6.2.4.2 Bolts

All bolts shall conform to ASTM F3125/F3125M Grade A325/A325M heavy hex style (Type 1 galvanized for galvanized components and Type 3 for all others). Nuts shall be heavy hex style and shall conform to ASTM A563/A563M. Hardened washers shall conform to ASTM F436/F436M.

Rotational capacity testing and reporting shall be performed in accordance with ASTM F3125/F3125M for each assembly lot of bolts, nuts and washers.

6.2.4.3 Stud Shear Connectors

All stud shear connectors shall conform to the chemical requirements of ASTM A108 Grade 1015, 1018 or 1020. In addition, they shall meet the mechanical properties specified in Table 7.1 of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 for Type B Studs. Certified mill test reports for the stud material shall be provided.

Stud shear connectors with a boron content exceeding 0.0008% will not be permitted. If the boron content is not provided on the stud shear connector mill test report, the boron content for each heat shall be tested and results submitted to the Department Representative for review and acceptance.

6.2.5 Welding

6.2.5.1 Filler Metals & Welding Processes

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. The deposited weld metal shall provide strength, durability, impact toughness, and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

All electrodes, electrode/flux combinations, and electrode/shielding gas combinations shall be CSA certified and associated mill test reports and product data sheets submitted to the Department Representative for review and acceptance in accordance with Subsection 6.2.2.3, Mill Test Reports and Product Data Sheets.

Only the following welding processes and associated consumables shall be used.

6.2.5.1.1 Submerged Arc Welding (SAW)

All flange and web groove welds shall be made by a semi or fully automatic submerged arc process acceptable to the Department Representative.

All web to flange fillet welds and all longitudinal stiffener to web fillet welds shall be made by a fully automatic submerged arc process acceptable to the Department Representative.

The submerged arc welding process may be used for flat and horizontal position welds.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H8 or lower. Use of cored filler wires in the submerged arc welding process or shielding gas process will not be permitted.

6.2.5.1.2 Shielded Metal Arc Welding (SMAW)

Shielded metal arc welding may be used for girder vertical stiffener to flange fillet welds, deck drains, bridge bearings, deck joint assemblies (extrusions), pier nose plates, and buffer angles.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4.

6.2.5.1.3 Metal Core Arc Welding (MCAW)

Metal core welding may be used for vertical stiffeners and horizontal gussets of the girders and miscellaneous components such as deck drains, bridge bearings, deck joint assemblies (extrusions), pier nose plates, hand rails, bridgerails, and buffer angles.

All electrodes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4.

6.2.5.2 Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

6.2.5.3 Tack and Temporary Welds

Tack and temporary welds will not be permitted unless they are incorporated within the final weld. Tack welds to be incorporated into final welds shall be completed using consumables compatible with the final weld. Tack welds shall have a minimum weld length at least 4 times the nominal weld size. Cracked tack welds shall be completely removed prior to final welding. Magnetic particle testing shall be completed by the Contractor to confirm complete removal of any cracked tack welds. Tack welds shall be equivalent in quality to the final weld and will be subject to the same inspection and testing requirements as final welds.

6.2.5.4 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required to acceptably complete the work. Run-off tabs shall be tack welded only to that portion of the material that will not remain part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the run-off tabs shall be removed by flame cutting. Removal of run-off tabs by breaking off will not be permitted.

6.2.5.5 Preheat and Interpass Temperatures

Preheat and interpass temperature requirements shall be in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5, except that all welds on girder flanges shall be preheated to a minimum temperature of 100°C unless a higher temperature is required by AASHTO/AWS Bridge Welding Code D1.5M/D1.5 for the flange thickness. The preheat temperature of the web to flange joint shall be measured 75 mm from the point of welding on the side of the flange opposite to the side where the weld is being applied.

6.2.5.6 Welding at Stiffener, Gusset Plate and Attachment Ends

Fillet welds shall terminate 10 mm short of all stiffener, gusset plate, and attachment ends.

6.2.5.7 Repair Procedures

The Contractor shall submit repair procedures to the Department Representative for review and acceptance for damaged base metal, defective weldments, and any other defect identified by the Department Representative, prior to commencement of the repair work. Repair procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Repair procedures incorporating arc gouging shall specify that the repair area be preheated to a minimum of 65°C prior to gouging.

The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

6.2.5.8 Arc Strikes

Arc strikes will not be permitted. In the event of an arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.4.1.4, Hardness Test Inspection Schedule when measured using a Microdur MIC 10 ultrasonic impedance tester. Repair areas will be examined by the Department Representative to ensure complete removal of the metal in the affected area.

6.2.5.9 Grinding of Welds

Flange groove welds shall be ground flush or to a specified slope on both sides. Web groove welds which are sufficiently smooth with a neat appearance and uniform profile as determined by the Department Representative will not require grinding.

Fillet welds shall be continuous with uniform size and profile.

Welds with unacceptable surface profile, as determined by the Department Representative, shall be ground to the specified profile without damaging the base metal.

Grinding shall be smooth and parallel with the line of stress. The Contractor shall take due care to prevent over grinding and damage of base metal and other components. Over grinding that results in reduced thickness of the base metal or size of the weld will not be permitted. Acceptability of the welds will be determined by the Department Representative.

6.2.5.10 Plug and Slot Welds

Plug welds or slot welds will not be permitted.

6.2.5.11 Welding to Girder Flanges and Webs

With the exception of longitudinal web to flange welds, all stiffeners, gusset plates, or any other detail material welded to girder flanges shall be a minimum of 300 mm from any flange groove weld. Stud shear connectors shall not be installed within 50 mm of any flange groove weld.

With the exception of longitudinal web to flange welds and longitudinal stiffeners to web welds, all stiffeners, gusset plate, or any other detail material welded to girder webs shall be a minimum of 300 mm from any web groove weld. A minimum of 50 mm shall be provided between the toes of any flange groove weld and stud shear connector weld.

6.2.6 Fabrication

Fabrication shall be performed in a fully enclosed facility and heated. The fabrication facility temperature shall be maintained at a minimum of 10°C at all times during fabrication.

6.2.6.1 Heat Number Transfer

As the plate is cut for the fabrication of steel girder webs and flanges, heat numbers shall be transferred to each individual piece. Heat number markings shall remain visible until such time as the material location in the final assembly has been recorded. Mill identification numbers stamped into the material shall be removed by grinding at a time acceptable to the Department Representative.

6.2.6.2 Marking Systems

The method of marking and the location of marks to maintain traceability throughout the fabrication process shall be reviewed and accepted by the Department Representative. Steel stamps shall not be used, except for the match marking of splice plates. Match marking of splice plates shall be completed using low stress stamps. The stamps and their location must be identified on the shop drawings and reviewed and accepted by the Department Representative.

6.2.6.3 Cutting of Plate

All plate material for main members, splice plates and any plate material welded to the main member shall be thermally cut by flame or plasma arc using an automatic cutting machine.

Plasma arc cutting will only be permitted for plates 25 mm thick or less. Only oxygen gas shall be used in the plasma arc cutting process. All dross on steel edges cut using the plasma arc cutting process, shall be removed by grinding in the principle direction of stress.

Girder flange plate up to including 25 mm in thickness may be thermally cut by flame or plasma arc.

Girder flange plate exceeding 25 mm in thickness shall be thermally cut by flame only.

6.2.6.4 Flange Stripping

All flange material shall be cut so that the direction of the applied stress will be parallel to the direction of the plate rolling.

6.2.6.5 Girder Flange Cut Edges

The surface roughness of the cut edges of flange plate and flange splice plates shall not exceed 500 µin (12.5 µm) in accordance with the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B46.1 and be sufficiently smooth to complete Brinell hardness testing without spot grinding. Thermally cut surfaces shall be finished by grinding in the direction of principal stress and free of nicks and gouges.

The Contractor shall provide a damage report for blow backs, signs of lamination or any other discontinuity detected on plate cut edges of tension members during the cutting of material. Signs of plate lamination shall be further evaluated by an NDT technician employed by an independent NDT testing agency certified to CSA W178.1 and certified to Level 2 of Canadian General Standards Board (CGSB) to determine the extent of any damage using ultrasonic testing. Damage reports and NDT evaluations shall be used in the development of repair procedures and shall be submitted to the Department Representative for review and acceptance prior to commencement of the work. The damage report, NDT evaluation and repair procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

6.2.6.6 Additional Material Splices

Additional splices to those shown on the shop drawings shall be reviewed and accepted by the Department Representative. All additional costs incurred by the Department Representative to review, inspect and test additional splices shall paid for by the Contractor.

6.2.6.7 Vertical Alignment

The structure shall be fabricated to conform to the requirements of the deflection and vertical curve, as noted on the Drawings. For rolled shapes, advantage shall be taken of mill camber that may be inherent in the material.

6.2.6.8 Shop Assembly

6.2.6.8.1 Plate Girders

The work shall be completed in accordance with the reviewed and accepted supply and fabrication ITP, fabrication sequence prefabrication submission, and this Subsection.

Shop assembly of girders shall be by the progressive assembly method according to AASHTO LRFD Bridge Construction Specifications, except that only two, instead of three, sections need to be assembled.

Each individual girder section shall meet the camber requirements for that particular length, with the splices between these sections falling on the theoretical camber line for the entire span. Correction for variation in flange thickness must be considered. When the camber of the girder fails to meet the required tolerance, the Contractor shall submit a proposed method of repair for review and acceptance by the Department Representative. Adjustment for camber will not be allowed without the prior review and acceptance of the procedure and supervision of the repairs by the Department Representative. The camber of each individual girder section must be known for the next two girder sections in the girder line prior to shop assembly of any particular girder section. This is to allow the Department Representative to determine the best fit line to reduce the effect of any camber differences should it be deemed necessary. Camber for plate girders will be measured on the top of the top flange. The camber of plate girders shall be measured in the “no load” condition.

6.2.6.8.2 Box Girders

The progressive shop assembly of box girders shall be in accordance with the requirements of Subsection 6.2.6.8.1, Plate Girders, and this Subsection.

The camber of box girders shall be measured on the top of the top flange, and each top flange of a box shall individually meet the required camber. Girder sections assembled for splicing shall be supported within 2 m of the end of each section. Girder sections shall be supported in such a manner as to provide the correct angular relationship at the splice between girder sections while the splices are being reamed or drilled. Shop drawings shall clearly indicate the expected dead load deflection of each section and the elevations of the sections while supported for the drilling or reaming of each splice.

6.2.6.8.3 Drilling

All splices shall be drilled from solid material while assembled or shall be sub-punched or sub-drilled and then reamed to full size while in the shop assembly position. Holes in the first girder segment may be drilled using computer numerically controlled (CNC) equipment in accordance with Article 11.4.8, Bolt holes, of the AASHTO 2017 LRFD Bridge Construction Specifications. The holes in the second girder in the splice shall be match drilled through solid material while in the assembled position. No reaming shall take place until acceptance of the assembly has been obtained from the Department Representative.

6.2.6.9 Splice Plates

After shop assembly, splice plates and girders shall be match marked to clearly identify the orientation and location of splice materials for girder erection, assembly and installation. All holes shall align with holes in the attached member. Splice plates shall then be removed, de-burred, solvent cleaned, to remove all oil and sandblasted to remove all mill scale, in order to provide an acceptable faying surface as determined by the Department Representative. The match markings shall be shown on the shop drawings.

Splice plates shall then be securely ship-bolted to the girders and protected. The method of securement shall be such that the splice plates can be adjusted to accommodate the transportation, handling and storage inspection of faying surfaces upon arrival at site. Cutting of the fasteners is not required for their removal within 150 mm of splice plates or girder components.

6.2.6.10 Bolt Holes

Article 11.4.8, Bolt holes, of the AASHTO 2017 LRFD Bridge Construction Specifications shall apply except that all bolt holes in load carrying segments of main members and any material welded to main members shall be drilled full size or sub-punched 5 mm smaller and reamed to full size.

Punching of full size holes for secondary members such as bracings, which are not welded to a main member, will only be permitted for material less than 16 mm thick. Diaphragm bracing members for kinked or curved girder bridges are considered primary structural members and therefore punching of full size holes will not be permitted.

Holes in girder splices and structural members shall be circular and perpendicular to the member. Holes shall be deburred inside and outside and free of nicks and gouges.

6.2.6.11 Dimensional Tolerances

The tolerance for structural steel fabrication and fitting between hole groups shall be ±3 mm unless specified otherwise. The dimensional tolerances for structural members shall meet the requirements of Subsection 3.5 of the AASHTO/AWS Bridge Welding Code D1.5M/D1.5 and CSA S6 Annex A10.1.7.5 b), except as noted in Subsection 6.2.6.11.1, Combined Warpage and Tilt, Subsection 6.2.6.11.2, Camber, Subsection 6.2.6.11.3, Box Girders, Subsection 6.2.6.11.4, Splices, Subsection 6.2.6.11.5, Splice Gap between Adjacent Girder Ends, Subsection 6.2.6.11.6, Subsection Stiffeners, Subsection 6.2.6.11.7, Facing of Flanges, Subsection 6.2.6.11.8, Web Panning, and Subsection 6.2.6.11.9, Bearing to Bearing Dimension.

6.2.6.11.1 Combined Warpage and Tilt

Combined warpage and tilt of a flange at any cross section of welded I-shape beams or girders shall be determined by measuring the offset at the toe of the flange from a line normal to the plane of the web through the intersection of the centerline of the web with the outside surface of the flange plate. This offset shall not exceed 1/200 of the total width of the flange or 3 mm whichever is greater at bolted splice locations. Bolted splices of main stress carrying members shall have parallel planes and the surfaces shall be in full contact without any gap.

6.2.6.11.2 Camber

Camber of beams and girders shall be uniform, true and accurate to the centreline of the top flange. Permissible variation in camber shall be within ± (0.2Lt + 3) mm; where Lt is the test length in metres. This applies to fabricated pieces only, prior to shop assembly. During shop assembly, splice points shall be located on the theoretical camber line or at a specified amount from the line should the Department Representative choose to correct for shop camber deviations.

Where field splices are eliminated by combining girder segments into longer girder lengths, the cambers of the girders at the eliminated splice points shall be within ±3 mm.

6.2.6.11.3 Box Girders

Tolerances for box girder camber, sweep and depth shall be measured relative to two imaginary surfaces: a vertical plane passing through the centre line of the girder, and a surface located at the theoretical underside of the top flanges following the theoretical camber of the girder.

6.2.6.11.4 Splices

Fill plates shall not be permitted at main girder field splices unless specified. The tolerance for girder depth or box girder geometry shall be as specified by AASHTO/AWS Bridge Welding Code D1.5M/D1.5, except that the difference between similar dimensions of the adjoining sections being spliced shall not exceed ±3 mm.

6.2.6.11.5 Splice Gap between Adjacent Girder Ends

At field splice locations, the gap between adjacent girder ends shall be 10 mm ±5 mm.

6.2.6.11.6 Stiffeners

The bearing ends of bearing and jacking stiffeners shall be flush and square with the web and shall have at least 75% of this area in contact with the flanges. The remaining 25% of the area may have a gap of up to 0.05 mm. Fitted stiffeners may have a gap of up to 1 mm between stiffener and flange.

6.2.6.11.7 Facing of Flanges

Surfaces of flanges which are in contact with bearing sole plates shall have a flatness tolerance of 0.001 x bearing dimension.

6.2.6.11.8 Web Panning

The maximum variation from flatness for webs shall be 0.01d where d, is the least dimension of the panel formed by the girder flanges and/or stiffeners. Localized deformation in the web shall not exceed 3 mm in 1 m.

If a web exhibits double curvature between the flanges within a single panel, the panning value specific to each direction of curvature shall be added together when determining the variation from flatness of the panel.

If the panning in one panel is convex and the panning in the adjacent panel is concave, then the sum of the panning in the two adjacent sections shall not exceed that allowed for one single panel.

6.2.6.11.9 Bearing to Bearing Dimension

Bearing to bearing distance shall not exceed ±2 mm.

6.2.6.12 Corner Chamfer

Corners of all flanges shall be ground to a 2 mm chamfer. Corners of structural sections, plates, and outside corners of stiffeners shall be ground to a 1 mm chamfer.

6.2.6.13 Field Weld Preparation

All material specified to be field welded shall be prepared in the shop. Field welding shall be completed in accordance with Section 13, Miscellaneous Iron.

6.2.6.14 Flame Straightening and Heat Curving

Flame straightening and heat curving will not be permitted without the written acceptance of the Department Representative . If flame straightening and heat curving is considered acceptable by the Department Representative, the Contractor shall submit a detailed flame straightening or heat curving procedure including the proposed locations, temperatures and cooling rates to the Department Representative for review and acceptance prior to commencement of the work. The flame straightening and heat curving procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. Flame straightening or heat curving shall only be performed in the presence of the Department Representative.

If the heat treatment of any structural steel component is required as determined by the Department Representative, the Contractor shall submit a heat treatment procedure to the Department Representative t a minimum of 2 weeks prior to the anticipated commencement of the work. The heat treatment procedure will be considered Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The heat treatment procedure shall include heat treatment charts outlining the temperature, time and material. Upon the completion of the heat treatment, all the mechanical properties, including notch toughness, shall be verified by a certified independent laboratory in Canada by testing the material to the specified material standards. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

6.2.6.15 Stress Relieving

When stress relieving is specified, it shall be performed in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5. Copies of the furnace charts shall be supplied to the Department Representative.

6.2.6.16 Handling and Storage

All lifting and handling shall be done using devices that do not mark, damage, or distort the assemblies or members in any way. Girders shall be stored upright, supported on sufficient skids and safely shored to maintain the proper section without buckling, twisting or in any way damaging or misaligning the material.

Softeners shall be used at all times where chains, flange hooks, restraint systems, or any other tie down devices are or may come in direct contact with the structural steel during transportation, handling, and storage. Softener components shall be durable for the intended use and constructed of materials that will prevent damage to the structural steel. Steel or other alloys will not be permitted. Handling and lifting devices shall not mark, damage, or distort members.

Structural steel to be stored shall be placed on timber blocking. Timber blocking shall be located at positions that prevent damage and/or distortion from deflection. The ground of the storage area shall be solid and unyielding, and drainage diverted away from the storage area.

Galvanized and metallized material shall be handled, stacked, bundled, transported, hauled and stored to prevent damage or wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. If damage or wet storage staining occurs, it shall be assessed and repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

6.2.7 Surface Preparation and Coating

6.2.7.1 Abrasive Blast Cleaning

All steel components shall be abrasive blast cleaned after fabrication in accordance with the Society for Protective Coating Standard (SSPC) SP6.

The exterior fascia of the exterior girders shall be uniform in appearance as determined by the Department Representative.

6.2.7.2 Coating

At all bearing locations, an organic zinc epoxy primer shall be applied to the underside of bottom flanges in contact with the bearing sole plate. The primer shall extend the full width of the flange and 15 mm beyond the projected contact surface of the bearing sole plate in the longitudinal direction.

At all deck joint locations, a complete SF2, SF3 or SF4 approved bridge coating system from the Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List shall be applied to the bottom flange surfaces (underside, top and edges), with the exception that the faying surface of the underside of bottom flange in contact with the bearing sole plate shall only receive the organic zinc epoxy primer. The coating system shall extend longitudinally from the girder end to a distance 100 mm beyond the bearing sole plate or 100 mm beyond the jacking stiffener, whichever distance is greater. The selected SF2, SF3 or SF4 coating system shall be applied to the full height of the bridge webs (both sides of web and including any applicable bearing/jacking stiffeners and diaphragm bracing members) and to the underside of the top flanges. The longitudinal extent of this coating shall be the same as described in this paragraph above. Faying surfaces of bolted connections shall only receive the organic zinc epoxy primer.

Any of the portions of the girder noted above that will be encased in cast-in-place concrete shall be left in the bare steel condition with no coating applied.

The approved organic zinc epoxy primer shall meet the requirements of a Class B coating in accordance with the Research Council on Structural Connections specification for Structural Joints Using High-Strength Bolts Appendix A, Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints. A certificate of compliance shall be provided to the Department Representative for review and acceptance prior to application. The top coat colour shall conform to US Federal Standard 595C colour FS30045.

6.2.7.3 Galvanizing and Metallizing

The fabricator shall provide a smooth finish on all edges and surfaces, remove weld spatter, and all welding flux residue from the steel components prior to galvanizing or metallizing.

The Contractor's Quality Control inspection and testing records and/or reports shall be submitted to the Department Representative for review within 5 days of completion of galvanizing or metallizing.

6.2.7.3.1 Galvanizing

Galvanizing shall be by the hot dip method, after fabrication, in accordance with ASTM A123/A123M and ASTM F2329/F2329M and as modified in these specifications. Factors contributing to galvanization-induced cracking shall be minimized.

Galvanized contact surfaces of bolted connections shall conform to a Class C slip coefficient surface condition and meet the requirements of CSA S6-19, Table 10.8.

Safeguarding measures to prevent embrittlement and testing to detect embrittlement shall be completed in accordance with ASTM A143/A143M except as modified in these specifications for all lots of high strength anchor rods conforming to ASTM A193/A193M Grade B7 or any other high strength rod with tensile strength exceeding 830 MPa. The cleaning and pickling procedure of high strength anchor rods shall be modified as follows prior to hot-dip galvanizing:

- Brush blast to remove mill scale and oil after threading ends;
- Flash pickle up to 5 minutes; and
- Quick dry prior to hot-dip galvanizing (not stored in flux or acid rinse).

For each lot of high strength rods being galvanized, the Contractor shall provide four unthreaded embrittlement test rods three of which are to be galvanized with the production rods. The remaining embrittlement test rod shall be left ungalvanized for baseline testing comparison. The embrittlement test rods shall be of sufficient length to facilitate bend testing as described below.

The Contractor shall engage an independent certified laboratory to perform bend testing on the embrittlement test rods in accordance with Subsections 9.1 and 9.2 of ASTM A143/A143M-20. The independent testing lab certification shall be submitted to the Department Representative for review and acceptance prior to the commencement of any testing. The radius of the bend shall be four to five rod diameters. The galvanized embrittlement test rod(s) shall withstand the same degree of bending, within five degrees, of the ungalvanized test rod without any cracking. The results of the embrittlement testing shall be submitted to the Department Representative for review and acceptance and recorded in the Contractor's ITP.

6.2.7.3.2 Metallizing

Metallizing shall be completed in accordance with SSPC-CS 23.00/AWS C2.23M/NACE No. 12 and the following requirements:

- Surface preparation shall be SSPC-SP 5 white metal blast cleaning;
- The metallizing feedstock material shall consist of 99.9% zinc or 85/15 zinc/aluminum complying with ASTM B-833 and ANSI/AWS C2.25/C2.25M;
- One metallizing thickness test shall be completed for each metallized component of each deck joint. The metallizing thickness test locations shall be randomly selected by the Contractor and be acceptable to the Department Representative;
- A job reference standard specimen will not be required; and
- One tensile adhesion test shall be completed for each deck joint at each substructure element. Tensile adhesion testing shall be completed to determine that the minimum value specified has been achieved. Testing to determine the value at which adhesion fails beyond the specified minimum is not required.

Metalized contact surfaces of bolted connections shall conform to a Class B slip coefficient surface condition. Slip coefficients surface conditions shall meet the requirements of CSA S6-19 Table 10.8.

6.2.7.3.3 Repair of Galvanized and Metallized Material

Repair of galvanized and metallized material shall be completed in accordance ASTM A780/A780M Method A3, Metallizing and will only be permitted when the repair areas are small and infrequent as determined by the Department Representative. The metallizing feedstock material shall be zinc. Aluminum or 85/15 Zn/Al alloy will not be permitted. Repair areas less than 100 mm^2 in area may be completed in accordance with ASTM A780/A780M Method A1, Repair Using Zinc-Based Alloy. The thickness of the coating for both methods shall be 180 µm, and the repair tested for adhesion. Adhesion testing shall be by the stout knife method in accordance with ASTM A123/A123M.

Galvanized and metallized material shall be stacked or bundled and stored to prevent wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. Light and medium wet storage stains shall be removed by brushing with a stiff-bristled nylon brush to the satisfaction of the Department Representative. Heavy and extreme wet storage stains shall be repaired.

Repair procedures for damage and/or wet storage stained galvanized or metallized material shall be submitted to the Department Representative for review and acceptance. The Department Representative's review comments shall be incorporated into the repair procedure to the satisfaction of the Department Representative prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Department Representative.

6.2.8 Inspection and Testing

6.2.8.1 Access

The Contractor shall provide acceptable facilities for the inspection and testing of the work. The Department Representative shall have full access to all phases of the work at all times. When required by the Department Representative, the Contractor shall also provide labour for assistance in checking layout and performing inspection and testing duties. The Department Representative shall be provided the time needed to complete any quality assurance inspection and testing.

6.2.8.2 Responsibility

Quality control inspection and testing shall be completed by the Contractor. Quality control shall be the sole responsibility of the Contractor.

Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories and consultant) to inspect and test bridge girders, trusses, deck joints and any other structural steel components being fabricated outside the Northwest Territories and including up to three trips to the fabrication facility by the Department Representative during the course of fabrication. For deck joint assemblies (extrusions) the number of potential trips required for the Department Representative will be reduced to one.

Inspection, testing and related costs incurred by the Department Representative as a result of defective work, non-conforming materials, or the Contractor's proposed modification to connection and/or field splice locations not specified on the Drawings shall be paid for by the Contractor. If the Department Representative, at their sole discretion, determines that the Contractor's quality control inspection and/or testing personnel are not meeting the minimum specified standards, the Contractor shall replace the personnel immediately and prior to continuing with the work.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative.

6.2.8.3 Non-Destructive Testing

Non-destructive testing (NDT) shall be completed in accordance with the following standards:

- Radiography - AASHTO/AWS Bridge Welding Code D1.5M/D1.5;
- Ultrasonic - AASHTO/AWS Bridge Welding Code D1.5M/D1.5;
- Magnetic Particle - ASTM E709;
- Dye-Penetrant - ASTM E165/E165M; and

- Hardness - ASTM A833 for cut flange plate and ASTM A1038 for accidental arc strike.

6.2.8.4 Quality Control Inspection and Testing by the Contractor

The Contractor's quality control plan, including visual inspection and non-destructive testing, shall be in accordance with the requirements of AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 Clause 6, except as follows:

- The Contractor's visual quality control welding inspector shall be certified by the CWB as a Level 2 or Level 3 inspector in accordance with CSA W178.2;
- Non-destructive testing (NDT) methods shall be in accordance with Subsection 6.2.8.3, Non-Destructive Testing;
- NDT technicians shall be certified to Level 2 in accordance with CAN/CGSB-48.9712 and employed by an independent testing agency certified to CSA W178.1;
- The non-destructive testing (NDT) schedules shall be completed in accordance with Subsection 6.2.8.4.1, Steel Girders, Trusses, and Associated Materials, Subsection 6.2.8.4.2, Deck Joint Assemblies (Extrusions), and Subsection 6.2.8.4.3, Other Structural Steel Components;
- The Contractor shall provide a minimum of 36 hours advance notice to the Department Representative prior to the commencement of any NDT; and
- Coating testing shall be completed by an independent National Association of Corrosion Engineers (NACE) Level 2 certified coating inspector.

The Contractor's quality control testing and inspection records and/or reports shall be submitted on a weekly basis to the Department Representative for review and acceptance, with the exception that NDT records and/or reports shall be submitted within 24 hours of completion of the testing. All quality control testing and inspection records and/or reports shall contain the written acceptance of the fabricator's QC manager.

6.2.8.4.1 Steel Girders, Trusses, and Associated Materials

6.2.8.4.1.1 Radiography Inspection Schedule

Each welded structural steel component shall be inspected using radiography in accordance with the following schedule:

- 100% of tension flange groove welds;
- 100% of flange groove welds in stress reversal locations;
- 100% of web, stiffener, and diaphragm groove welds;
- 100% of attachment to flange plate groove welds; and
- 25% minimum of all other flange groove welds, as determined by the Department Representative.

Steel members greater than or equal to 65 mm in thickness shall also have 25% of the welds inspected by ultrasonic method in addition to radiography.

6.2.8.4.1.2 Magnetic Particle Inspection Schedule

Each welded structural steel component shall be inspected using magnetic particle testing in accordance with the following schedule:

- 50% of the web to flange welds or any fillet welds placed on flange plates. The tests shall be in 1.5 m lengths including a 1.5 m length at each end of each web to flange weld;

- 20% of the stiffener to web welds;
- 100% of the stiffener and diaphragm connector plate to flange welds;
- 100% of the bearing sole plate to flange welds;
- 20% of the diaphragm connector plate welds to web;
- 100% of all manual (SMAW) welds; and
- 25% of all fillet welds for other bridge components.

6.2.8.4.1.3 Dye Penetrant Inspection Schedule

Each welded structural steel component shall be inspected using dye penetrant testing in accordance with the following schedule:

- When flange plate groove welds are completed before cutting of the individual flange plates, 100% of the ends of weld metal for each flange groove weld after the removal of run-off tabs and each groove welded flange plate has been cut; and
- When the individual flange plate is cut before the flange groove weld is completed, 100% of ends of the weld metal of flange groove welds after the removal of run-off tabs shall be tested.

6.2.8.4.1.4 Hardness Test Inspection Schedule

Thermally cut edges of girder flanges shall be tested for hardness prior to assembly. A minimum of three hardness tests shall be taken for each cut edge (at each end and mid-point along length of cut edge). The location of selected hardness tests shall be reviewed and accepted by the Department Representative . The hardness of the cut edges shall not exceed a maximum Brinell as follows:

- For carbon steels with a yield strength less than and including 300 MPa, the maximum Brinell shall be 200 BHN; and
- For carbon steels with yield strengths greater than 300 MPa, the maximum Brinell shall be 220 BHN.

Edges that exceed the specified hardness shall be repaired, re-tested and re-inspected prior to assembly.

6.2.8.4.1.5 Stud Shear Connectors

A minimum of 10 studs for each stud diameter and each change in weld surface geometry shall be bend tested. Bend testing of stud shear connectors shall be completed in the presence of the Department Representative. All the remaining studs shall be tested by striking with a hammer. Studs with a dull sound shall be bend tested to confirm integrity. Girder and diaphragm shear stud connectors shall be bent towards the centre of the member.

6.2.8.4.1.6 Coatings

The dry film thickness of the primer, mid-coat and top-coat applied to each girder flange, web, stiffener, and bracing members required to be coated as specified in Subsection 6.2.7.2, Coating shall be measured. Dry film coating thickness measurements shall be completed at a minimum of 5 locations of each flange, web, stiffener and bracing members in accordance with SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges.

6.2.8.4.2 Deck Joint Assemblies (Extrusions)

Each deck joint assembly (extrusion) shall be inspected and tested by the Contractor in accordance with the following schedule:

- 50% of groove welds using ultrasonic testing;
- 25% of fillet welds using magnetic particle testing; and
- Ring testing of stud shear connectors in addition to the bend testing requirements specified in Subsection 6.2.8.4.1, Steel Girders, Trusses, and Associated Materials.

6.2.8.4.3 Other Structural Steel Components

Welds of other structural steel components shall be inspected by the Contractor using radiography in accordance with the following schedule:

- 100% of the groove welds in each tension member; and
- 50% of the groove welds in each non tension member.

Steel members greater than or equal to 65 mm in thickness shall also have 25% of the welds inspected by ultrasonic method in addition to radiography.

6.2.8.5 Quality Assurance Inspection and Testing by the Department Representative

The Department Representative will complete visual inspection of all welds and review all quality control inspection and testing records and/or reports produced by the Contractor to verify their compliance with the Contract. The Department Representative may complete additional quality assurance inspection and/or testing at their sole discretion. The Contractor shall provide full access to the work in accordance with Subsection 6.2.8.1, Access.

6.2.8.6 Witness Points and Hold Points

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified witness points and hold points within the ITP.

If fabrication continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Department Representative may suspend the supply and fabrication work and the Contractor shall be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the work, as determined by and to the satisfaction of the Department Representative.

Inspection stations shall be set up by the Contractor within the fabrication facility to the satisfaction of the Department Representative for each of the specified witness points and hold points such that the associated inspection and/or testing requirements can be acceptably completed.

6.2.8.6.1 Girders

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP for structural steel girders:

- After plate has been cut but before any welding (witness point);
- Flange plate shop splicing (hold point);
- Web plate shop splicing (hold point);
- Completion of web to flange welding prior to fitting of stiffeners (witness point);
- Fitting and welding of stiffeners prior to field splice drilling (witness point);
- Field splice setup prior to match drilling splice plates (witness point);

- Surface preparation (witness point) and coating (witness point);
- Verification testing and inspection of structural steel girders if fabricated outside of Canada and the United States (hold points); and
- Final inspection (hold point).

6.2.8.6.2 Deck Joint Assemblies and (Extrusions)

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP for deck joint assemblies (extrusions):

- Dimensional checks and verification of specified tolerances prior to welding (witness point);
- Visual inspection and NDT of all welding prior to coating (hold point);
- Plate gap measurements at the locations specified after completion of fabrication, at both the -5°C and +15°C deck joint gap settings with the joint in a relaxed condition (prior to tightening shipping angles) (hold point);
- Verification testing and inspection of deck joint assemblies (extrusions) if fabricated outside of Canada and the United States (hold points); and
- Final inspection (hold point).

If the specified tolerances are not met, the Contractor shall repair or replace the deck joint assembly (extrusion) to the satisfaction of the Department Representative. If the Contractor proposes to repair the deck joint assembly (extrusion), a repair procedure shall be submitted to the Department Representative for review and acceptance prior to commencement of the work. The repair procedure will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

6.2.8.7 Final Inspection

The Contractor and the Department Representative shall provide written acceptance of all fabricated structural steel upon the completion of fabrication. Review and acceptance of structural steel by the Department Representative at the fabrication facility will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

6.2.8.8 Fabrication Outside of Canada and the United States of America

In addition to the requirements of Subsection 6.2.8, Inspection and Testing, structural steel fabricated outside of Canada or the United States of America shall be shipped to a shop located in Canada that is certified by CWB in accordance with CSA W47.1 to Division 1 and by CISC in the category of steel bridges for verification inspection and testing. The structural steel shall be in a condition that facilitates verification inspection and testing requirements. Verification inspection and testing shall be completed in accordance with Subsection 6.2.8, Inspection and Testing in the Canadian shop. The visual welding inspector shall also inspect all structural steel for the presence of transportation damage.

Components shall not be shipped from the Canadian shop until all requirements have been met and the work has been reviewed and accepted by the Department Representative.

The Contractor shall be responsible for all verification inspection and testing costs, including all costs incurred by the Department Representative (from the Government of the Northwest Territories and consultant). The Contractor shall also be responsible for all hourly charge out rates, travel, meals and accommodation of the Department Representative inspector(s) to complete inspection and testing duties at the fabrication facility for 100% of the fabrication time. The Contractor shall also be responsible for the cost of one trip every two weeks for two Department Representatives to and from the fabrication facility.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

6.3 Construction

The Contractor shall erect, assemble, and install the structural steel as shown on the Drawings, in accordance with these specifications and the Special Provisions of the Contract.

Cranes shall be used for the handling and erection of structural steel girders and truss members.

Lifting forces of structural steel girders shall be vertical at all times.

Lifting devices shall not be welded to structural steel components or require the removal of any stud shear connectors for attachment to the structural steel component. Drilling of additional holes or any other modifications, including field welding will not be permitted.

Softeners shall be used at all times where chains, flange hooks, restraint systems, or any other tie down devices are or may come in direct contact with the structural steel during transportation, handling, storage, assembly, erection and installation. Softener components shall be durable for the intended use and constructed of materials that will prevent damage to the structural steel. Steel or other alloys will not be permitted for use as softeners. Handling and lifting devices shall not mark, damage, or distort members.

6.3.1 Transportation, Handling and Storage

Girders shall be transported, handled and stored with their webs in the vertical position.

Structural steel shall be protected from dirt, mud, road salts, slush or other contaminants during transportation, handling and storage.

Structural steel shall be transported, hauled, and stored on timber blocking. Timber blocking shall be located at positions that prevent damage and/or distortion from deflection. The ground of the storage area shall be solid and unyielding, and drainage diverted away from the storage area.

Galvanized and metallized material shall be handled, stacked, bundled, transported, hauled and stored to prevent damage or wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. If damage or wet storage staining occurs, it shall be assessed and repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

6.3.1.1 Transportation, Handling, and Storage Drawings and Assessment

The Contractor shall submit transportation, handling and storage drawings to the Department Representative for review and acceptance a minimum of 4 weeks prior to shipping structural steel. The transportation, handling and storage drawings shall include all specified requirements.

If the Contractor proposes to transport, handle or store the girders with webs in a position other than vertical, in addition to the transportation, handling and storage drawings, the Contractor shall also submit a girder transportation, handling and storage assessment to the Department Representative for review and acceptance a minimum of 2 weeks prior to shipping from the fabrication facility.

The transportation, handling and storage assessment, at a minimum, shall include design notes, drawings, rationale for the proposed transport position, and statement indicating the proposed method will not damage the girders. Design notes shall include evaluation of the static and dynamic forces and associated stresses during handling, transportation, and storage using a dynamic load allowance of 100%. The stresses shall be in accordance with CSA S6-19 Clause 10.10, Beams and Girders and the maximum cyclic stress range shall not exceed the constant amplitude fatigue threshold for the appropriate fatigue categories specified in CSA S6-19 Table 10.4, Fatigue life constants and constant amplitude threshold stress ranges.

The girder transportation assessment will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. Review comments provided by the Department Representative shall be incorporated into the transportation, handling and storage drawings and assessment and resubmitted to the Department Representative for review and acceptance prior to shipping from the fabrication facility. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the work in a manner that does not, in the opinion of the Department Representative, damage the girders. All costs associated with the transportation, handling and storage assessment will be considered incidental to the Work and no separate or additional payment will be made.

6.3.1.2 Clearance to Ship

The Contractor shall provide the Department Representative a transportation schedule for structural steel a minimum of 72 hours prior to shipment from the fabrication facility. Written acceptance in accordance with Subsection 6.2.8.7, Final Inspection shall be provided by both the Contractor and the Department Representative prior to the commencement of shipping.

Review and acceptance at the fabrication facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

6.3.1.3 Inspection

Upon arrival at the site, after cleaning if required, and a minimum of 24 hours prior to erection, the Contractor and the Department Representative shall inspect materials for cleanliness and presence of damage. If girders and structural steel components are to be stored on site prior to erection, assembly, or installation, the Contractor shall provide an area and adequate space between components and access equipment for the Department Representative to complete their inspection. If girders and other structural steel components are to be erected, assembled or installed directly from transportation equipment, the Contractor shall provide access equipment acceptable to the Department Representative to complete the required inspections, remove restraints and provide temporary restraints, if required, to facilitate a complete inspection. Erection, assembly or installation shall not commence until the Department Representative has provided written acceptance of transportation, handling, and storage inspection results to the Contractor.

Structural steel that becomes contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to inspection, assembly, erection or installation. Cleaning, if determined necessary by the Department Representative, shall be completed in accordance with Subsection 6.3.1.4, Cleaning.

If any structural steel component is identified as damaged during the transportation, handling, and storage inspection, the Contractor shall submit an assessment report and/or field repair procedure to the Department Representative for review and acceptance prior to commencement of the work. The assessment report and/or field repair procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Department Representative may also require that further independent inspection, non-destructive testing, and/or assessment be completed. Field repairs shall be completed by the Contractor and reviewed and accepted by the Department Representative prior to erection, assembly or installation. All costs to repair damage to the satisfaction of the Department Representative will be the sole responsibility of the Contractor.

The transportation, handling, and storage inspection will be considered a hold point. The Contractor and the Department Representative shall provide written acceptance of the hold point prior to the commencement of erection. If structural steel erection commences without the written acceptance of the transportation, handling, and storage inspection by both the Contractor and the Department Representative, the Department Representative will have cause to suspend structural steel erection work. The Contractor shall also be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

6.3.1.4 Cleaning

Structural steel that becomes contaminated with dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned to the satisfaction of the Department Representative and in accordance with the following requirements a minimum of 48 hours prior to erection, assembly or installation:

- Cleaning shall be completed by high pressure washing and/or steam;
    - The washing system used for cleaning shall maintain wash water at a minimum temperature of 90°C, have a minimum pressure of 3000 PSI, maximum pressure of 3500 PSI, and a minimum flow rate of 5 GPM;
    - Wash water shall be potable and of a quality acceptable to the Department Representative;
    - Wash water shall be contained and managed in a manner acceptable to the Department Representative and in compliance with all applicable environmental requirements and the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements;
    - Washing shall be completed from the highest elevation of the component in its washing position to the lowest elevation;
- Components shall be supported on timber blocking to provide a minimum clearance of 900 mm from the ground along the entire length of the component;
- Components shall be stored to provide a minimum clearance of 1200 mm from each other;
- Transportation, handling and storage restraints, and their softeners, shall be removed or repositioned to permit complete and full cleaning of the structural steel;

- Locations of chains, flange hooks, restraint systems, other tie down devices, and timber blocking shall be adjusted to permit cleaning at contact areas;
- Splice plates, if secured to the steel girders during transportation, shall be removed from the girder or separated from the girder to provide a minimum of 75 mm of clearance between splice plates and girders; and
- Access equipment and/or specialized telescoping pressure washing equipment shall be used to wash structure steel that is 3 m or greater above the ground.
- Structural steel that has been contaminated with road salts, slush or other contaminants shall have their surfaces tested for soluble salts after cleaning in accordance with the Bresle Method, ISO 8502-9, Field method for the conductometric determination of water-soluble salts and ISO 8502-6, Extraction of soluble contaminants for analysis. Testing shall be completed at a minimum frequency of 1 test per 30 m^2 of structural steel surface area or 3 tests per component, whichever is greater up to a maximum of 6 tests per component. The test locations shall be determined by the Department Representative.
- Cleaning shall result in structural steel surfaces having less than 7 $\mu g/cm^2$ of chloride ions. All testing shall be carried out by the Contractor and the results submitted to the Department Representative for review and acceptance prior to erection, assembly or installation. Structural steel surfaces that exceed the specified limits for contaminants shall be further cleaned and testing repeated until the steel surfaces meet the specified limits.
- Cleaning of the exterior fascia web and flanges of an exterior steel girder shall result in a uniform appearance without streaking and free of pressure washing spray patterning. Additional cyclic wetting, fogging and drying may be required to achieve uniformity of appearance as determined by the Department Representative.
- Structural steel shall be free of ice prior to erection. Methods to remove ice shall be reviewed and accepted by the Department Representative.
- All costs associated with cleaning, testing, and removing ice from the surfaces of structural steel surfaces will be considered incidental to the Work and no separate or additional payment will be made.

6.3.1.5 Faying Surfaces of Connections

Splice plates, if secured to the steel girders during transportation, shall be removed from the girder or separated from the girder to provide a minimum of 75 mm of clearance between splice plates and girders such that their condition and the condition of faying surfaces can be inspected in accordance with Subsection 6.3.1.3, Inspection and to the satisfaction of the Department Representative. A faying surface is defined as the plane of contact between two plies of a bolted assembly with or without collateral materials that is used to join two structural elements. The Department Representative will determine the need to remove or separate splice plates from the girder. Splice plates transported using other methods shall also be separated for inspection by the Contractor and Department Representative.

Faying surfaces that are contaminated, have loose or flaking rust, as determined by the Department Representative, shall be cleaned in accordance with Subsection 6.3.1.4, Cleaning. If contaminates, loose or flaking rust can not be acceptably removed by pressure washing, as determined by the Department Representative the Contractor shall prepare faying surfaces by abrasive blast cleaning to the satisfaction of the Department Representative prior to erection. Wire brushing and other surface preparation methods will not be permitted.

6.3.2 Erection

The Contractor shall not erect structural steel on substructure concrete until it has cured a minimum of 3 days and achieved a minimum of 80% of the 28 day specified concrete strength or a strength acceptable to the Department Representative.

The Contractor shall maintain structural steel stability; location; and horizontal, vertical and longitudinal alignment at all times during construction.

Bearings and grout pads shall be installed in accordance with Section 8, Bearings.

6.3.2.1 Structural Steel Erection Inspection and Test Plan

The Contractor shall submit an erection inspection and test plan (ITP) for all structural steel to the Department Representative for review and acceptance a minimum of 6 weeks prior to the commencement of structural steel erection work. Erection shall not commence until the Contractor's erection ITP has been reviewed and accepted in writing by the Department Representative.

The Contractor's erection ITP shall include bolt material submissions and structural steel erection procedure activities. The Contractor's erection ITP shall clearly identify the party and person/position responsible for providing written acceptance of erection procedure activities including witness points and hold points.

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified hold points within the erection ITP prior to release of the work from the hold point. If structural steel erection continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative or deviates from the engineered erection procedure, the Department Representative will have cause to suspend the erection work .

6.3.2.2 Structural Steel Erection Procedure

The Contractor shall submit an erection procedure for all structural steel to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of structural steel erection work. The erection procedure will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall not commence any erection work until review of the erection procedure by the Department Representative has been completed and all comments arising from that review have been addressed to the satisfaction of the Department Representative. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of their methods or equipment, nor from carrying out the work in full accordance with the erection procedure, drawings and specifications. The Contractor shall follow the engineered erection procedure at all times.

Layout and component identification of the structural steel contained in the erection procedure shall be consistent with the layout and component identification shown on the Drawings. The erection procedure shall include drawings and supporting documents necessary to describe the following:

- Traffic Accommodation Strategy (TAS);
- Access to the work, including temporary access berms and/or work bridges;
- Details of temporary works and supporting structures, including:
    - Location, elevation, and grade of support bearings;
    - Theoretical top of girder or truss elevations at bearing and splice locations; and
    - Vertical, horizontal, and longitudinal position adjustment mechanisms;
- An as constructed survey of substructure elements (hold point), including:
    - Location and elevation of all bearing grout pad recesses including anchor rod voids;
    - Shim height required at each bearing location; and
    - Longitudinal and transverse measurements between centreline of bearings of all substructure elements;

- Bearing installation procedure in accordance with Subsection 8.4.3.1, Bearing Installation Procedure;
- Superstructure layout plan, including installation details of reference lines and markings of substructure and bearing components used to determine final bearing and structural steel positions, and theoretical top of girder or truss elevations at substructure bearings and splice locations;
- Type and capacity of cranes;
- Sequence of work including position of cranes and delivery trucks;
- Position of cranes relative to substructure elements such as abutment backwalls; details of load distribution of wheels and outriggers; geotechnical loads and ground capacity requirements;
- Lifting device details, location of lifting devices, and lifting forces;
- Structural steel and girder stabilization details, methods of maintaining structural steel location and alignment, and details of blocking for girders and bearings, and trusses;
- Diaphragm and bracing installation schedule and sequence (hold point);
- Bolting;
    - Summary of bolt assembly lots to be installed;
    - Pre-installation verification testing procedure;
    - Erection bolting details including field splice bolt and pin layouts, and minimum bolting of bracing requirements;
    - Bolt tightening sequence, snug-tightening, final tensioning (witness point) including pin removal; and
- Method and schedule of temporary supporting structures release and removal.

A construction milestone meeting shall occur a minimum of 2 weeks prior to commencement of structural steel erection work. The Contractor's project manager, structural steel fabricator, hauler, structural steel erector's project manager, field superintendent, and bolting foreman shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder shall be an integral part of the work. The Contractor shall immediately provide the Department Representative with any documentation required by the Occupational Health and Safety Regulations upon request.

6.3.2.3 Fall Protection System

The Contractor shall provide 100% fall protection system for structural steel erection and deck forming work. The fall protection system and an associated safe work procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall provide a copy of the fall protection system and safe work procedure to the Department Representative a minimum of 2 weeks prior to commencement of the work. The fall protection system shall be removed after the deck formwork has been removed and deck concrete has been reviewed and accepted by the Department Representative.

6.3.2.4 Assembly

Members shall be assembled as shown on the Drawings and all fabrication match marks shall be followed. The material shall be carefully handled to prevent damage. Hammering shall not enlarge holes, damage or distort bolts, cylindrical erection pins or members.

Contact faying surfaces of bolted connections shall be cleaned to the satisfaction of the Department Representative prior to assembly of members. Contact surfaces that have not been cleaned to the satisfaction of the Department Representative shall be un-bolted and cleaned in accordance with Subsection 6.3.1.5, Faying Surfaces of Connections.

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be de-scaled or carry the normal tight mill scale as determined by the Department Representative. Contact surfaces shall be free of dirt, paint, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts.

Bolts in exterior girders shall be installed with the heads on the outside face of the girder web. Bolts located in the bottom flange of all girders shall have the heads installed on the bottom face of the lower splice plate unless noted otherwise. Nuts for bolts that will be partially embedded in concrete shall be located on the side of the member that will be encased in concrete.

Connections shall be assembled with a hardened washer under the bolt head or nut, whichever is the element turned in tightening. The smooth side of the hardened washer shall be placed against the structural steel. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel.

For sloped surfaces, bevelled washers shall be used. The bevelled washers shall be designed to produce a bearing surface normal to the bolt axis.

6.3.2.4.1 Storage of Bolts

Bolts shall be protected from dirt and moisture in closed containers at the site of installation. Only as many bolts as are anticipated to be installed during the work shift shall be taken from protected storage. Bolts that are not incorporated into the work shall be returned to protected storage at the end of the work shift. Bolts shall not be cleaned or modified from the as-delivered condition. Bolts that accumulate rust or dirt shall not be incorporated into the work

6.3.2.4.2 Pre-Installation Verification Testing

Prior to erection and the installation of bolts in joints/connections, the Contractor shall complete pre-installation verification testing in the presence of the Department Representative of the bolt assembly lot to be installed. Pre-verification testing of the bolt assembly lot shall be completed no more than 1 week prior to their installation. Each combination of bolt, nut and washer manufacturing lots will be considered a bolt assembly lot.

Pre-installation verification testing of bolts shall be completed in accordance with Section 7 of the Research Council on Structural Connections, Specification for Structural Joints Using High-Strength Bolts and these specifications. In the case of conflicting requirements, the requirements of these specifications shall govern.

Each tool to be used in the installation of bolts to complete snugging and tensioning procedures shall be used to complete a minimum of one of the pre-installation verification testing samples.

Each worker who will be installing bolts shall successfully complete one of the pre-installation verification test samples in the presence of the Department Representative using the same tools and methods that will be used in the actual installation. Any worker who under or overtightens bolts during pre-installation verification testing will not be permitted to install bolts unless they successfully complete a retest in the presence of the Department Representative. If any bolt fails to meet the specified minimum tension, the entire bolt assembly lot will be rejected.

6.3.2.4.3 Field Rotation Capacity Testing

Rotational capacity testing reports of bolt assembly lots shall be reviewed and accepted by the Department Representative in accordance with Subsection 6.2.4.2, Bolts prior to the commencement of preinstallation verification testing.

If in the opinion of the Department Representative the condition of bolt assemblies have changed during the work, the Contractor shall complete field rotational capacity testing. Field rotational capacity testing shall be completed in accordance with ASTM F3125/F3125M in the presence of the Department Representative. If any bolt sample tested fails to meet the specified requirements, as determined by the Department Representative, the entire bolt assembly lot will be rejected.

6.3.2.4.4 Erection Bolting

Unless otherwise detailed in the structural steel erection procedure, bolted field splice connections shall have a minimum of 25% of the holes filled with bolts and 25% of the holes filled with cylindrical erection pins. Bolts and pins shall be evenly distributed throughout the field splice connection upon assembly. Field splice connections carrying traffic during erection shall have 75% of the holes filled equally with bolts and cylindrical erection pins.

Bracing and diaphragm erection bolting requirements shall be detailed in the structural steel erection procedure.

Bolts shall be located on either side of cylindrical erection pin locations, except at locations where pins are located in the corners of bolted field splice connections.

Fit up bolts, if used during erection bolting to bring the plies of the connection into contact, shall be permanently marked and distinguishable in length and type from production bolts. Fit up bolts shall be of the same nominal diameter as production bolts. Cylindrical erection pins shall be 1 mm larger in diameter than the specified bolt size.

Cranes shall not be released from the structural steel component until all required erection bolts, cylindrical erection pins, temporary stability measures, and the bracing installation hold point has been accepted in writing by both the Contractor and the Department Representative.

When adjustments in elevation of field splices are required as determined by the Department Representative, only enough cylindrical pins or bolts shall be removed to allow free rotation of the splice.

6.3.2.4.5 Turn-of-Nut Method

All bolts within bolted joints/connections shall be tensioned using the turn-of-nut method for slip-critical joints/connections in accordance with Section 8 of the Research Council on Structural Connections, Specification for Structural Joints Using High-Strength Bolts and these specifications. In the case of conflicting requirements, the requirements of these specifications shall govern.

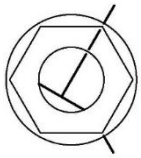
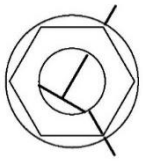
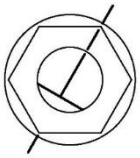
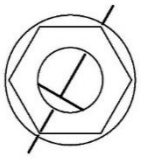
After erection bolting, but before final bolt tensioning, the remaining holes (without bolts or cylindrical erection pins) within a joint/connection shall be completely filled with bolts. Once the connection is completely filled with bolts and the number of cylindrical erection pins specified in the structural steel erection procedure, bolts shall be brought to a snug-tight condition to ensure that the parts of the joint/connection are brought into full contact with each other. Snug-tight condition is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a worker using an ordinary spud wrench. No visible gap shall remain between the faying surfaces when all bolts are brought to the snug-tight condition. The Department Representative shall be provided full access to assess the snug-tight condition of the joint/connection upon request. Joints/connections with individual plates greater than 25 mm in thickness, may require multiple cycles of sequential snug-tightening to minimize relaxation of previously tightened bolts prior to final tensioning.

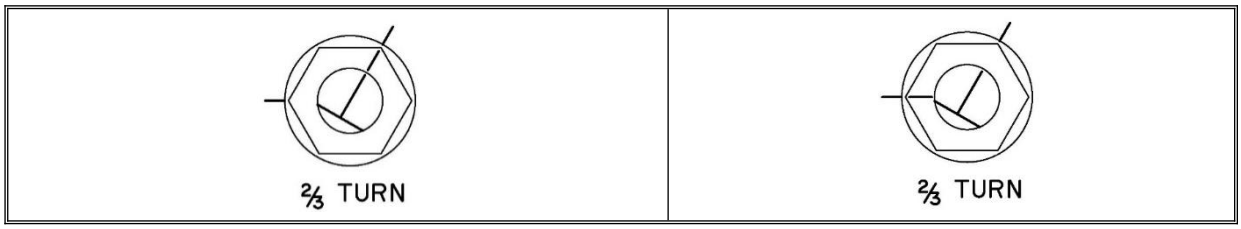
Snug-tightening and final tensioning shall be completed sequentially from the most rigid part of the joint/connection to its free edges. The sequence of snug-tightening and final bolt tensioning shall be detailed in the structural steel erection procedure. The elevation and alignment of girders, including bracing and diaphragms, or other structural steel components, shall be reviewed and accepted by the Department Representative prior to any final bolt tensioning.

After all bolts in the joint/connection have been acceptably brought to the snug-tight condition, the Contractor shall accurately match mark the protruding end of bolt, outer face of each nut, and steel surfaces in accordance with Table 6-1, Required Match Markings for Turn-of-Nut Tightening. Once all bolts in the joint/connection have been accurately match marked, they shall be tensioned by the applicable amount of additional nut rotation. During this operation there shall be no rotation of the part not being turned by the tightening tool. The amount of rotation of nut relative to the bolt, regardless of whether the nut or bolt is turned, shall be as follows:

- 1/3 turn where bolt length is 4 bolt diameters or less;
- 1/2 turn where bolt length is over 4 bolt diameters and not exceeding 8 bolt diameters;
- 2/3 turn where bolt length exceeds 8 bolt diameters.

Table 6-1 Required Match Markings for Turn-of-Nut Tightening

Match Markings After Snug-Tight Before Turn-of-Nut for Fraction of Required Turn	**Match Markings After Turn-of-Nut for Fraction of Required Turn**
	
	



The rotational tolerance shall be +1/6 (60°), – 0 (nothing less than the minimum specified).

Once the bolts of the joint/connection have acceptably received the applicable amount of nut rotation and final tensioning is complete as determined by the Department Representative, cylindrical erection pins used for erection bolting shall be removed. After cylindrical erection pins have been removed, the remaining holes shall be filled with bolts; the bolts brought to a snug-tightened condition; match marked; and final tensioning completed. Snug-tightening and final tensioning at this stage shall also be completed sequentially from the most rigid part of the joint/connection to its free edges.

6.3.2.4.6 Bolt Tension

Each bolt shall be tightened so as to provide, when all bolts in the joint are tight, at least the minimum bolt tension shown in Table 6-2, Bolt Tension for the size of bolt used.

Table 6-2 Bolt Tension

Specified Bolt Size	**Minimum Bolt Tension**		**Equivalent Imperial Size**	**Minimum Bolt Tension**	
(ASTM F3125 Grade A325M Bolts)	**Kilonewtons**	**pounds-force**	**(ASTM F3125 Grade A325M Bolts)**	**Kilonewtons**	**pounds-force**
M16X2	94	21,180	5/8	85	19,200
M20X2.5	147	33,050	3/4	126	28,400
M22X2.5	181	40,700	7/8	175	39,250
M24X3	212	47,660	1	227	51,500
--	--	--	1 1/8	251	56,450
M30X3.5	337	75,760	1 1/4	319	71,700
--	--	--	1 3/8	380	85,450
M36X4	490	110,160	1 1/2	463	104,000

6.3.2.4.6.1 Reuse of Bolts

Bolts shall only be tensioned once. Reuse of bolts will not be permitted. Retightening previously tightened bolts, which may have loosened by tightening of adjacent bolts, will not be considered reuse.

6.3.2.4.6.2 Inspection

The Contractor and the Department Representative shall inspect bolt tightening of all joint/connections in accordance with Section 9 of the Research Council on Structural Connections Specification for Structural Joints Using High-Strength Bolts. Both the Contractor and the Department Representative shall provide written acceptance of all joints/connections and in accordance with the structural steel erection ITP.

The Contractor shall provide safe and adequate access meeting the Northwest Territories Safety Act and Occupational Health and Safety Regulations to all working areas, including all necessary access equipment to enable the Department Representative to carry out their inspection. The Contractor shall provide a competent workman to assist the Department Representative in the checking of bolt tightening work.

When the Contractor or the Department Representative determine that bolts may not have the specified tension, the arbitration process outlined in Section 10 of the Research Council on Structural Connections Specification for Structural Joints Using High-Strength Bolts shall be used to determine the acceptability of the joint. All joints/connections shall be tensioned to the satisfaction of the Department Representative.

6.3.2.5 Structural Steel Adjustment

Adjustment to position, bearing location and bearing elevation of girders or other structural steel components shall be completed to achieve the lines and grades shown on the Drawings or those reviewed and accepted by the Department Representative.

The Contractor shall maintain the correct alignment of the structural steel at all times during construction.

6.3.2.6 Misfits

Misfits shall be immediately reported to the Department Representative. The Contractor shall submit a detailed repair procedure to the Department Representative for review and acceptance to correct misfits. Repairs shall not be completed until the repair procedure has been reviewed and accepted by the Department Representative. Reaming of primary members will not be permitted.

6.3.2.7 Straightening Bent Material

Straightening of plates, angles or other shapes will not be permitted without the acceptance of the Department Representative. In all cases, a detailed written procedure shall be submitted to the Department Representative for review and acceptance prior to any straightening being undertaken. The procedure to straighten bent material will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Following the accepted straightening of a bend or buckle, the surface of the metal shall be inspected for evidence of fractures, which may include non-destructive testing. The Department Representative will determine the type of NDT required to be completed by the Contractor. All costs associated with straightening bent material shall be the responsibility of the Contractor.

6.3.3 Removal of Temporary Supporting Structures and Clean-up

Upon completion of structural steel erection, the Contractor shall remove all earth material or temporary supporting structures used during construction. The Contractor shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of their work. Disposal of surplus materials shall be in a manner and location satisfactory to the Department Representative.

The Contractor shall leave the bridge site, roadway and adjacent property in a condition acceptable to the Department Representative. When required, the Contractor shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

6.3.4 Deck Joint Assembly (Extrusions)

6.3.4.1 Deck Joint Assembly (Extrusion) Delivery and Installation Inspection and Test Plan

The Contractor shall submit a deck joint assembly (extrusion) delivery and installation inspection and test plan (ITP) for deck joint assemblies (extrusions), and any other structural steel components identified in the Special Provisions of the Contract to the Department Representative a minimum of 4 weeks prior to commencement of the work. The Contractor's deck joint assembly (extrusion) delivery and installation ITP shall include, but not be limited to, transportation and delivery requirements, specified witness points and hold points, for each deck joint assembly (extrusions) being installed. The Contractor's deck joint assembly (extrusion) delivery and installation ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, inspection requirements, testing requirements, and reporting requirements.

No Work shall commence until the Contractor's deck joint assembly (extrusion) delivery and installation ITP has been reviewed and accepted in writing by the Department Representative.

If the work continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be solely responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

6.3.4.2 Watertightness Testing of Strip Seals and Cover Plated V-Seals

Upon completion of strip seals and cover plated v-seals deck joint assembly installation, the assemblies shall be tested by the Contractor in the presence of the Department Representative for leakage by flooding with water. Any areas of leakage shall be investigated and a repair procedure developed by the Contractor and submitted to the Department Representative for review and acceptance. The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative. Seals with cracks, tears, puncture damage, or other damage shall be removed and replaced, as determined by and to the satisfaction of the Department Representative.

6.4 Payment

6.4.1 Structural Steel

Payment for structural steel will be made at the lump sum price bid for "Structural Steel – Supply and Fabrication, Delivery and Erection" for the type and size specified, and will be full compensation for the supply and fabrication of structural steel; for inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; storage at the project site; erection; assembly; installation; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. The lump sum price bid will be paid in accordance with Subsection 6.4.1.1, Supply and Fabrication, Subsection 6.4.1.2, Delivery, and Subsection 6.4.1.3, Erection.

6.4.1.1 Supply and Fabrication

50% of the lump sum price bid for "Structural Steel – Supply and Fabrication, Delivery and Erection" will be paid once the structural steel has been acceptably supplied; fabricated; inspected; tested; stored; and written acceptance within the supply and fabrication inspection and test plan has been provided by both the Department Representative and the Contractor for each specified witness point and hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the supply and fabrication inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for supply and fabrication of structural steel; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. Monthly payments will be considered on a pro-rata basis for girder segments acceptably completed.

6.4.1.2 Delivery

25% of the lump sum price bid for "Structural Steel – Supply and Fabrication, Delivery and Erection" will be paid once the structural steel has been acceptably loaded; transported; hauled; unloaded; stored; cleaned and/or repaired, if required; and written acceptance of the transportation, handling and storage inspection hold point has been provided by both the Department Representative and the Contractor. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for delivery of structural steel; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. All necessary approvals and permits, will be considered incidental to the Work and no separate or additional payment will be made. Monthly payments will be considered on a pro-rata basis for girder segments acceptably completed.

6.4.1.3 Erection

25% of the lump sum price bid for "Structural Steel – Supply and Fabrication, Delivery and Erection" will be paid once the structural steel has been acceptably erected, assembled, and installed; and written acceptance within the structural steel erection inspection and test plan has been provided by both the Department Representative and the Contractor for each specified hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the structural steel erection inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for erection of the structural steel; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. Monthly payments will be considered on a pro-rata basis for girder segments acceptably completed.

6.4.2 Deck Joint Assemblies (Extrusions)

Payment for structural steel deck joint assemblies will be made at the lump sum prices bid for "Deck Joint Assemblies – Supply, Fabrication, Delivery and Installation" for the type(s) specified, and will be full compensation for the supply and fabrication of deck joint assemblies (extrusions); for storage; loading; transporting; hauling to the project site; unloading; cleaning, if required; storage at the project site; assembly; installation; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

The lump sum price bid will be paid in accordance with Subsection 6.4.2.1, Supply and Fabrication, and Subsection 6.4.2.2, Delivery and Installation.

6.4.2.1 Supply and Fabrication

60% of the lump sum price bid for "Deck Joint Assemblies – Supply, Fabrication, Delivery and Installation" will be paid once the deck joint assembly (extrusion) has been acceptably supplied; fabricated; inspected; tested; stored, loaded; transported; hauled, unloaded, stored, cleaned and/or repaired, if required and written acceptance within the supply and fabrication inspection and test plan has been provided by both the Department Representative and the Contractor for each specified witness point and hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the supply and fabrication inspection and test plan has not been provided. Payment will be full compensation for supply and fabrication of structural steel; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. Monthly payments will be considered on a pro-rata basis for deck joints acceptably completed.

6.4.2.2 Delivery and Installation

40% of the lump sum price bid for "Deck Joint Assemblies – Supply, Fabrication, Delivery and Installation" will be paid once the deck joint assembly (extrusion) has been acceptably delivered; installed; and written acceptance within the delivery and installation inspection and test plan has been provided by both the Department Representative and the Contractor for each specified witness point and hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. Payment will be full compensation for supply and fabrication of structural steel; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. Monthly payments will be considered on a pro-rata basis for deck joints acceptably completed.

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7.1 General

This specification is for the supply, delivery, erection, and post-tensioning of precast concrete units.

Precast concrete units, also referred to "units" in this Section, shall include girders, full- and partial-depth deck panels, approach slabs, abutment and pier caps, and any other components produced with precast concrete. Also included are bracing, fasteners, shoe plates, deck drains, anchor rods, dowels, buffer angles, anchor rod sleeves, any other miscellaneous components and associated materials as shown on the Drawings or specified in the Special Provisions of the Contract.

Girder types referenced in this Section correspond to Alberta Transportation girder types in accordance with Alberta Transportation Standard Drawings. However, girders referenced in this Section also encompasses all other precast concrete girder types.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

7.2 Supply and Fabrication

The Contractor shall be responsible for the work of fabricators and their sub-contractors. Qualification and Contract requirements shall apply to all fabricators and their sub-contractors.

The fabrication of prestressed and precast concrete units shall be in accordance with CSA A23.4 and the Precast/Prestressed Concrete Institute (PCI) Quality Control Manual MNL-116, with the most stringent of the requirements governing. All Quality Control requirements within these standards shall be met by the fabricator.

The Contractor shall submit a supply and fabrication inspection and test plan (ITP) for precast concrete units to the Department Representative a minimum of 6 weeks prior to commencement of the work. The Contractor's supply and fabrication ITP shall include, but not be limited to, all specified witness points, hold points, inspection and testing requirements, and the associated acceptance criteria for each component being fabricated. The Contractor's supply and fabrication ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, quality control inspection and testing, and reporting requirements.

Fabrication shall not commence until the Contractor's supply and fabrication ITP has been reviewed and accepted in writing by the Department Representative.

7.2.1 Qualifications

Precast concrete units shall be supplied and fabricated by a fabricator certified by the Canadian Precast Concrete Quality Assurance (CPCQA) Certification Program in the applicable Product Group classification.

The fabrication of precast concrete units shall be done in a sufficiently large environmentally controlled permanent building capable of supplying and fabricating products in a well-organized and continuous operation. A permanent building is defined as a steel, wood, or concrete framed insulated structure that incorporates supporting walls or columns and a permanently framed roof that may or may not be retractable. The permanent building shall incorporate overhead doors to facilitate the movement of materials in and out of the structure. The permanent building temperature shall be maintained between 15ºC and 30ºC and prevent contamination and/or deterioration of materials.

7.2.2 Prefabrication Submissions

The Contractor shall submit the following information to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of fabrication unless noted otherwise:

- List of fabricators and qualifications;
- Fabrication sequence and equipment;
- Mill test reports and product data sheets;
- Shop drawings;
- Prestressing strand load/elongation curves and jack calibration certificates;
- Stressing calculations;
- Modifications to precast concrete units, if applicable;
- Concrete mix design;
- Curing and finishing requirements; and
- Fabrication schedule.

Prefabrication submissions will be considered hold points and shall be included in the Contractor's supply and fabrication ITP. The Contractor and the Department Representative shall provide written acceptance of the prefabrication submission hold points in the supply and fabrication ITP prior to the commencement of fabrication.

7.2.2.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications. The Contractor shall also submit the quality control plans, proofs of qualifications and certifications, and certification audit reports of all fabricators and their sub-contractors.

7.2.2.2 Fabrication Sequence and Equipment

The Contractor shall submit details of the fabrication sequence and equipment that will be used to complete the work. The fabrication sequence, at a minimum, shall include the order of fabrication and details of surface preparation, casting, curing and storage.

7.2.2.3 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided in English for all materials a minimum of 1 week prior to the commencement of fabrication.

Re-classification of materials using a mill test report or mill test report verification testing data will not be permitted.

In addition to the reporting of the yield strength, breaking strength, and elongation properties of prestressing strand, relaxation properties shall be included on the mill test report. Verification of relaxation properties from prestressing strand manufactured outside Canada or the United States of America will not be required.

Mill test reports and rotational capacity testing for fasteners shall be submitted to the Department Representative for review and acceptance 6 weeks prior to the commencement of erection, assembly or installation.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. Boron content verification testing is only required for steel that is being welded. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

7.2.2.4 Shop Drawings

Shop drawings shall be provided in electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- Properties of all materials used;
- Material properties, material reference standards, and product data sheets for each component;
- Dimensional information of all precast concrete units;
- Reinforcing steel;
- Prestressing strand;
- Steel diaphragms;
- Miscellaneous steel;
- Blockouts and Voids;
- Stressing system;
- Anchorage and hold down devices;
- Void support system; and
- Screed rail details.

Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work.

The shop drawings will be reviewed by the Department Representative solely to determine general conformance with the Contract. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate final as-built details into the shop drawings, including the actual mill test report heat numbers for each component. One unlocked electronic copy (PDF format) of as-built shop drawings shall be submitted to the Department Representative within 3 weeks of construction completion.

7.2.2.5 Prestressing Strand Load/Elongation Curve and Jack Calibration Certificates

A copy of the load/elongation curve for each lot of prestressing strand shall be submitted to the Department Representative for review and acceptance. All prestressing strand load/elongation curves shall be provided in English and be legible.

Jack calibrations shall be completed no more than 6 months prior to stressing. Jack calibration certificates shall be provided to the Department Representative for review and acceptance with stressing calculation design notes and independent check notes. Jack calibration shall be completed by a certified independent agency.

7.2.2.6 Stressing Calculations

The Contractor shall submit design notes and independent check notes of stressing calculations. The design notes and independent check notes will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The design notes and independent check notes will be reviewed by the Department Representative for conformance with the Government of the Northwest Territories' design requirements and the Contract requirements. Review comments provided by the Department Representative shall be incorporated into the design notes and independent check notes and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work. The design engineer of record and independent checker shall submit separate authenticated design notes and check notes. The design and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement of fabrication.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

7.2.2.7 Modifications to Precast Concrete Units

If modifications to precast concrete units are proposed by the Contractor, design notes, independent check notes, and shop drawings shall be submitted to the Department Representative for review and acceptance a minimum of 6 weeks prior to commencement of the work. The design notes, independent check notes, and shop drawings will be reviewed by the Department Representative for conformance with the Government of the Northwest Territories' design requirements and the Contract requirements. Review comments provided by the Department Representative shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work. The design notes, independent check notes and shop drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The design engineer of record and independent checker shall submit separate authenticated design notes and check notes. The design notes and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement of fabrication.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

7.2.2.8 Concrete Mix Design

Concrete mix designs shall be submitted to the Department Representative in accordance with Subsection 4.4.3, Concrete Mix Design Submission Requirements for review and acceptance.

The mix design shall specify the maximum slump or slump flow at which the mix is stable without segregation. The maximum slump or slump flow of the concrete used in the production shall be 10 mm less than the limit identified in the concrete mix design. The visual stability index of flowable concrete shall not be greater than 1 in accordance with CSA A23.2-19C.

The Contractor is required to complete a trial batch for each concrete mix. The trial batches shall be performed a minimum of 28 days prior to placement of concrete. Written notification of the trial batch schedule shall be provided to the Department Representative a minimum of 1 week prior to commencement of the trial batch. The fabricator's quality control manager shall attend all trial batches. Trial batch testing shall include slump or slump flow, air content, and temperature measurements at 15, 30, and 60 minutes after batching. Trial batch testing shall also include stripping/release, 7 and 28 day concrete compressive strength testing and hardened air void system in accordance with the requirements of Subsection 4.4.1.2, Class HPC and Class HPC with Steel Fibres.

Sampling and testing of concrete completed for trial batches shall be completed in accordance with Subsection 4.9, Inspection and Testing. An independent testing laboratory certified to CSA A283 shall complete all hardened concrete testing in accordance with the specified material reference standards.

Only the reviewed and accepted concrete mix design shall be used. No changes to the reviewed concrete mix design will be permitted. If changes are proposed by the Contractor, a new concrete mix design review letter shall be provided in accordance with Subsection 4.4.3, Concrete Mix Design Submission Requirements, and trial batches completed.

All trial batch testing shall be repeated at a minimum frequency of 180 days in conjunction with the required petrographic examination of coarse and fine aggregate testing.

7.2.2.9 Fabrication Schedule

The Contractor shall provide and maintain a current and complete fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors.

7.2.3 Prefabrication Meeting

A prefabrication meeting shall be held for the supply and fabrication of precast concrete units.

The prefabrication meeting shall not occur until the prefabrication submission hold points have been completed, reviewed and written acceptance provided by both the Contractor and the Department Representative.

The prefabrication meeting shall be coordinated by the Contractor and held at the fabricator's facility on a date and time acceptable to the Department Representative. A minimum of 2 weeks advance notice shall be provided to the Department Representative prior to the date of the proposed prefabrication meeting.

The Contractor, fabricator and their sub-contractors shall be in attendance at the prefabrication meeting including project manager(s), fabrication superintendent(s), independent testing agency representatives, and all employees involved in supervision of the work.

The Department Representative will prepare the prefabrication meeting agenda and chair the meeting.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (up to 3 representatives from the Government of the Northwest Territories and consultant) to attend prefabrication meeting(s) outside the Northwest Territories.

7.2.4 Materials

7.2.4.1 Hydraulic Cement

Hydraulic cement shall meet the requirements of CSA A3001.

7.2.4.2 Water

Water to be used for mixing concrete, concrete patching materials, or concrete finishing materials, shall conform to the requirements of CSA A23.1 and shall be free from harmful amounts of alkali, organic materials or deleterious substances. The Contractor shall not use slurry water, treated wash water or water from shallow, stagnant or marshy sources.

7.2.4.3 Silica Fume

Silica fume shall conform to the requirements of CSA A3001, Type SF have a minimum SiO_2 content of 85%, a maximum loss on ignition of 10%, and no more than 1% SO_3 content.

7.2.4.4 Aggregates

Fine and coarse standard weight aggregates shall meet the requirements of Subsection 4.4.3, Concrete Mix Design Submission Requirements.

The maximum coarse aggregate size shall be 14 mm.

7.2.4.5 Air Entraining Agent

Air entraining agent shall conform to the requirements of the ASTM C260/C260M.

7.2.4.6 Admixtures

Admixtures shall be compatible with all mix constituents.

Water reducing agents and superplasticizers shall conform to ASTM C494/C494M.

The addition of calcium chloride, retarders, accelerators or set controlling admixtures and air reducing agents will not be permitted.

7.2.4.7 Concrete

Concrete shall consist of hydraulic cement, condensed silica fume, coarse and fine aggregates, water and admixtures. Concrete strength requirements will be specified on the Drawings.

10% silica fume by weight of cement (±0.5%) shall be used in all precast concrete.

Air content shall be in accordance with CSA A23.1 Table 4, based on the maximum aggregate size used.

The maximum air void spacing of hardened concrete shall be 230 μm.

7.2.4.8 Reinforcing Steel

Reinforcing steel shall conform to Section 5, Reinforcing Steel.

7.2.4.9 Prestressing Strand

Prestressing strand shall be uncoated Grade 1860, low relaxation 7-wire strand conforming to the requirements of ASTM A416/A416M. Shop drawings and stressing calculations shall clearly identify the type of prestressing strand to be used. Changes to the type of prestressing strand during fabrication will not be permitted.

7.2.4.10 Lifting Hooks

Prestressing strand used for fabricating lifting hooks shall conform to the requirements of the ASTM A416/A416M and shall be fabricated in a manner that distributes the load evenly to all strands.

7.2.4.11 Miscellaneous Steel, Steel Diaphragms and Fasteners

Miscellaneous steel and steel diaphragms shall be in accordance with the material standards specified on the Drawings. The fabrication of steel materials shall be completed in accordance with Section 6, Structural Steel and these specifications.

The boron content of steel to be welded shall not exceed 0.0008%.

All bolts shall conform to ASTM F3125/F3125M Grade A325/A325M heavy hex style Type 1 galvanized.

Nuts shall be heavy hex style and shall conform to ASTM A563M.

Hardened washers shall conform to ASTM F436/F436M.

Rotational capacity testing and reporting shall be performed in accordance with ASTM F3125/F3125M for each assembly lot of bolts, nuts and washers and results submitted to the Department Representative for review and acceptance.

7.2.4.12 Anchor Rods for Bridgerail

Anchor Rods for bridgerail anchor assemblies shall meet the requirements of Subsection 12.2.4.2, Anchor Rods and be hot dip galvanized after fabrication. All nuts and washers shall be shop assembled on the anchor rods.

7.2.4.13 Voids, Ducts, and Conduit

Duct and conduit materials shall meet the requirements of Section 11, Ducts and Conduits and the Drawings and product data sheets submitted to the Department Representative for review and acceptance.

Void material shall be multiple layers of 100 percent recycled paperboard, spirally wound, and laminated with adhesive or a moulded closed cell expanded polystyrene insulation product conforming to the requirements of CAN/ULC-S701 Type 1 or an equivalent acceptable to the Department Representative.

All voids, ducts, and conduits shall remain dimensionally stable during the casting and steaming of the precast concrete units. Voids shorter than 400 mm shall not be used unless noted on the Drawings.

Post-Tensioning ducts shall be corrugated, semi-rigid galvanized metal tubes and be capable of withstanding concrete pressures without excessive deformation or permitting the entrance of the cement paste during the placement of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of support. The interval between supports shall not exceed 1.0 m.

7.2.4.14 Galvanizing

Galvanizing shall be completed in accordance with Subsection 6.2.7.3, Galvanizing and Metallizing.

7.2.5 Fabrication

7.2.5.1 Forms

Precast concrete units are to be fabricated in steel forms which are acceptable to the Department Representative.

For all beam members the forms shall be designed to be removed without damaging the beam. For all “I” or “T” Beam members the side forms shall be designed to be removed without damaging the top flange of the beam. The forms shall be removed horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. The top flange shall not be subjected to a vertical force at any time.

Holes or voids cast into the top flange of “I” or “T” girders to accommodate deck formwork will not be permitted.

7.2.5.2 Reinforcing Steel

Fabrication, handling, storage, and fastening of all steel reinforcement shall conform to Section 5, Reinforcing Steel.

Reinforcing steel placing tolerances shall be in accordance with Subsection 7.2.5.4, Void, Duct, Conduit and Reinforcement Placing Tolerances.

The Contractor shall place and fasten the reinforcement and have the work inspected and accepted by the Department Representative prior to placement of concrete.

7.2.5.3 Prestressing Strand

Placement of prestressing strand and post tensioning ducts shall be in accordance with Subsection 7.2.5.4, Void, Duct, Conduit and Reinforcement Placing Tolerances.

Prestressing strand shall be free of corrosion, dirt, grease, rust, oil or other foreign material that may impede bond between the steel and the concrete. Prestressing strand shall be protected at all times during manufacture through to encasing in concrete or grout. Prestressing strand that has sustained physical damage at any time shall be rejected. Prestressing strand splices shall not be placed within a precast concrete unit.

The Contractor shall submit the methods, procedures and devices to accurately position the prestressing strand to the Department Representative for review and acceptance. The submission shall include strand anchorage, draping, hold downs, guides or any other required devices.

Prestressing strands shall not be stressed more than 36 hours prior to being encased in concrete. The force in each prestressing strand shall be measured by both elongation and pressure gauge.

Each prestressing strand shall be stressed to a calculated elongation, and a gauge pressure reading shall be taken as a check against the calculated force. During stressing, each prestressing strand shall first be pulled to a predetermined pre-pull gauge pressure to eliminate any slack and a reference mark be placed on the prestressing strand at the front of the stressing jack. A second mark shall be placed on the prestressing strand away from the first with a distance corresponding to the calculated elongation on the stressing sheet. Each prestressing strand shall then be pulled to the second reference mark and the gauge pressure reading taken.

This process may be reversed, i.e. each prestressing strand shall be stressed to a calculated force (determined by a gauge pressure calibration chart) and the elongation shall be measured as a check against the calculated force. During stressing, each prestressing strand shall first be pulled to a predetermined pre-pull gauge pressure to eliminate any slack and a reference mark be placed on the prestressing strand at the front of the stressing jack. Each prestressing strand shall then be stressed to the gauge pressure corresponding to the stressing sheet and a second reference mark be placed on the prestressing strand at this gauge pressure. The elongation shall be the distance measured between the two reference marks.

At the completion of tensioning, the two control measurements, force and elongation, shall meet the verification requirements of Subsection 5.2.2, Tensioning of Tendons, of the Precast/Prestressed Concrete Institute (PCI) Quality Control Manual MNL-116-99.

Changes in prestressing strand temperature and slippage at prestressing strand anchorages shall be measured between stressing and concrete encasement and any changes in prestressing strand stress due to these effects shall be accounted for in the design. The stressing procedure and stressing calculations shall be submitted for review and acceptance of the Department Representative.

Prestressing strand with any broken or damaged wire shall be removed and replaced. All prestressing strands shall be checked for wire breaks and damage before placement of concrete. Prestressing strand damage includes nicks, gouges, and indentations.

The precast concrete unit ends shall have 15 mm deep prestressing strand termination recesses formed around the strands. All prestressing strands shall be cut flush with the bottom of the recesses, and the recesses shall then be filled flush with the ends of the units with a moisture insensitive epoxy paste adhesive meeting the requirements of ASTM C881/C881M Type IV, Grade 3, Class B or C. The paste shall be grey in colour. An approved Type 1c sealer shall be applied over the patched recessed areas in accordance with Subsection 7.2.5.14, Concrete Sealer. Sealer shall not be applied to the patched recessed areas when precast concrete unit ends are designed to be encased in field cast concrete.

The Contractor shall provide traceability of prestressing strand by recording the young's modulus (E value) and heat/coil number for each prestressing strand placed into each precast component by including this information on the shop drawing. A shop drawing for each component with the prestressing strand traceability information along with the original handwritten stressing sheets signed by the stressing technician and the plant QC manager shall be submitted to the Department Representative upon completion of the fabrication process.

7.2.5.4 Void, Duct, Conduit and Reinforcement Placing Tolerances

Voids, ducts, and conduits shall be placed as shown on the Drawings and must be tied and securely held in the required positions to prevent movement. Continuous ducts shall align precisely. The ends of the voids shall be sealed by methods reviewed and accepted by the Department Representative. Voids found to be distorted, damaged or of insufficient strength, as determined by the Department Representative, will be rejected. Blow holes caused by air expanding within the voids and rising to the surface, shall be repaired when the concrete is still in the plastic state.

Reinforcing steel, prestressing strand, and post-tensioning ducts for precast concrete shall be placed within the following tolerances:

- Concrete cover: ± 5 mm;
- Vertical position of prestressing strand: ± 5 mm;
- Post-tensioning ducts: ± 10 mm, except ± 5 mm at splice points;
- Length of debond on prestressing strand: ± 50 mm;
- Stirrup spacing:
    - When spacing is 100 mm or less: ± 15 mm;
    - When spacing is greater than 100: ± 25 mm;
    - When spacing is 300 mm or greater: ± 30 mm;
- Location, where the smallest dimension of the element is:
    - 400 mm or less: ± 8 mm;
    - Larger than 400 mm but less than 800 mm: ± 12 mm;
    - 800 mm or larger: ± 20 mm;
- Longitudinal locations and ends of bars, except at ends or edges of elements: ± 50 mm; and
- Longitudinal location of ends of bars at ends or edges of elements: ± 20 mm.

The clear distance between reinforcement shall not be less than 1.5 times the nominal diameter of the reinforcement, 1.5 times the maximum coarse aggregate size, or 40 mm.

Post-tensioning duct support spacing shall not exceed 1000 mm.

7.2.5.5 Identification of Precast Concrete Units

The fabricator's name, year of fabrication, unit serial number and design loading shall be cast into the bottom of the precast concrete units in 50 mm letters approximately 1 m from the precast concrete unit end.

7.2.5.6 Concrete Measuring, Mixing and Placing

The procedures outlined in ACI Standard 304, Guide for Measuring, Mixing, Transporting and Placing Concrete, shall be followed. The time from initial mixing of the concrete until placing the concrete in the forms shall not exceed 1 hour. The rate of concrete placement shall be such that cold joints do not occur.

7.2.5.7 Concrete Temperature

The concrete temperature shall be between 10°C and 30°C at the time of placing in the forms.

7.2.5.8 Riding Surface Finish

Where the top surface of the unit is designed to be the riding surface, the use of a continuous screed rail, independent of the top of the grout keys, shall be used. The top surface shall follow a smooth profile, which incorporates the required camber adjustments.

7.2.5.9 Camber Hubs

Three camber hubs shall be placed in each girder or other applicable unit, located along the centreline of the girder at the midspan and 150 mm from each end. The camber hubs shall consist of 10 mm galvanized threaded rods inserted in to an internally threaded insert cast a minimum of 20 mm below the concrete surface. The threaded rod camber hubs shall be of sufficient length to project vertically 10 mm above the girder top surface.

The Contractor shall store the units in such a manner as to provide access for measuring camber as determined by the Department Representative. The Contractor shall provide personnel as requested to assist the Department Representative with the camber readings. The Contractor shall record the camber at the midspan of each girder within 24 hours of destressing.

7.2.5.10 Concrete Surface Finishes

The exposed face of exterior units shall have a Class 2 rubbed surface finish, unless specified otherwise. Other than the top surface, all remaining surfaces shall have a Class 1 ordinary surface finish.

For NU girders with conventional abutment systems the abutment ends of girder units shall receive an abrasive blast followed by the application of a hot applied rubberized asphalt membrane meeting the requirements of Section 16, Waterproofing. For girders with post tensioning, the hot rubberized asphalt membrane shall be applied to the girder end after the post tensioning blockouts have been filled with concrete.

7.2.5.10.1 Class 1 Ordinary Surface Finish

7.2.5.10.1.1 Unformed Surfaces

Immediately following placing and consolidation, the concrete shall be screeded to conform to the required surface elevations, and then floated to ensure that the surface is free from open texturing, plucked aggregate, and local projections or depressions.

When checked with a 1.2 m long straight edge placed in any direction on the concrete surface, the gap between the bottom of the straight edge and the concrete surface shall not exceed 3 mm unless specified otherwise.

7.2.5.10.1.2 Formed Surfaces

This finish is essentially that obtained when concrete has been cast and adequately consolidated in an acceptably oiled steel form. All fins, honeycomb, irregularities, cavities over 10 mm diameter or other similar defects shall be thoroughly chipped out. These areas shall be saturated with water for a period of not less than thirty minutes, carefully pointed and trued with mortar of a colour which will match the existing concrete. Mortar used for pointing shall be less than 1 hour old. The patches shall be properly cured by placing the repaired precast concrete unit in the steam cure for a period of four days immediately after patching. The finished surfaces shall be true and uniform. Surfaces that are not repaired to the satisfaction of the Department Representative shall receive a Class 2 rubbed surface finish.

7.2.5.10.2 Class 2 Rubbed Surface Finish

Immediately following the removal of forms, all concrete fins and irregular projections shall be removed and concrete surfaces thoroughly exposed. Once concrete surfaces have been exposed they shall be inspected to determine the presence of defects in accordance with Subsection 7.2.5.13, Concrete Defects.

After surface preparation has been reviewed and accepted by the Department Representative, surface voids greater than 19 mm diameter but less than 0.05 m^2 in area and less than or equal to 30 mm deep shall be filled with an approved concrete patching material listed on Alberta Transportation's Products List in the Overhead/Vertical (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and placed in accordance with the manufacturer's published product data sheet. Surface voids less than 19 mm in diameter and less than or equal to 30 mm deep may be filled with a pre-bagged sack rub material. Sack rub materials shall be mixed and placed in accordance with the manufacturer's recommendations over the entire prepared surface. Sack rub and patching materials shall be cured in accordance with the manufacturer's recommendation. The use of curing compounds will not be permitted. When the patching and sack rub materials have adequately cured, a carborundum stone or method acceptable to the Department Representative shall be used to finish the surface to a smooth, uniform and closed texture. Any voids or cavities opened during the stone rubbing process shall be refilled. Parging or surface patching to correct irregularities will not be permitted.

All prepared concrete surfaces, including all patching and sack rubbing shall be uniform in colour and texture. After the surface preparation has been completed to the satisfaction of the Department Representative, the Contractor shall apply sealer as required in Subsection 7.2.5.14, Concrete Sealer. If application of the Type 1c sealer is applied in a uniform and manner acceptable to the Department Representative, any subsequent change in the uniformity of concrete surface colour will be considered acceptable.

7.2.5.10.3 Class 3 Bonded Concrete Surface Finish

Concrete surface finish shall be completed in accordance with Subsection 7.2.5.10.2, Class 2 Rubbed Surface Finish, except that uniformity in colour is not required.

After the surface finish has been completed to the satisfaction of the Department Representative, the concrete surface shall be pressure washed to remove all dust, dirt, laitance and all other bond breaking materials. After the concrete surface has dried for a minimum of 24 hours and before becoming contaminated with dust or other bond breaking materials, the Contractor shall apply an approved pigmented concrete sealer that meets the requirements for a Type 3 sealer of the Alberta Transportation Material Testing Specifications for Concrete Sealers B388.

The pigmented Type 3 concrete sealer shall be applied in accordance with the manufacturer's specifications and as a minimum two applications totaling Alberta Transportation's approved application rate of the pigmented sealer are required. The colour(s) of the proposed coating scheme, which typically shall be similar to the natural colour of cured concrete, must be acceptable to the Department Representative before application of the coating. If a colour scheme has been designed for the site it will be specified in the Special Provisions. When spray application is used the surface shall be back rolled. The Contractor shall ensure that no colour variation is visible and shall match the colour of any previously sealed adjoining surfaces. Acceptance of the pigmented sealer used will not be considered to relieve the Contractor of the sole responsibility for its acceptable performance and appearance.

7.2.5.10.4 Class 4 Floated Surface Finish

After the concrete has been consolidated and the surface carefully screeded to the cross section and profile shown on the Drawings, it shall be floated as necessary to provide a closed, uniformly textured surface without brooming.

7.2.5.10.5 Class 5 Floated Surface Finish, Broomed Texture

After the concrete has been consolidated, the surface shall be carefully screeded to the cross section and profile shown on the Drawings. When the concrete has hardened sufficiently, the surface shall be finished with a broom that is acceptable to the Department Representative. The broom strokes shall be perpendicular to the edge of the precast concrete unit, and extended from edge to edge, with adjacent strokes slightly overlapped producing corrugations of 2 to 3 mm in depth. Brooming shall be done when the concrete has set sufficiently to produce clear, crisp brooming marks which do not sag or slump, without tearing the surface or disturbing coarse aggregate particles. After final brooming the surface finish shall be free of porous spots, irregularities, depressions, pockets and rough spots and must not vary more than 5 mm when measured using a 3 m straight edge.

Finishing, grooving and edging tools acceptable to the Department Representative shall be used on all edges and joints after brooming.

7.2.5.11 Curing

All precast concrete units shall be cured at an elevated temperature. The curing of precast concrete units shall be in accordance with CSA A23.4 unless otherwise specified. The ambient curing temperature shall be increased at a rate not exceeding 20°C per hour until a maximum temperature of not more than 60°C is attained. After curing, the temperature of the precast concrete units shall be reduced at a rate not exceeding 10°C per hour until the temperature of the concrete has fallen to within 10°C of the ambient air temperature outside the enclosure.

The Contractor shall record and provide in formwork and after removal from formwork curing data including ramp-up and ramp-down temperature changes to the Department Representative. The Government of the Northwest Territories' asset ID number, precast concrete unit serial number, casting date, curing start date, additional curing days due to non-compliant days, and curing completion date shall be identified on the curing data submitted to the Department Representative for review and acceptance. A coloured graph documenting Time-Temperature-Humidity data throughout the curing phase shall be submitted as part of the curing data.

The Contractor shall protect precast concrete units from thermal shock at all times until the precast concrete units have been fully cured.

Two continuously recording thermometers and two continuously recording hygrometers shall be provided for each curing enclosure to monitor the concrete ambient temperature and relative humidity. All time-temperature and time-humidity recordings shall be clearly shown on the graph and all recordings shall be submitted to the Department Representative for review and acceptance.

7.2.5.11.1 Prestressed Precast Concrete Units

7.2.5.11.1.1 Curing in the Form

The initial application of heat shall commence only after the last of the freshly placed concrete has attained its initial set, normally 2 to 4 hours after casting. Heat shall not be applied directly to the concrete, but by a method that will produce a consistent ambient temperature throughout the entire form and enclosure. The increase in temperature and the holding temperature shall be monitored and permanently recorded by the Contractor on a chart at a minimum of 3 quarter points along the form.

7.2.5.11.1.2 Curing after Removal from the Form

Upon removal from the forms the precast concrete units shall be cleaned, patched, and finished within a period not exceeding 12 hours, except for application of concrete sealers which shall be applied in accordance with Subsection 7.2.5.14, Concrete Sealer. Precast concrete units shall be placed in a location and manner acceptable to the Department Representative that facilitates clean up or repair work and permits inspection of all surfaces.

Within 24 hours of form removal, precast concrete units shall be placed within an enclosure for curing. The curing enclosure shall provide a minimum of 150 mm of free air space between the concrete surfaces and the coverings. Flexible coverings shall be secured to prevent any moisture loss. The difference in ambient air temperature adjacent to the concrete at different locations within the enclosure shall not exceed 10°C at any time. The enclosure and its performance shall be acceptable to the Department Representative.

Curing within the enclosure shall commence immediately and be continuous for a period of not less than 4 days using one of the following methods:

Steam Curing;

- Steam jets shall not directly deposit steam onto concrete surfaces. The amount and temperature of the steam shall maintain the enclosure's atmosphere between 95% and 100% relative humidity and 40°C to 60°C;
- If 4 or more hours within a 24 hour period do not meet the specified temperature or humidity range, that 24 hour period shall not be included in the cure period and an additional 24 hours of steam curing will be required for each non-compliant period of time.

Curing with Continuous Misting and Heat;

- Atomizing misting nozzles shall be located to produce a fine mist and maintain the enclosure's atmosphere between 95% and 100% relative humidity. The water supply for misting shall be preheated. Radiant heaters shall be used to maintain the temperature within the enclosure to between 40°C to 60°C. Direct heat shall not be applied to the concrete surfaces at any time. An emergency control system shall be installed to turn off the heat if the humidity drops below 95% in the enclosure. If the temperature within the concrete exceeds 40°C without misting, the Department Representative will have cause to reject the precast concrete unit.

7.2.5.11.2 Non-Prestressed Precast Concrete Units

Curing of all non-prestressed precast concrete units shall be in accordance with one of the methods in the following Subsections.

7.2.5.11.2.1 Elevated Temperature Curing

The precast concrete units shall be cleaned, patched, finished and then cured in accordance with Subsection 7.2.5.11.1, Prestressed Precast Concrete Units. After surface preparation has been reviewed and accepted by the Department Representative, surface voids greater than 19 mm diameter but less than 0.05 m^2 in area and less than or equal to 30 mm deep shall be filled with an approved concrete patching material listed on the Alberta Transportation's Products List in the Overhead/Vertical (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and placed in accordance with the manufacturer's published product data sheet. Surface voids less than 19 mm in diameter and less than or equal to 30 mm deep may be filled with a pre-bagged sack rub material. Sack rub materials shall be mixed and placed in accordance with the manufacturer's recommendations over the entire prepared surface. Sack rub and patching materials shall be cured in accordance with the manufacturer's recommendation. The use of curing compounds will not be permitted. When the patching and sack rub materials have adequately cured, a carborundum stone or method acceptable to the Department Representative shall be used to finish the surface to a smooth, uniform and closed texture. Any voids or cavities opened during the stone rubbing process shall be refilled. Parging or surface patching to correct irregularities will not be permitted.

7.2.5.11.2.2 Moist Curing

The precast concrete units may be moist cured in lieu of elevated temperature curing in accordance with the following:

Upon removal from the forms the precast concrete units shall be cleaned, patched, finished, and ready for inspection by the Department Representative within a period not exceeding 12 hours. Patching shall be performed with an approved concrete patching material product and at an ambient temperature of 10°C to 25°C. After completion of patching and finishing, within 24 hours of removal from the form, the precast concrete units shall be placed under two layers of light coloured filter fabric at an ambient temperature of not less than 15°C. The filter fabric or burlap shall be kept in a continuously wet condition throughout the curing period by means of a soaker hose or other means as reviewed and accepted by the Department Representative. Curing with filter fabric or burlap and water shall be maintained for a minimum period of 7 days.

7.2.5.12 Release of Prestressing Strand

The prestressing strand shall not be released until the specified concrete release strength is achieved. The release of prestressing strand shall be in accordance with the sequence reviewed and accepted by the Department Representative.

Casting defects shall be reported to the Department Representative prior to release of the prestressing strands.

7.2.5.13 Concrete Defects

Honeycomb, cavities, spalls, chips, cracking and other defects shall be immediately reported to the Department Representative.

The location, type and size of a concrete defect shall determine if a precast concrete unit defect is repairable or if the precast concrete unit requires replacement. The location of defects shall be identified in one of the following areas:

- Anchorage area;
- Bearing area; and
- All other areas.

The anchorage area shall be the full height of the unit by a length of 2 times the height of the unit from the end of the unit, excluding the bearing area.

The bearing area of an SL, SLW, or SLC type precast concrete girder will be the greater of 145 mm or the thickness of the bottom soffit by a length of 500 mm from the end of the girder.

The bearing area of an NU girder shall be the girder bottom flange up to, but not including, the radius transition between the bottom flange and the web by a length measured from the end of the girder to 75 mm beyond the edge of the shoe plate.

The Contractor shall submit a repair procedure to the Department Representative for review and acceptance for concrete defects, as determined by the Department Representative, prior to commencement of the repair work. Repair procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The Contractor shall not complete repairs of any defects until written acceptance of the repair procedure has been provided by the Department Representative.

7.2.5.13.1 Cracks

The following cracks are unacceptable and will result in rejection of the precast concrete unit unless otherwise reviewed and accepted by the Department Representative:

- Cracks in the bearing area of a unit ;
- Cracks in the anchorage area of a unit exceeding 0.5 mm in width or longer than 300 mm; or
- Cracks outside of the unit bearing and anchorage areas exceeding 0.2 mm in width or longer than 300 mm.

All repairable cracks less than 0.2 mm in width shall receive two coats of a Type 1c sealer unless the crack will be fully encased in a cast-in-place concrete diaphragm or the precast concrete unit requires a Class 3 finish on the surface where the crack is present.

All repairable cracks 0.2 mm or greater in width shall be repaired by epoxy injection in accordance with the epoxy manufacturer’s instructions. The epoxy resin shall meet the requirements of ASTM C881/C881M Type IV, Grade 1, Class B or C and have a viscosity less than 500 cP. An injection procedure shall be submitted by the Contractor to the Department Representative for review and acceptance prior to commencing repairs.

The Contractor shall immediately notify the Department Representative, if a crack that has a potential to be a shear crack exceeds 0.15 mm in width and longer than 0.25 times the unit depth. Crack length shall be measured along the horizontal axis and a crack will be considered to be a shear crack if inclined at an angle between 30° and 60° from horizontal.

7.2.5.13.2 Honeycombs, Spalls, Cavities, Chips and Other Defects

The following conditions of honeycomb, spall, cavity, chip or other defect are unacceptable and will result in rejection of the precast concrete unit unless otherwise reviewed and accepted by the Department Representative:

- Any honeycomb, spall, cavity, chip or other defect in the bearing or anchorage areas of the unit ; or
- Honeycombs, spalls, cavities, chips or other defects that are more than 30 mm deep or more than 0.05 m^2 in area located outside the bearing and anchorage areas of a unit .

Honeycombs, spalls, cavities or chips less than or equal to 0.05 m^2 in area or 30 mm in depth, shall be repaired in accordance with Subsection 7.2.5.10.2, Class 2 Rubbed Surface Finish and may be completed after destressing.

As a minimum, repair procedure for honeycombs, spalls, cavities or chips shall include removing and replacing the defective concrete with the originally specified class of concrete or if acceptable to the Department Representative, an approved concrete patching material. Repair extents shall also be saw cut 20 mm deep in neat perpendicular lines and concrete removed to a depth of 20 mm below reinforcing and prestressing strand. Repair areas shall be roughened to remove all loose material and laitance. Exposed reinforcing and prestressing strand shall be cleaned and repaired to its original condition. Repair areas shall be saturated with water prior to concrete placement. Repair areas shall be free of standing water and saturated surface dry immediately prior to concrete placement. Repairs shall be completed before destressing.

Concrete defect repairs shall be completed prior to curing of the precast concrete unit at an ambient temperature between 15°C and 30°C. Depending on the size and location of the defect, repairs may be required before or after destressing as determined by the Department Representative. Damaged concrete shall be repaired by the Contractor at their expense to the satisfaction of the Department Representative. Precast concrete units shall be maintained in a saturated surface dry condition prior to and during the implementation of any approved repair work.

7.2.5.14 Concrete Sealer

The Contractor shall supply and apply concrete sealer to the unit surfaces as shown on the Drawings.

Concrete sealers shall meet Alberta Transportation Material Testing Specifications for Concrete Sealers B388 and be selected from the Alberta Transportation's Products List.

The sealer shall be applied on clean dry surfaces free of form oil, and in accordance with the manufacturer's recommendations however the application rate shall be increased by 30% from that indicated on the approved products list and the substrate temperature shall be a minimum of 5°C. Sealer shall not be applied until the concrete is a minimum of 14 days old and has a maximum moisture content of 4%. Concrete patching materials shall be cured for a minimum of 72 hours. The concrete surface shall be pressure washed to remove all dust and accepted by the Department Representative prior to applying sealer. In order to ensure uniform and sufficient coverage rates the Contractor shall apply measured volumes of sealing compound to appropriately dimensioned areas of concrete surface, using a minimum of 2 coats.

The Contractor shall ensure that the sealer is not applied in the grout pockets, lifting hook pockets or areas of the units that will have field concrete cast against them. The Department Representative reserves the right to sample and test the sealer supplied by the Contractor.

7.2.5.15 Surface Roughening

The roughening of concrete surfaces in shear key, block out, diaphragm and unit end void locations shall be achieved by sandblasting or other means acceptable to the Department Representative. Concrete surfaces shall be roughened to a concrete surface profile (CSP) 6 or 7. Concrete surface profiles shall be uniform and in accordance with the International Concrete Repair Institute (ICRI) Guideline No. 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair. The roughening shall be sufficient to remove all laitance and uniformly expose the course aggregate

7.2.5.16 Dimensional Tolerances of Precast Concrete Units

The maximum dimensional deviation in mm, of precast concrete units from that specified on the Drawings shall not exceed the following:

- Length: ± 20 mm x length (m) ÷ 50;
- Width: ± 3 mm;
- Depth: ± 5 mm;
- Camber: ± 20 mm x length (m) ÷ 50;
- Sweep (NU Girders): 1 mm/m;
- Sweep (Other Units): deviation from true, 20 mm x length (m) ÷ 50;
- Projection of Stirrups from Top of Unit: ± 12 mm;
- Bearing Areas: out of flatness 3 mm;
- Bulkheads: warpage or tilt of ends, 5 mm;
- Anchor Bolts:
    - out of line, 5 mm;
    - in spacing, 5 mm; and
    - in projection, 5 mm;
- Dowel Holes: out of plumb, 5 mm; and
- Void Location: surface to void dimension, ±15 mm after casting.

Camber and dimensional tolerances for sweep shall be measured immediately prior to shipping to the project site.

7.2.5.17 Handling and Storage

Precast concrete units shall be handled by means of lifting devices which have been reviewed and accepted by the Department Representative and at the designated locations. Precast concrete units shall be maintained in an upright position, supported near the ends and on stable foundations.

7.2.6 Inspection and Testing

7.2.6.1 Access

The Contractor shall provide acceptable facilities for the inspection and testing of the work. The Department Representative shall have full access to all phases of the work at all times. When required by the Department Representative, the Contractor shall also provide labour for assistance in checking layout and performing inspection and testing duties. The Department Representative shall be provided the time needed to complete quality assurance inspection and testing requirements.

7.2.6.2 Responsibility

Quality control inspection and testing shall be completed by the Contractor. Quality control shall be the sole responsibility of the Contractor.

Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant) to inspect and test precast concrete units being fabricated outside the Northwest Territories and including up to three trips to the fabrication facility by the Department Representative during the course of fabrication.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work, non conforming materials, or the Contractor's proposed modification to precast concrete units shall be paid for by the Contractor.

If the Department Representative, at their sole discretion, determines that the Contractor's quality control inspection and/or testing personnel are not meeting the minimum specified standards, the Contractor shall replace the personnel immediately and prior to continuing with the work.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative.

7.2.6.3 Quality Control Inspection and Testing by the Contractor

As a minimum, quality control testing, inspection and personnel performing these activities shall conform to the requirements of CSA A23.4 and the Precast/Prestressed Concrete Institute (PCI) Quality Control Manual MNL-116. In the case of conflicting requirements, the most stringent requirement shall apply, as determined by the Department Representative.

Sampling, casting, curing and testing concrete specimens shall be completed by the Contractor in accordance with the requirements of the following CSA standards:

- Sampling - CSA A23.2-1C;
- Concrete Test Cylinders - CSA A23.2-3C;
- Testing Concrete Cylinders - CSA A23.2-9C;
- Air Content - CSA A23.2-4C;
- Density of Concrete - CSA A23.2-6C; and
- Air Void Determination - CSA A23.2-17C.

The Contractor's quality control testing and inspection records and/or reports shall be submitted on a weekly basis to the Department Representative for review and acceptance, with the exception that concrete compressive strength results shall be submitted within 24 hours of completion of the testing. All quality control testing and inspection records and/or reports shall contain the written acceptance of the fabricator's QC manager.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work or Contractor proposed details not specified on the Drawings shall be paid for by the Contractor.

7.2.6.3.1 Release Strength Concrete Test Cylinders

The Contractor shall sample, prepare, and complete compressive strength testing of concrete test cylinders to evaluate the timing of prestressing strand release. Prestressing strand shall not be released until the concrete compressive strength specified on the Drawings has been achieved.

When one or more precast concrete units are cast continuously, at minimum, two concrete test cylinders shall be taken that represent the last precast concrete unit cast to represent the release strength for all precast concrete units. These strength test cylinders shall be cured with the last precast concrete unit cast. Only testing of the first cylinder will be required if the specified release strength is achieved. If concrete test cylinders do not achieve the required compressive strength for release, the Contractor shall submit a proposed time to release the prestressing strand to the Department Representative for review and acceptance. Prestressing strand shall not be released until the timing has been reviewed and accepted by the Department Representative.

7.2.6.3.2 28 Day Strength Testing

The Contractor shall cast concrete test cylinders to determine the 28-day strength. The Department Representative will determine from which batch the test cylinders shall be taken. Samples for testing shall be taken from the plastic concrete being placed in the forms at the rate of one set of concrete test cylinders for every three precast concrete units cast continuously. Additional cylinders shall be cast at the discretion of the Contractor or the Department Representative. A set shall consist of three cylinders. A strength test will be the average of the 28-day strengths of the three cylinders (one set). Continuous casting shall mean no break in the casting longer than one hour.

The Contractor shall be responsible for transporting the concrete test cylinders to an independent CSA testing laboratory certified to CSA A283. The transportation and testing of concrete test cylinders shall be at the Contractor's expense. These tests shall represent the strength of the cast concrete. Test results shall be forwarded to the Department Representative within 24 hours of testing.

7.2.6.4 Quality Assurance Inspection and Testing by the Department Representative

The Department Representative will inspect the work and review all QC inspection and testing records and/or reports produced by the Contractor to verify their conformance to the Contract requirements.

The Department Representative may also complete additional quality assurance inspection and/or testing at their sole discretion. The Contractor shall provide full access to the work in accordance with Subsection 7.2.6.1, Access.

7.2.6.5 Witness Points and Hold Points

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified witness points and hold points within the ITP.

If fabrication continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Department Representative may suspend the supply and fabrication work, and the Contractor shall be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the work, as determined by and to the satisfaction of the Department Representative.

Inspection stations shall be set up by the Contractor within the fabrication facility to the satisfaction of the Department Representative for each of the specified witness points and hold points such that the associated inspection and/or testing requirements can be acceptably completed.

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP:

- Form dimensions and set-up (witness point);
- Placement of reinforcing steel, post tensioning ducts, cross bracing anchorage devices, bridgerail anchor rod assemblies and prestressing strand (hold point);
- Placement of voids and other hardware (witness point);
- Stressing (hold point);
- Concrete sampling and testing (witness point);
- Detensioning (witness point);
- Clean-up and repair (witness point);
- Curing (witness point);
- Concrete surface roughening and application of concrete surface finishes and concrete sealer (witness point);
- Storage of precast concrete units (witness point);
- Verification testing and inspection of precast concrete units if fabricated outside of Canada and the United States (hold points); and
- Final inspection including dimensional tolerances (hold point).

7.2.6.6 Final Inspection

The Contractor and the Department Representative shall provide written acceptance of all fabricated precast concrete units upon the completion of fabrication. Review and acceptance of precast concrete units by the Department Representative at the fabrication facility will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

7.2.6.7 Fabrication Outside of Canada and the United States of America

In addition to the requirements of Subsection 7.2.6, Inspection and Testing, precast concrete units fabricated outside of Canada and the United States of America shall be shipped to a shop located in Canada that is certified by the Canadian Precast Concrete Quality Assurance (CPCQA) Certification Program in the applicable Product Group classification of the precast concrete unit for verification inspection and testing. The precast concrete units shall be in a condition that facilitates verification testing and inspection requirements. Verification testing and inspection shall be completed in accordance with Subsection 7.2.6, Inspection and Testing. A Prestressed/ Precast Concrete Institute (PCI) certified Level 2 inspector shall also inspect precast concrete units for the presence of damage that may have occurred during transportation.

In addition to the verification testing and inspection requirements, three concrete cores shall be taken from each precast concrete unit, at locations determined by the Department Representative, and tested by a laboratory certified to CSA A283 to determine that the concrete meets all Contract requirements.

Precast concrete units shall not be shipped from the Canadian shop until all requirements have been met and the work has been reviewed and accepted by the Department Representative.

The Contractor shall be responsible for all verification inspection and testing costs, including all costs incurred by the Department Representative (from the Government of the Northwest Territories and consultant). The Contractor shall also be responsible for all hourly charge out rates, travel, meals and accommodation of the Department Representative to complete inspection and testing duties at the fabrication facility for 100% of the fabrication time. The Contractor shall also be responsible for the cost of one trip every two weeks for two Department Representatives to and from the fabrication facility.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

7.3 Construction

The Contractor shall erect, assemble, and install precast concrete units as shown on the Drawings, in accordance with these specifications and the Special Provisions of the Contract.

Cranes shall be used for the handling and erection of precast concrete units.

Lifting forces shall be vertical for NU type precast concrete girders and other precast concrete girder types. SL, SLW, and SLC precast concrete girder lifting forces shall be vertical unless otherwise detailed on the engineered fabrication shop drawings and precast concrete girder erection procedure.

Lifting devices shall not require the removal or modification of projecting reinforcing steel and be acceptable to the Department Representative. Drilling or coring of additional holes or any other modifications will not be permitted. Lifting devices shall only be attached at locations identified on the engineered fabrication shop drawings and precast concrete unit erection procedure.

Softeners shall be used at all times where chains, flange hooks, restraint systems, or any other tie down devices are or may come in direct contact with precast concrete units during transportation, handling, storage, and erection. Softener components shall be durable for the intended use and constructed of materials that will prevent damage to the precast concrete units. Steel or other alloys will not be permitted for use as softeners. Handling and lifting devices shall not mark, damage, or distort members.

The Contractor shall maintain unit stability; location; and horizontal, vertical and longitudinal alignment at all times during construction.

Bearings and grout pads shall be installed in accordance with Section 8, Bearings.

7.3.1 Transportation, Handling and Storage

Girders with webs shall be transported with their webs in the vertical position.

Precast concrete units shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage.

Precast concrete units shall be transported, hauled and stored on timber blocking. Timber blocking shall be located at positions that prevent damage and/or distortion from deflection. The ground of the storage area shall be solid and unyielding and drainage diverted away from the storage area.

Galvanized and metallized material shall be handled, stacked, bundled, transported, hauled and stored to prevent damage or wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. If damage or wet storage staining occurs, it shall be assessed and repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

7.3.1.1 Transportation, Handling and Storage Drawings

The Contractor shall submit transportation, handling and storage drawings to the Department Representative for review and acceptance a minimum of 4 weeks prior to shipping precast concrete units. The transportation, handling and storage drawings shall include all specified requirements.

7.3.1.2 Clearance to Ship

The Contractor shall provide the Department Representative a transportation schedule for precast concrete units a minimum of 72 hours prior to shipment from the fabrication facility. Written acceptance in accordance with Subsection 7.2.6.6, Final Inspection shall be provided by both the Contractor and the Department Representative prior to the commencement of shipping.

Review and acceptance at the fabrication facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

7.3.1.3 Inspection

Upon arrival at the site, after cleaning if required, and a minimum of 24 hours prior to erection, the Contractor and the Department Representative shall inspect materials for cleanliness and presence of damage. The Contractor shall provide an adequate area and space between components and access equipment for the Department Representative to complete their inspection. If precast units will be erected, assembled or installed directly from transportation equipment, the Contractor shall provide access equipment acceptable to the Department Representative to complete the required inspections, remove restraints and provide temporary restraints, if required, to facilitate a complete inspection. Erection shall not commence until the Department Representative has provided written acceptance of transportation, handling, and storage inspection results to the Contractor.

Precast concrete units that become contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to inspection, assembly, erection or installation. Cleaning, if determined necessary by the Department Representative, shall be completed in accordance with Subsection 7.3.1.4, Cleaning.

If any precast concrete units are identified as damaged during the transportation, handling, and storage inspection, the Contractor shall submit an assessment report and/or field repair procedure to the Department Representative for review and acceptance. The assessment report and/or the field repair procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Department Representative may also require that further independent inspection, non-destructive testing, and/or assessment be completed. Field repairs shall be completed by the Contractor and reviewed and accepted by the Department Representative prior to erection, assembly or installation. All costs to repair damage to the satisfaction of the Department Representative will be the sole responsibility of the Contractor.

The transportation, handling, and storage inspection will be considered a hold point. The Contractor and the Department Representative shall provide written acceptance of the hold point prior to the commencement of erection. If erection commences without the written acceptance of the transportation, handling, and storage inspection by both the Contractor and the Department Representative, the Department Representative will have cause to suspend erection work. The Contractor shall be responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

7.3.1.4 Cleaning

Precast concrete units that become contaminated with dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned to the satisfaction of the Department Representative and in accordance with the following requirements a minimum of 48 hours prior to erection, assembly or installation:

- Cleaning shall be completed by high pressure washing and/or steam;
    - The washing system used for cleaning shall maintain wash water at a minimum temperature of 90°C, have a minimum pressure of 3000 PSI, maximum pressure of 3500 PSI, and a minimum flow rate of 5 GPM;
    - Wash water shall be potable and of a quality acceptable to the Department Representative;
    - Wash water shall be contained and managed in a manner acceptable to the Department Representative and in compliance with all applicable environmental requirements and the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements;
    - Washing shall be completed from the highest elevation of the component in its washing position to the lowest elevation;
- Components shall be supported on timber blocking to provide a minimum clearance of 900 mm from the ground along the entire length of the component;
- Components shall be stored to provide a minimum clearance of 1200 mm from each other;
- Transportation, handling and storage restraints, and their softeners, shall be removed to permit cleaning of the precast concrete units. The sequencing of removal and reinstallation, if required, shall be reviewed and accepted by the Professional Engineer who authenticated the transportation, handling and storage plan;
- Locations of chains, flange hooks, restraint systems, other tie down devices, and timber blocking shall be adjusted to permit cleaning at contact areas; and
- Access equipment and/or specialized telescoping pressure washing equipment shall be used to wash precast concrete units that are 3 m or greater above the ground.
- Precast concrete units that have been contaminated with road salts, slush or other contaminants shall have their surfaces tested for soluble salts after cleaning in accordance with the Bresle Method, ISO 8502-9, Field method for the conductometric determination of water-soluble salts and ISO 8502-6, Extraction of soluble contaminants for analysis. Testing shall be completed at a minimum frequency of 1 test per 30 m^2 of precast concrete unit surface area or 3 tests per component, whichever is greater, up to a maximum of 6 tests per precast concrete unit.
- Cleaning shall result in precast concrete surfaces having less than 7 $\mu g/cm^2$ of chloride ions. All testing shall be carried out by the Contractor and the results submitted to the Department Representative for review and acceptance prior to erection, assembly or installation. Precast concrete unit surfaces that exceed the specified limits for contaminants shall be further cleaned and testing repeated until the precast concrete unit surfaces meet the specified limits.

- Cleaning of the exterior fascia exterior precast concrete unit surfaces shall result in a uniform appearance without streaking and free of pressure washing spray patterning. Uniformity of appearance shall be achieved, as determined by the Department Representative.
- All costs associated with cleaning and testing of precast concrete unit surfaces will be considered incidental to the Work and no separate or additional payment will be made.

7.3.2 Erection

The Contractor shall not erect the precast concrete units until the substructure concrete has been cured a minimum of 3 days and achieved 80% of the 28 day specified concrete strength or a strength acceptable to the Department Representative.

The Contractor shall maintain unit stability; location; and horizontal, vertical and longitudinal alignment at all times during construction.

Bearings and grout pads shall be installed in accordance with Section 8, Bearings.

7.3.2.1 Unit Erection Inspection and Test Plan

The Contractor shall submit a unit erection inspection and test plan (ITP) to the Department Representative for review and acceptance a minimum of 6 weeks prior to the commencement of unit erection work. No Work shall commence until the Contractor's unit erection ITP has been reviewed and accepted in writing by the Department Representative.

The Contractor's unit erection ITP shall include fastener submission requirements and unit erection procedure activities. The Contractor's unit erection ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of unit erection procedure activities including witness points and hold points.

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified hold points within the unit erection ITP prior to release of the work from the hold point. If unit erection continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative or deviates from the engineered unit erection procedure, the Department Representative will have cause to suspend the unit erection work.

A unit erection ITP will not be required for SL, SLW, or SLC girder types.

7.3.2.2 Girder Erection Procedure

The Contractor shall submit a girder erection procedure to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of girder erection work. The girder erection procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall not commence any erection work until review of the girder erection procedure by the Department Representative has been completed and all comments arising from that review have been addressed to the satisfaction of the Department Representative. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of their methods or equipment, nor from carrying out the work in full accordance with the girder erection procedure, drawings and specifications. The Contractor shall follow the engineered girder erection procedure at all times.

Girder layout and component identification contained in the erection procedure shall be consistent with the girder layout and component identification shown on the Drawings. The erection procedure shall include drawings and supporting documents necessary to describe the following:

- Traffic Accommodation Strategy (TAS);
- Access to the work, including temporary access berms and/or work bridges;
- Details of temporary works and supporting structures, including:
    - Location, elevation, and grade of support bearings;
    - Theoretical top of girder elevations at bearing and splice locations as applicable; and
    - Vertical, horizontal, and longitudinal position adjustment mechanisms;
- An as constructed survey of substructure elements (hold point), including:
    - Location and elevation of all bearing grout pad recesses including anchor rod voids;
    - Shim height required at each bearing location; and
    - Longitudinal and transverse measurements between centreline of bearings of all substructure elements.
- Bearing installation procedure in accordance with Subsection 8.4.3.1, Bearing Installation Procedure;
- Superstructure layout plan, including installation details of reference lines and markings of substructure and bearing components used to determine final bearing and girder positions, and theoretical top of girder elevations at substructure bearing locations;
- Type and capacity of cranes;
- Sequence of work, including position of cranes and delivery trucks;
- Position of cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers; geotechnical loads and ground capacity requirements;
- Lifting device details, location of lifting devices, and lifting forces;
- Girder stabilization details, methods of maintaining girder location and alignment, and details of blocking for girder and bearings;
- Diaphragm and bracing installation schedule and sequence (hold point);
- Bolt tightening schedule and sequence (witness point);
- Post-tensioning procedures, including prestressing strand specifications, jack dimensions, pressures, forces and elongations, and grouting;
- Lift hook cutting sequence and repair procedure for lifting holes and pockets;
- Method and schedule of temporary supporting structures release and removal.

A construction milestone meeting shall occur a minimum of two (2) weeks prior to commencement of girder erection work. The Contractor's project manager, girder fabricator, hauler, girder erector's project manager, field superintendent(s), post-tensioning superintendent, and foreman shall attend a construction milestone meeting at a date, time and location acceptable to the Department Representative.

Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder shall be an integral part of the work. The Contractor shall immediately provide the Department Representative with any documentation required by the Occupational Health and Safety Regulations upon request.

7.3.2.3 Fall Protection System

The Contractor shall provide 100% fall protection system for girder erection and deck forming work. The fall protection system and an associated safe work procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall provide a copy of the fall protection system and safe work procedure to the Department Representative a minimum of 2 weeks prior to commencement of the work. The fall protection system shall be removed after the deck formwork has been removed and deck concrete has been reviewed and accepted by the Department Representative.

7.3.2.4 Unit Adjustments

Adjustment to unit position, bearing location and bearing elevation shall be completed to achieve the lines and grades shown on the Drawings or those otherwise reviewed and accepted by the Department Representative.

The Contractor shall maintain the correct alignment of the precast concrete units at all times during construction.

The Contractor shall minimize differential camber (unit to unit) and the sweep of the units by jacking, loading of units, or winching in a manner acceptable to the Department Representative. Once unit position has been reviewed and accepted by the Department Representative, the Contractor shall provide the necessary temporary attachments to maintain unit position.

The maximum dimensional deviation in mm, of erected precast concrete unit from that as detailed on the drawings shall not exceed the following:

- Sweep (NU Girders): 1 mm/m;
- Sweep (Other Precast Concrete Units): deviation from true, 20 mm x length (m) ÷ 50

7.3.2.5 Lifting Hooks, Lifting Holes and Camber Hubs

After the Department Representative has reviewed and accepted the erected unit locations and positions, lifting hooks shall be cut off 50 mm below the concrete surface and camber hub threaded rods removed. All lifting holes, camber hub holes and pockets shall be filled with a concrete patching product listed on Alberta Transportation’s Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List in the applicable category in accordance with the manufacturer’s recommendations specified on the published product data sheet.

7.3.2.6 Bolting

Bolted connections shall be completed in accordance with Subsection 6.3.2.4, Assembly.

7.3.3 Post-Tensioning and Grouting

7.3.3.1 Post-Tensioning Inspection and Test Plan

The Contractor shall submit a post-tensioning inspection and test plan (ITP) to the Department Representative a minimum of 6 weeks prior to commencement of the work. The Contractor's post-tensioning and grouting inspection and test plan ITP shall include, but not be limited to, stressing system submissions, all specified witness points, hold points, inspection requirements, testing requirements, and reporting requirements for each post-tensioning duct. The Contractor's post-tensioning and grouting ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, inspection and testing, and reporting requirements.

No post-tensioning work shall commence until the Contractor's post-tensioning ITP has been reviewed and accepted in writing by the Department Representative.

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified hold points prior to release of the work from the hold point. If post-tensioning continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative or deviates from the specified requirements, the Department Representative will have cause to suspend the post-tensioning work . The Contractor shall also be solely responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

7.3.3.2 Standards

The following standards shall be followed:

- CSA A23.1 and CSA A23.2 - Concrete Materials and Method of Concrete Construction;
- CSA A23.4 - Precast Concrete Materials and Construction;
- Section 4, Cast-In-Place Concrete;
- Post-Tensioning Institute (PTI) Guide Specification Acceptance Standards for Post Tensioning Systems;
- PTI Specifications for Grouting of Post Tensioned-Structures; and
- AASHTO LRFD Bridge Construction Specifications.

In the case of conflicting requirements, the most stringent requirement shall govern.

7.3.3.3 Qualifications

The Contractor shall have extensive experience in this Work and shall utilize only fully trained, competent and experienced personnel. The Contractor shall ensure the site supervisor responsible for the post tensioning and grouting operations is at the site whenever these operations are being completed. The Contractor's personnel completing post-tensioning shall have the following minimum qualifications:

- The site supervisor of post tensioning and grouting operations shall be certified to PTI Level 2 Bonded PT Field Specialist;
- The foreman for each installation and stressing crew shall be certified to PTI Level 2 Bonded PT Field Specialist;
- The foreman for each grouting crew shall be certified to PTI Level 2 Bonded PT Field Specialist; and
- At least 25% of the members of each crew shall be certified in PTI Level 1 Bonded – Field Installation.

7.3.3.4 Stressing System Submissions

The Contractor shall submit mill test reports and load/elongation curves for the prestressing strand, post-tensioning design notes, independent check notes and shop drawings to the Department Representative for review and acceptance a minimum of 4 weeks prior to commencement of the work. As a minimum, details of the stressing system and associated design calculations and the stressing sequence shall be provided on shop drawings and within the design notes and independent check notes.

Design notes, independent check notes and shop drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The design notes, independent check notes, and shop drawings will be reviewed by the Department Representative for conformance with the Government of the Northwest Territories' design requirements and the Contract requirements. Review comments provided by the Department Representative shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work. The design engineer of record and independent checker shall submit separate authenticated design notes and check notes. The design and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

7.3.3.5 Materials

7.3.3.5.1 Prestressing Strand

Prestressing strand shall conform to the requirements of Subsection 7.2.4.9, Prestressing Strand and Subsection 7.2.5.3, Prestressing Strand.

Corrosion inhibitor will be required when the stressing and grouting operations are not completed within 20 calendar days of the installation of the prestressing stand. The corrosion inhibitor, when required, shall be water-soluble and have no deleterious effect on the prestressing strand, grout, concrete, or bond strength of the prestressing strand to concrete.

7.3.3.5.2 Anchorages and Distribution

All prestressing strand shall be secured at the ends by means of permanent anchoring devices that have been reviewed and accepted by the Department Representative. These devices shall comply with CSA S6-19 Clause 8.4.4.1, Anchorages for post-tensioning tendons.

Steel distribution plates or assemblies may be omitted when the anchoring devices are sufficiently large and used in conjunction with an embedded steel grillage that effectively distributes the compressive stresses to the concrete.

7.3.3.5.3 Ducts

Post-Tensioning duct material shall be in accordance with Subsection 7.2.4.13, Voids, Ducts, and Conduit.

The Contractor shall provide mortar tight inlets and outlets in all ducts with a nominal diameter of 20 mm in the following locations:

- The anchorage area;
- All high points of the duct, when the vertical distance between the highest and lowest point is more than 0.5 m;
- Place an inlet at or near the lowest point; and
- Place free draining outlet at all low points of duct.

The Contractor shall provide inlets and outlets with valves, caps or other devices capable of withstanding the grouting pressure. The ducts and vents shall be securely fastened in place to prevent movement. The Contractor shall provide details of inlets and outlets on the shop drawings.

7.3.3.5.4 Concrete

Concrete shall be supplied in accordance with Subsection 7.2.4.7, Concrete and meet the following requirements:

- The minimum 28 day concrete compressive strength shall be 50 MPa unless otherwise specified; and
- The maximum nominal size of the coarse aggregate shall be in accordance with CSA A23.1-19 Subsection 4.3.2.2.

7.3.3.5.5 Grout

Grout shall be a Class C grout meeting the requirements described in Table 10.9.3-1 and the properties listed in Table 10.9.3-2 of the AASHTO 2017 LRFD Bridge Construction Specifications. The wet density shall also be provided by the manufacturer in accordance with ASTM C138/C138M.

The average minimum compressive strength of 3 cubes at 28 days shall be 50 MPa and measured in accordance with CSA A23.2-1B.

Pre-bagged grouts shall be packaged in plastic lined bags or coated containers, stamped with the date of manufacture, lot number and mixing instructions. Copies of the quality control data for each lot number and shipment sent to the job site shall be provided to the Department Representative for review prior to grouting. Materials with a total time from manufacture to usage in excess of 6 months shall be retested and certified by the supplier before use, or shall be removed from the job site and replaced.

7.3.3.6 Equipment

7.3.3.6.1 Stressing

Hydraulic jacks and pumps of sufficient capacity shall be used for tensioning of prestressing strands.

The force induced in the prestressing strand shall be measured using calibrated jacking gauges, load cells or a calibrated dynamometer.

The pressure gauge shall have an accurate reading dial at least 150 mm in diameter.

The forces to be measured shall be within 25% and 75% of the total graduated capacity of the gauge, unless calibration data clearly establishes consistent accuracy over a wider range.

The measuring devices shall be calibrated at least once every 6 months. The jack and the gauge shall be calibrated together. A certified calibration chart shall be kept with each gauge.

7.3.3.6.2 Grouting

A high speed shear mixer shall be used that is capable of continuous mechanical mixing and producing grout that is free of lumps and undispersed cement. The water supply to the mixer shall be measured by an accurate gauge.

The holding tank shall be capable of keeping the mixed grout in continuous motion until it is used. The outlet to the pump shall have a screen with 3 mm maximum clear opening.

A positive displacement type pump shall be used which is capable of producing an outlet pressure of at least 1 MPa. A pressure gauge having a full-scale reading of no greater than 2 MPa shall be placed at some point in the grout line between the pump outlet and the duct inlet.

The Contractor shall have an additional backup pump s on site ready for use at all times during grouting operations.

Standby flushing equipment with water supply shall be available at the site prior to commencing grouting.

The grouting equipment shall be of sufficient capacity to ensure that grouting of the longest duct can be completed within 30 minutes after mixing.

Grout hoses and their rated pressure capacity shall be compatible with the pump output and the maximum grout pressure. All connections from the grout pump to the duct shall be airtight so that air cannot draw into the duct.

7.3.3.7 Construction

The stressing and grouting shall be completed in the presence of the Department Representative. The Contractor shall ensure that a minimum of 48 hours notice is given to the Department Representative for these operations and access to the work is provided at all times.

7.3.3.7.1 Checking Post-Tensioning Ducts

Placement of post-tensioning ducts shall be in accordance with Subsection 7.2.5.4, Void, Duct, Conduit and Reinforcement Placing Tolerances.

Prior to placing prestressing strand, the Contractor shall demonstrate to the satisfaction of the Department Representative that all ducts are unobstructed and will be considered a hold point.

7.3.3.7.2 Welding

Proposed welding of prestressing strand ends will require the Department Representative s review and acceptance. The greater of the length of the prestressing strands used within the electrical circuit or 1 m shall be cut off from the welded end prior to stressing.

7.3.3.7.3 Post-Tensioning

Post-tensioning shall be carried out in accordance with the reviewed and accepted drawings and stressing calculations. The stressing and release of tendons shall be done in the sequence specified on the Drawings. All strands in each tendon shall be stressed simultaneously with a multi-strand jack. The force in the tendons shall be measured by means of pressure gauge and shall be verified by means of tendon elongation. All tendons shall be tensioned to a preliminary force as necessary to eliminate any slack in the tensioning system before elongation readings are started. This preliminary force shall be between 15% and 25% of the final jacking force.

Stressing tails of post-tensioned tendons shall not be cut off until the record of actual gauge pressures (preliminary, final) and actual tendon elongations are provided by the Contractor to the Department Representative for review and acceptance. The records of actual gauge pressures (preliminary, final) and actual tendon elongations submission will be considered a hold point.

A record of the following post-tensioning operations shall be kept by the Contractor and submitted to the Department Representative for review and acceptance within 1 week of grouting for each tendon installed:

- Project Name & Asset ID Number;
- Contractor/Subcontractor;
- Tendon location & size;
- Date tendon installed;
- Tendon pack/heat number;
- Modulus of elasticity (E);
- Date stressed;
- Jack and gauge identifier;
- Required jacking force and gauge pressures;
- Elongation (anticipated and actual);
- Anchor set (anticipated and actual);
- Stressing sequence;
- Witnesses to stressing operation;
- Grout information (Brand Name);
- Time of grouting each tendon; and
- Date grouted.

7.3.3.7.4 Concreting

The anchorage recesses shall be concreted after tensioning but before grouting the tendons.

The concrete surface of the anchorage recesses shall be abrasive blasted. Prior to concrete placement, concrete surfaces shall be blown clean with compressed air and saturated with water meeting the requirements of Subsection 7.2.4.2, Water.

7.3.3.7.5 Grouting

All ducts or openings shall be clean and free of all deleterious matter that would impair bonding of the grout to the ducts and prestressing strand. All ducts shall be thoroughly blown out with oil free compressed air. All inlets and outlets shall be checked by the Contractor for their capacity to accept injection of grout by blowing oil free compressed air through the system. The Department Representative will review and accept the condition of ducts prior to grouting.

Before stressing and grouting internal or external tendons, the Contractor shall install all grout caps, inlets and outlets and test each duct with oil free compressed air to determine whether duct connections need repair. The Contractor shall pressurize each duct to 345 kPa (50 psi) and lock-off the outside air source and record pressure for one minute. A pressure loss of 170 kPa (25 psi) is acceptable for ducts up to 45 m long, and a pressure loss of 100 kPa (15 psi) is acceptable for ducts longer than 45 m. If the pressure loss exceeds the acceptable limit, the Contractor shall repair the leaking connections using methods acceptable to the Department Representative, and then retest.

A thoroughly mixed grout, meeting all the requirements described in Subsection 7.3.3.5.5, Grout, shall be passed through a screen with 3 mm maximum clear openings before entering the pump. All grout vents shall be opened prior to commencement of grouting. The duct shall be completely filled by injecting grout from the lowest end of the tendon on an uphill direction. Grout shall be pumped continuously through the duct until no visible signs of water or air are ejected at the outlet. A fully operational grout pump shall be on site for all pumping procedures. A continuous, one way flow of grout shall be maintained at a rate of 5 to 15 lineal metres of duct per minute. The grouting of a tendon shall be completed within 30 minutes of mixing unless otherwise reviewed and accepted by the Department Representative.

Normal pumping pressure shall be between 0.1 to 0.4 MPa, measured at the inlet. The pumping pressure at the injection vent shall not exceed 1 MPa. If the actual pressure exceeds the maximum allowed, the injection vent shall be closed and the grout shall be injected at the next vent that has been or is ready to be closed as long as one way flow is maintained. Grout shall not be injected to a succeeding vent from which grout has not yet flowed. For each tendon, immediately after uncontaminated uniform grout discharge begins, a fluidity test shall be performed. The measured grout efflux time shall not be faster than the efflux time measured at the inlet or the minimum efflux time established. If the grout efflux time is not acceptable as determined by the Department Representative, additional grout shall be discharged from the discharge outlet. This cycle shall be continued until an acceptable grout fluidity is achieved. In addition to the fluidity test, the grout density shall be tested using the Mud Balance Test in accordance with Subsection 7.3.3.7.5.4, and the density at the final outlet shall not be less than the grout density at the inlet. Vents shall be closed in the designed sequence under pressure when the tendon duct is completely filled with grout. Valves and caps shall not to be removed until the grout has set.

Grouting will not be permitted when the air temperature is below 5°C or above 25°C, nor when there are other conditions determined by the Department Representative to be detrimental to the grouting operations.

The Contractor shall provide 50 mm deep grout tube termination recesses formed around the tubes projecting from top of the deck concrete. After grouting, all tubes shall be cut flush with the bottom of the recesses, and the recesses shall then be grouted flush with the top of the deck concrete.

The Contractor shall complete grout testing in accordance with Subsection 7.3.3.7.5.1, Compressive Strength Test, Subsection 7.3.3.7.5.2, Bleed Test, Subsection 7.3.3.7.5.3, Fluidity Test, Subsection 7.3.3.7.5.4, Mud Balance Test and ensure that the testing is witnessed by the Department Representative. The grout testing shall be completed by ACI or CSA certified testers and reviewed and accepted by the Department Representative. Grout testing reports shall be submitted to the Department Representative within 3 days of test completion.

7.3.3.7.5.1 Compressive Strength Test

The compressive strength test of the grout shall be completed by an independent testing laboratory certified to CSA A283 and in accordance with CSA A23.2-1B. The frequency of compressive strength testing shall be as follows:

- Precast Concrete Girders – One compressive strength test per girder line; and

- Cast-In-Place Girders – One compressive strength test for every 4 longitudinal ducts.

7.3.3.7.5.2 Bleed Test

At the beginning of each day's grouting operation, a wick induced bleed test shall be completed in accordance with ASTM C940 and with modifications noted in Table 10.9.3-2 of the AASHTO 2017 LRFD Bridge Construction Specifications.

7.3.3.7.5.3 Fluidity Test

At the inlet and outlet of each duct, a fluidity test shall be completed in accordance with the standard ASTM C939/C939M flow cone test or the modified ASTM C939/C939M test.

7.3.3.7.5.4 Mud Balance Test

A mud balance test shall be completed for each batch of grout in accordance with the American Petroleum Institute (API) Mud Balance Test API Practice 13B-1, Standard Procedures for Field Testing Water-based Drilling Fluids.

7.3.4 Removal of Temporary Supporting Structures and Site Clean-up

Upon completion of unit erection, including post-tensioning where specified, the Contractor shall remove all earth material or temporary supporting structures used during construction. The Contractor shall remove all piling, excavated or surplus materials, rubbish and temporary buildings, replace or renew any damaged fences, and restore in an acceptable manner all property damaged during the execution of their work. Disposal of surplus materials shall be in a manner and location satisfactory to the Department Representative.

The Contractor shall leave the bridge site, roadway and adjacent property in a condition acceptable to the Department Representative. When required, the Contractor shall provide written evidence that affected property owners or regulatory agencies have been satisfied.

7.4 Payment

7.4.1 Precast Concrete Units

Payment for precast concrete units will be made at the lump sum price bid for "Precast Concrete Units – Supply and Fabrication, Delivery and Erection" for the type and size specified, and will be full compensation for the supply and fabrication; inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; erection; assembly; installation; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. The lump sum price bid will be paid in accordance with Subsection 7.4.1.1, Supply and Fabrication, Subsection 7.4.1.2, Delivery, and Subsection 7.4.1.3, Erection.

7.4.1.1 Supply and Fabrication

50% of the lump sum price bid for "Precast Concrete Units – Supply and Fabrication, Delivery and Erection" will be paid once the precast concrete units have been acceptably supplied; fabricated; inspected; tested; stored; and written acceptance within the supply and fabrication ITP has been provided by both the Department Representative and the Contractor for each specified witness point and hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the supply and fabrication inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for supply and fabrication of precast concrete units for the types and size specified, less any applicable payment adjustments for compressive strength in accordance with Subsection 7.4.1.1.1, Failure to Meet Compressive Strength Requirements; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. Monthly payments will be considered on a pro-rata basis for units acceptably completed.

7.4.1.1.1 Failure to Meet Compressive Strength Requirements

7.4.1.1.1.1 Right of Rejection

The Department Representative reserves the right to reject concrete that does not meet the specified requirements. The Department Representative may, at its sole discretion, accept precast concrete units that do not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Subsection 7.4.1.1.1.2, Payment Adjustment Schedule.

7.4.1.1.1.2 Payment Adjustment Schedule

When the specified 28-day concrete compressive strength is not met, the precast concrete unit shall be paid in accordance with Table 7-1, Payment Adjustment Schedule.

Table 7-1 Payment Adjustment Schedule

Strength below the specified 28-day strength	Percentage of Unit Price to be paid
1 MPa or less	95%
1 MPa to 2 MPa	90%
2 MPa to 3 MPa	85%
3 MPa to 4 MPa	80%

In the event that the concrete tested is more than 4 MPa below the specified 28-day strength, the precast concrete units fabricated from the concrete represented by the test specimens shall be rejected. In the event that the precast concrete unit has been delivered and/or erected in the field, it shall be removed and returned to the Contractor's plant for replacement. The entire cost of replacement, including delivery and erection costs, shall be at the Contractor's expense.

7.4.1.2 Delivery

25% of the lump sum price bid for "Precast Concrete Units – Supply and Fabrication, Delivery and Erection" will be paid once the Precast Concrete Units have been acceptably loaded; transported; hauled; unloaded; stored; cleaned and/or repaired, if required; and written acceptance of the transportation, handling and storage inspection hold point has been provided by both the Department Representative and the Contractor. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for delivery of precast concrete units; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. All necessary approvals and permits, will be considered incidental to the Work and no separate or additional payment will be made. Monthly payments will be considered on a pro-rata basis for precast concrete units acceptably delivered.

7.4.1.3 Erection

25% of the lump sum price bid for "Precast Concrete Units – Supply and Fabrication, Delivery and Erection" will be paid once the precast concrete units have been acceptably erected, assembled, and installed; and written acceptance within the unit erection inspection and test plan has been provided by both the Department Representative and the Contractor for each specified hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the unit erection inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for erection of the precast concrete units; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. Monthly payments will be considered on a pro-rata basis for precast concrete units acceptably delivered.

7.4.2 Post-tensioning and Grouting

Payment for post-tensioning and grouting will be made at the lump sum price bid for "Post-Tensioning and Grouting" and will be full compensation for supply and installation of post tensioning systems; the supply and placement of grout; and written acceptance within the unit post-tensioning and grouting ITP has been provided by both the Department Representative and the Contractor for each specified hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the post-tensioning and grouting inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for post-tensioning and grouting; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

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8.1 General

This specification is for the supply, fabrication, delivery and installation of plain and laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings. The pot bearing components between sole plates and baseplates shall be designed by the bearing supplier in accordance with the requirements of the Drawings and these specifications.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

8.2 Design

The design of bearings shall be completed by the bearing fabricator/supplier in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, unless bearings are fully designed in the contract documents or otherwise specified in the contract documents.

Bearings shall be designed to accommodate the loadings, translations and rotations specified on the Drawings, in accordance with the requirements of CSA S6, and the exceptions noted in these specifications.

Sole plates and baseplates shall be supplied by the bearing supplier and shall conform to the details shown on the Drawings. Any proposed adjustments of these details shall be submitted to the Department Representative for review and acceptance prior to fabrication.

The bearing assembly, between the sole plate and baseplate, shall be designed such that the bearing assembly can be removed and replaced by jacking the superstructure by an amount not exceeding the vertical relaxation recovery of the elastomeric bearing material plus 5 mm. The designed procedure of bearing replacement shall not result in damage to the structure or involve removal of concrete, welds or anchorages.

Bearings shall not be recessed into plates, or welded to plates, that are permanently attached to the structure.

Bearings shall be designed to prevent moisture and dirt from entering the internal surfaces. The bearings shall be fabricated from materials that are durable and are protected from corrosion so as to perform the intended function.

8.2.1 Elastomeric Bearings

8.2.1.1 Sliding Surfaces

Sliding surfaces shall allow translation by sliding of a stainless steel surface against a flat mating polytetrafluoroethylene (PTFE) sheet. The flat PTFE sheet shall be recessed and bonded into a 2.5 mm deep recess in the top 9.5 mm laminate. The top 9.5 mm laminate shall be a galvanized or metalized steel or stainless steel plate vulcanized to the top of the elastomeric pad. The top 9.5 mm laminate shall have the same plan dimensions as the elastomeric pad. The stainless steel sliding surface shall be welded to the bottom of the sole plate.

8.2.1.2 PTFE Element

The PTFE element shall be 5 mm thick unfilled and unlubricated flat PTFE sheet.

8.2.1.3 Self-Rocking Pintle

A single self-rocking pintle welded under the baseplate shall be used to ensure uniform contact between the elastomeric bearing pad and the girder bottom flange. Where double pintles are shown on the Drawings, the pintles shall be centred beneath the bearing along a line perpendicular to the longitudinal axis of the girder. The pintle or pintles shall be supported on galvanized steel shim stacks of the appropriate thickness to achieve the correct bearing elevation.

8.2.2 Pot Bearings

8.2.2.1 Loadings, Translations and Rotations

The average stress in the elastomer at serviceability limit state loads shall not exceed 30 MPa.

Provision for translation shall be through sliding of a stainless steel surface against a mating PTFE element. The translational capacity in an unrestrained direction shall be as specified on the Drawings.

Provision for rotation about any horizontal axis shall be by means of a single disc of confined elastomer. Brass rings shall not be considered in determining the effective thickness of the elastomeric disc. The effective thickness of the elastomeric disc to evaluate the rotational capacity shall be limited to the thickness of the disc excluding the brass rings.

The rotational capacity about any horizontal axis shall be as specified on the Drawings. The rotational capacity about the vertical axis through the centre of the bearing shall be as specified or ±1°, whichever is greater.

Rotational bearings shall be capable of resisting the specified lateral loads in any direction in combination with the applicable vertical loads.

Brass sealing rings shall be flat and smooth on all surfaces and conform to the requirements of CSA S6.

The pot and piston surfaces in contact with the confined elastomer shall be lubricated with silicone grease. The bearing shall be sealed by a one-piece continuous preformed closed-cell compressible ring to prevent entry of dirt, dust, and moisture between the elastomer and the pot and piston contact surfaces. Any joint in the ring shall be bonded and the strength shall be at least equal to the strength of the ring.

8.2.2.2 Sliding Surfaces

Sliding surfaces shall allow translation by sliding of a metal surface against a mating PTFE element. For plain surfaces, the metal surface shall be stainless steel. The stainless steel metal surface shall overlap the PTFE by a minimum of 25 mm beyond the design movement on each side except for guides for lateral restraints. At abutments the stainless steel metal surface shall overlap the PTFE by a minimum of 50 mm beyond the design movement on each side except for guides for lateral restraint. Stainless steel metal surfaces shall be positioned above the PTFE element.

Except when used as mating surfaces for guides for lateral restraint, the PTFE resin shall be virgin material and shall be used as unfilled sheets and shall contain spherical reservoirs for lubricant pressed into its surface. The diameter of the reservoirs shall not exceed 8 mm measured at the surface of the PTFE, and the depth shall not be less than 2 mm nor more than half the thickness of the PTFE. The reservoirs shall be evenly distributed across the surface of the PTFE and shall occupy 20% to 30% of the surface. PTFE used as mating surface for guides for lateral restraint shall not be dimpled or lubricated. All PTFE elements shall be fully bonded and recessed in a rigid backing material.

All PTFE surfaces except those that act as mating surfaces for guides for lateral restraint or that are subjected to a contact pressure of less than 5 MPa shall be permanently lubricated with silicone grease.

The average contact pressure for unfilled PTFE elements based on the gross area of the PTFE shall not exceed the values given in Table 8-1, Average Contact Pressure for Unfilled PTFE Elements .

Table 8-1 Average Contact Pressure for Unfilled PTFE Elements

Limit State	Permanent Load, MPa	Total Load, MPa
Serviceability (SLS)	25	35
Ultimate (ULS)	40	55

The maximum contact pressures at the extreme edges of flat and curved PTFE elements shall not exceed 1.2 times the values indicated above.

The average contact pressure at serviceability limit state loads for PTFE elements filled with up to 15% mass of glass fibers used to face mating surfaces of guides for lateral restraints shall not exceed 45 MPa.

The coefficient of friction between stainless steel sliding surfaces and lubricated virgin PTFE shall be in accordance with Article 14.7.2.5, Coefficient of Friction, and Table 14.7.2.5-1, of the AASHTO 2020 LRFD Bridge Design Specifications.

8.2.2.3 Fasteners, Anchorages, and Guides for Lateral Restraint

Fasteners, anchorages and translational elements with lateral restraints shall be capable of resisting either of the following lateral loads:

- For bearings with a capacity of 5,000 kN or less at serviceability limit state (SLS), 10% of the vertical load capacity.
- For bearings with a capacity over 5,000 kN at serviceability limit state, 500 kN plus 5% of the vertical load in excess of 5,000 kN.
- In all cases the minimum restrainer force shall conform to CSA S6-19 Clause 4.4.10, Design forces and support lengths.

Guides for lateral restraint shall be arranged to permit the required rotations about both the horizontal and vertical axis. The translational elements of guides for lateral restraint shall be faced with stainless steel and shall provide lateral restraint by sliding against mating surfaces faced with PTFE.

The beneficial effect of friction shall be neglected in proportioning fasteners and anchors, except for slip resistant connections which shall be designed to the requirements of CSA S6-19 Clause 10.18.2, Bolted connections.

8.3 Supply and Fabrication

The Contractor shall be responsible for the work of fabricators and their sub-contractors. Contract requirements shall apply to all fabricators and their sub-contractors.

Fabrication of plain and laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings shall conform to:

- AASHTO LRFD Bridge Construction Specifications;
- AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, M251-06 (2016), Standard Specification for Plain and Laminated Elastomeric Bridge Bearings; and
- The AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

The Contractor shall submit a supply and fabrication inspection and test plan (ITP) for bearings to the Department Representative a minimum of 6 weeks prior to commencement of the work. The Contractor's supply and fabrication ITP shall include, but not be limited to, all specified witness points, hold points, inspection and testing requirements, and the associated acceptance criteria for each component being fabricated. The Contractor's supply and fabrication ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, quality control inspection and testing, and reporting requirements.

Fabrication shall not commence until the Contractor's supply and fabrication ITP has been reviewed and accepted in writing by the Department Representative.

8.3.1 Qualifications

Bearings shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with CSA W47.1 to Division 1 or 2. Fabrication shall be completed within a fabrication facility that is permanent, fully enclosed, and heated to maintain a minimum temperature of 10°C.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Department Representative upon request.

The fabricator and/or their sub-Contractor completing metalizing shall be certified by the SSPC to QP-6, Thermal Spray (Metalizing) Contractor Certification Program or ISO9001. These certification requirements will not be required for fabricators or sub-contractors completing repair of galvanized and metallized material in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

8.3.2 Prefabrication Submissions

The Contractor shall submit the following information to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of fabrication unless noted otherwise:

- List of fabricators and qualifications;
- Fabrication sequence and equipment;
- Mill test reports and product data sheets;
- Proprietary Structure Design Report;
- Welding procedures; and
- Fabrication schedule.

Prefabrication submissions will be considered hold points and shall be included in the Contractor's supply and fabrication ITP. The Contractor and the Department Representative shall provide written acceptance of the prefabrication submission hold points in the supply and fabrication inspection and test plan prior to the commencement of fabrication.

8.3.2.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications. The Contractor shall also submit the quality control plans, proof of qualification, and certifications of all fabricators and their sub-contractors.

8.3.2.2 Independent Inspection and Testing Laboratory Qualifications

The Contractor shall submit proof of qualification and certification of inspection and testing laboratories that will be used to complete the specified independent inspection and testing requirements.

8.3.2.3 Fabrication Sequence and Equipment

The Contractor shall submit details of the fabrication sequence and equipment that will be used to complete the work. The fabrication sequence shall include the order of fabrication, details of shop assembly, and surface preparation and coating. The details of shop assembly shall also include the method of assembly, support point locations, and dimensional and tolerance checks.

8.3.2.4 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided in English for all materials and welding consumables a minimum of 1 week prior to the commencement of fabrication.

Re-classification of materials using a mill test report or mill test report verification testing data will not be permitted.

Mill test reports and rotational capacity testing for fasteners shall be submitted to the Department Representative for review and acceptance 6 weeks prior to the commencement of erection, assembly or installation.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

8.3.3 Proprietary Structure Requirements, and Shop Drawings

8.3.3.1 Laminated Elastomeric and Pot Bearings

The Contractor shall submit proprietary design documents in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, unless otherwise specified in this Section.

Shop drawings shall be provided in electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- Material properties, material reference standards, and product data sheets for each component ;
- Connection attachments;
- Fasteners and accessories;
- Bearing identification;
- Installation orientation markings;
- Load capacity information at serviceability and ultimate limit states as follows:
    - Maximum vertical permanent and total load;
    - Maximum lateral load and corresponding vertical load; and
    - Maximum rotational capacity about any horizontal axis and about the vertical axis at the centre of the bearing.
    - Maximum translational capacities about any horizontal axis; and
    - Expected vertical deformation of the bearing under unfactored dead loads.

The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

8.3.3.2 Plain Elastomeric and Fixed Steel Plate Rocker Bearings

A proprietary design report in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, is not required for plain elastomeric and fixed steel plate rocker bearings.

The Contractor shall submit shop drawings for each bridge structure and bearing type in the Contract. The shop drawings will be reviewed by the Department Representative for conformance with the Contract requirements. Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work.

Shop drawings shall be provided in electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- Material properties, material reference standards, and product data sheets for each component;
- Connection attachments;
- Fasteners and accessories;
- Bearing identification;
- Installation orientation markings;
- Load capacity information at serviceability and ultimate limit states as follows:
    - Maximum vertical permanent and total load;
    - Maximum lateral load and corresponding vertical load; and
    - Maximum rotational capacity about any horizontal axis and about the vertical axis at the centre of the bearing.

The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction details into the design notes, independent check notes, and shop drawings, including actual mill test report heat numbers for each component. One unlocked electronic copy (PDF format) of as-built design notes, independent check notes, and shop drawings shall be submitted to the Department Representative within 3 weeks of construction completion.

8.3.3.3 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. All weld procedures and weld procedure datasheets shall be accepted by the CWB. Welding procedures shall reference CSA W47.1 and either CSA W59 or AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5. The preheat and interpass temperature, and heat input shall be in accordance with AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 except as required in Subsection 8.3.6.5, Preheat and Interpass Temperatures. Only weld procedure data sheets referenced on the shop drawings shall be submitted. Weld procedures and weld procedure datasheets will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut. The Professional Engineer shall be a welding engineer with extensive experience in welding procedures for this type of work.

8.3.3.4 Fabrication Schedule

The Contractor shall provide and maintain a current and complete fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors.

8.3.4 Prefabrication Meeting

A prefabrication meeting shall be held for the supply and fabrication of laminated elastomeric bearings, pot bearing and fixed steel plate rocker bearings.

The prefabrication meeting shall not occur until prefabrication submission hold points have been completed, reviewed and written acceptance provided by both the Contractor and the Department Representative.

The prefabrication meeting shall be coordinated by the Contractor and held at the fabricator's facility on a date and time acceptable to the Department Representative. A minimum of 2 weeks advance notice shall be provided to the Department Representative prior to the date of the proposed prefabrication meeting.

The Contractor, fabricator and their sub-contractors shall be in attendance at the prefabrication meeting including project manager(s), fabrication superintendent(s), independent testing agency representatives, and all employees involved in supervision of the work.

The Department Representative will prepare the prefabrication meeting agenda and chair the meeting.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (up to 3 representatives from the Government of the Northwest Territories and consultant) to attend the prefabrication meeting(s) for bearings being fabricated outside the Northwest Territories.

8.3.5 Materials

All materials shall be new. No reclaimed material shall be incorporated into the work.

8.3.5.1 Steel

The steel for baseplate, keeper bars, pintels, pot plates, piston plates, and shims shall conform to the requirements of CSA G40.21 Grade 300W or 350W or ASTM A572/A572M Grade 50. The steel for sole plates and fixed rockers shall be in accordance with the Drawings. Re-classification of steel using mill test report or mill test report verification data is not permitted.

The steel laminates within laminated elastomeric bearings shall be rolled mild steel with minimum yield strength of 230 MPa.

The boron content of steel to be welded shall not exceed 0.0008%.

8.3.5.2 Stainless Steel

Stainless steel shall conform to the requirements of the American Iron and Steel Institute (AISI) Type 304. The chemical and mechanical properties shall conform to the requirements of ASTM A240/A240M.

Stainless steel sheets shall have a minimum thickness of 3.2 mm and finished to a No. 8 mirror (0.2 μm) finish.

The boron content of stainless steel to be welded shall not exceed 0.0008%.

8.3.5.3 Brass

Brass sealing rings for pot bearings shall conform to the requirements of ASTM B36/B36M, half-hard.

8.3.5.4 Elastomer

Cured elastomeric compounds shall be low temperature Grade 5 and meet the minimum requirements listed in Table X1 of AASHTO M251-06 (2016). Cured elastomeric compounds shall have a shear modulus of 0.81 MPa (±0.15 MPa) for elastomeric bearing pads (laminated and plain) and a shear modulus between 0.65 and 0.80 MPa for pot bearings (elastomeric disc) unless otherwise stated in the contract documents.

Cured elastomeric compounds for fully integral abutments and piers shall be low temperature Grade 5, unless otherwise specified, and meet the minimum requirements listed in Table X1 of AASHTO M251-06 (2016). Cured elastomeric compounds for fully integral abutments and piers shall have a shear modulus between 0.65 and 0.80 MPa unless otherwise stated in the contract documents.

Cured elastomeric compounds shall also meet the requirements of ASTM D2240 for low temperature crystallinity increase in hardness at an exposure of -25°C for 168 hours.

8.3.5.5 PTFE

PTFE shall be unfilled, 100% virgin polymer conforming to Article 18.8.2.5, Unfilled PTFE Sheet, of the AASHTO 2017 LRFD Bridge Construction Specifications, including all interim revisions. Material used as the mating surface for guides for lateral restraint may be one of the following:

- Unfilled PTFE.
- PTFE filled with up to 15% by mass of glass fibres.

8.3.5.6 Lubricant

Lubricant shall be silicone grease, effective to -40°C and comply with Society of Automotive Engineers specification SAE AS8660.

8.3.5.7 Adhesive

Adhesive for bonding PTFE to metal shall be an epoxy resin satisfying the requirements of AASHTO M 235M/M 235 (ASTM C881/C881M) FEP film or equal producing a bond with a minimum peel strength of 4 N/mm, when tested according to ASTM D429 Method B. Adhesives shall not degrade in the service environment.

8.3.5.8 Anchor Rods and Connecting Bolts

Anchor rods and connecting bolts shall be in accordance with Table 8-2, Anchor Rod and Connecting Bolt Requirements.

Table 8-2 Anchor Rod and Connecting Bolt Requirements

Description	Grades
For stainless steel bearing anchor rods in contact with black steel.	Stainless steel AISI Type 316 (Fy = 290 MPa based on 0.2% offset)
Galvanized mild steel anchor rods in contact with galvanized bearing plates.	Galvanized CSA G40.21 Grade 300W or ASTM A307
Galvanized high strength anchor rods in contact with galvanized bearing plates	Galvanized ASTM A193/A193M Grade B7 (Fy=725 MPa, Fu=860 MPa).
Bolts connecting galvanized bearing components.	• Galvanized 22 mm diameter ASTM F3125/F3125M Grade A325/A325M Type 1 heavy hex style bolts (rotational capacity testing required); • Galvanized nuts ASTM A563M; • Galvanized hardened washers ASTM F436/F436M; and • Galvanized direct tension indicator washer ASTM F959

8.3.6 Welding

8.3.6.1 Filler Metals & Welding Processes

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used. The deposited weld metal shall provide strength, durability, impact toughness, and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

All electrodes, electrode/flux combinations, and electrode/shielding gas combinations shall be CSA certified and associated mill test reports and product data sheets submitted to the Department Representative for review and acceptance in accordance with Subsection 8.3.2.4, Mill Test Reports and Product Data Sheets.

Only the welding processes and associated consumables detailed in the following Subsections shall be used:

8.3.6.1.1 Submerged Arc Welding (SAW)

All welds shall be made by a semi or fully automatic submerged arc process that is acceptable to the Department Representative.

The submerged arc welding process may be used for flat and horizontal position welds.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H8 or lower. Use of cored filler wires in the submerged arc welding process or shielding gas process will not be permitted.

8.3.6.1.2 Shielded Metal Arc Welding (SMAW)

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4.

8.3.6.1.3 Metal Core Arc Welding (MCAW)

All electrodes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4

Field welding using the metal core arc welding process will not be permitted.

8.3.6.2 Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding. For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

8.3.6.3 Tack and Temporary Welds

Tack and temporary welds will not be permitted unless they are incorporated within the final weld. Tack welds to be incorporated into final welds shall be completed using consumables compatible with the final weld. Tack welds shall have a minimum weld length at least 4 times the nominal weld size. Cracked tack welds shall be completely removed prior to final welding. Magnetic particle testing shall be completed by the Contractor to confirm complete removal of any cracked tack welds. Tack welds shall be equivalent in quality to the final weld and will be subject to the same inspection and testing requirements as final welds

8.3.6.4 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required to acceptably complete the work. Run-off tabs shall be tack welded only to that portion of the material that will not remain part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the run-off tabs shall be removed by flame cutting. Removal of run-off tabs by breaking off will not be permitted.

8.3.6.5 Preheat and Interpass Temperatures

Preheat and interpass temperature requirements shall be in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5, except that all welds to girder flanges shall be preheated to a minimum temperature of 100°C unless a higher temperature is required by AASHTO/AWS Bridge Welding Code D1.5M/D1.5 for the flange thickness. The preheat temperature shall be measured 75 mm from the point of welding on the opposite side where the weld is being applied.

The Contractor shall not damage elastomeric materials nor other bearing components during welding.

8.3.6.6 Grinding of Welds

Welds which are sufficiently smooth with a neat appearance and uniform profile as determined by the Department Representative will not require grinding. Welds with unacceptable profile, as determined by the Department Representative, shall be ground to the specified profile without damage of the base metal.

Grinding shall be smooth and parallel with the line of stress. The Contractor shall take due care to prevent over grinding and damage of base metal and other components. Over grinding that results in reduced thickness of the base metal or size of the weld will not be permitted. Acceptability of the welds will be determined by the Department Representative.

8.3.6.7 Repair Procedures

The Contractor shall submit repair procedures to the Department Representative for review and acceptance for damaged base metal, defective weldments, and any other defect, prior to commencement of the repair work. Repair procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Repair procedures incorporating arc gouging shall specify that the repair area be preheated to a minimum of 65°C prior to gouging.

The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

8.3.6.8 Arc Strikes

Arc strikes will not be permitted. In the event of an arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.4.1.4, Hardness Test Inspection Schedule. Repair areas will be examined by the Department Representative to ensure complete removal of the metal in the affected area.

8.3.6.9 Plug and Slot Welds

Plug welds or slot welds will not be permitted.

8.3.6.10 Stainless Steel Sliding Sheets

Welding of stainless steel sliding sheets for expansion bearings shall conform to the American Welding Society (AWS) Structural Welding Code – Stainless Steel D1.6/D1.6M.

8.3.7 Fabrication

8.3.7.1 Plain Elastomeric Bearings

Plain elastomeric bearing pads shall be moulded individually, cut from moulded strips or slabs of the required thickness, or extruded and cut to length.

8.3.7.2 Laminated Elastomeric Bearings

Laminated elastomeric bearings shall be moulded under pressure as a single unit and heated in moulds that have a smooth surface finish.

The steel laminates shall be of uniform 3 mm nominal thickness without any sharp edges. The bond between the elastomer and the steel laminates shall be such that when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and steel laminate. The top 9.5 mm laminate for sliding bearings shall have a 2.5 mm recess. The recessed surface shall be machined in accordance with Subsection 8.3.7.5, Machining. The top 9.5 mm steel laminate shall be either galvanized, metallized or stainless steel.

8.3.7.3 Pot Bearings

Stainless steel sheets in contact with PTFE shall be continuously welded around the perimeter to its backing plate to prevent ingress of moisture. The weld shall be clean, uniform, and without overlaps and be located outside the area in contact with PTFE.

The threaded portion of the bolts shall be coated with silicone grease prior to installation.

Virgin or glass filled PTFE elements shall be recessed in a rigid backing material and bonded over the entire area with adhesive. The rigid backing material shall be grit blasted and cleaned with oil free compressed air prior to applying the adhesive.

The PTFE elements used as mating surfaces for guides for lateral restraint shall extend to within 10 mm from the ends of the backing plates.

8.3.7.4 Fixed Steel Plate Rocker Bearings

The curved surface of steel rocker bearings shall be machined in accordance with Subsection 8.3.7.5, Machining.

8.3.7.5 Machining

Machining shall be done after welding. All metal to metal contact surfaces shall be machined.

For pot bearings, the pots and pistons shall be machined from solid metal plate or castings. There shall be no openings or discontinuities in the metal surfaces that are in contact with the confined elastomer or PTFE.

The surfaces of sole plates of expansion laminated elastomeric bearings, the central 250 mm of rocker plates, and pot and piston plate surfaces in contact with confined elastomer of pot bearings shall be machined to a surface finish of 6.4 μm and a flatness tolerance of 0.001 times the bearing dimension.

8.3.7.6 Identification

Each bearing shall be marked with the fabricator's name, date of manufacture and unique identification number. The characters shall be not less than 10 mm in height.

8.3.7.7 Galvanizing and Metallizing

Galvanizing and metallizing shall be completed in accordance with Subsection 6.2.7.3, Galvanizing and Metallizing.

Metallizing of sole plates incorporating sliding stainless steel sheets is acceptable after the sliding stainless steel sheet has been welded on. Subsequent to welding, the stainless steel surface shall be accurately and adequately covered before and during metallizing to protect the stainless steel surface from damage and contamination.

Pot and piston plates of pot bearings, except the surfaces in contact with the elastomer, shall be metallized. The top 9.5 mm laminate for laminated elastomeric sliding bearings may be metallized in lieu of hot dip galvanizing.

8.3.7.8 Base Plate Corrosion Protection

The bottom surface of each baseplate shall be protected by a medium grey concrete colour barrier coating. The barrier coating shall be a mid coat polyamide epoxy technology coating selected from the Alberta Transportation's Products List Bridge Coating Systems - Paint or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

The galvanized surface shall be prepared and/or roughened in accordance with the barrier coating manufacturer's recommendations. The dry film thickness (DFT) of the coating shall be in accordance with the manufacturer's published product data sheet.

8.3.7.9 Tolerances

Plain and laminated elastomeric bearing fabrication tolerances shall meet the requirements of AASHTO M251-06 (2016). The Contractor shall record bearing dimension and tolerance verification checks in their ITP.

Pot bearing fabrication tolerances shall be as follows:

- The deviation from flatness of PTFE surfaces shall not exceed:
  - 0.2 mm, when the diameter or diagonal is equal to or less than 800 mm;
  - 0.00025 of the diameter or diagonal when the diameter or diagonal is greater than 800 mm;
- The deviation from flatness of stainless steel in contact with PTFE for plain surfaces and from the theoretical surface for spherical surfaces shall not exceed:
  - 0.0003 L x H mm for a rectangular PTFE element;
  - 0.0006 R x H mm for a circular PTFE element;

  where:

  L = the greater plan dimension for a rectangular bearing
  R = the radius of a circular bearing
  H = the free height of PTFE element
- For pot bearings, the tolerance of fit between the piston and the pot shall be +0.50 to +1.25 mm. The inside diameter of the pot cylinder shall be the same as the nominal diameter of the elastomer and shall be machined to a tolerance of:
  - 0 to +0.125 mm for diameters up to and including 500 mm;
  - 0 to +0.175 mm for diameters over 500 mm;
- The plan dimensions of the recess for PTFE shall be the same as the nominal plan dimensions of the PTFE and shall be machined to a tolerance of 0 to +0.2% of the diameter or diagonal:
  - Overall bearing plan dimension ± 3 mm;

  - Overall bearing height ± 3 mm;
  - Machined surface dimensions ± 0.4 mm;
- Elastomeric components shall meet the following tolerances:
  - Diameter 0 to -1.5 mm for diameters ≤500 mm;
    0 to -2 mm for diameters >500 mm;
  - Thickness 0 to +1 mm;
- Brass rings shall meet the following tolerances:
  - Difference between internal diameter of brass ring and diameter of recess in the moulded elastomer shall be 0 to + 0.5 mm;
  - Difference between sum of thicknesses of brass rings and recess depth in the moulded elastomer 0 to + 0.25 mm;
- Recessed Guide Bars shall meet the requirements of the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B4.1 American National Standard Clearance Location Fits Class LC3;
- Guides for lateral restraints shall have a 0.50 mm ± 0.25 mm gap between metal restraints surfaces and mating PTFE elements; and
- PTFE components shall meet the following requirements:
  - The plan dimension of the PTFE shall be 0 to -0.2% of the diameter or diagonal;
  - The thickness of the PTFE shall be within 0 to +10% of the design thickness;
  - The depth of recess of the PTFE shall be 0 to +0.3 mm of the design depth.

8.3.8 Inspection and Testing

8.3.8.1 Access

The Contractor shall provide acceptable facilities for the inspection and testing of the work. The Department Representative shall have full access to all phases of the work at all times. When required by the Department Representative, the Contractor shall also provide labour for assistance in checking layout and performing inspection and testing duties. The Department Representative shall be provided the time needed to complete quality assurance inspection and testing requirements.

8.3.8.2 Responsibility

Quality control inspection and testing shall be completed by the Contractor. Quality control shall be the sole responsibility of the Contractor.

Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant) to inspect and test bearings being fabricated outside the Northwest Territories and including up to three trips to the fabrication facility by the Department Representative during the course of fabrication.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work, non conforming materials shall be paid for by the Contractor.

If the Department Representative, at their sole discretion, determines that the Contractor's quality control inspection and/or testing personnel are not meeting the minimum specified standards, the Contractor shall replace the personnel immediately and prior to continuing with the work.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative.

8.3.8.3 Quality Control Inspection and Testing by the Contractor

The Contractor's quality control plan, including visual inspection and non-destructive testing, shall be in accordance with the requirements of AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 Clause 6, except as follows:

- The Contractor's visual quality control welding inspector shall be certified by the CWB as a Level 2 or Level 3 inspector in accordance with CSA W178.2;
- Non-destructive testing (NDT) methods shall be in accordance with Subsection 6.2.8.3, Non-Destructive Testing;
- NDT technicians shall be certified to Level 2 in accordance with CAN/CGSB-48.9712 and employed by an independent testing agency certified to CSA W178.1;
- The NDT schedule shall be as follows:
    - 25% of all fillet and partial penetration welds shall be inspected by magnetic particle testing;
    - The Contractor shall provide a minimum of 36 hours advance notice to the Department Representative prior to the commencement of any non-destructive testing; and
- Adhesion coating testing shall be completed by an independent National Association of Corrosion Engineers (NACE) Level 2 certified coating inspector.

The Contractor shall engage an AASHTO National Transportation Product Evaluation Program (NTPEP) Elastomeric Bridge Bearing Pad Designated Laboratory or an equivalent independent certified testing laboratory, acceptable to the Department Representative, to complete testing of the bearing materials and the completed bearings. The independent testing laboratory certification shall be submitted to the Department Representative for review and acceptance prior to commencement of testing in accordance with Subsection 8.3.2, Prefabrication Submissions.

Testing of the adhesive for bonding PTFE to the top recessed steel laminate plate shall be completed by an independent testing laboratory and demonstrate the minimum peel strength is achieved. Testing shall be completed for each lot of adhesive and with the type of steel laminate used. Each test shall consist of a minimum of three individual test samples.

Independent certified laboratory testing of the PTFE material shall be completed to verify material properties conform to the requirements of Subsection 8.3.5.5, PTFE.

The Contractor shall measure the baseplate barrier coating dry film thickness of one baseplate for each bearing type (laminated elastomeric, pot, and fixed steel plate rocker) at each substructure element. Coating thickness measurements shall be completed at a minimum of 5 locations (4 corners and centre) of the baseplate in accordance with SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges.

The Contractor shall complete adhesion testing of the baseplate barrier coating application using adhesion test plates. One adhesion test plate shall be supplied and fabricated for each bearing type (laminated elastomeric, pot, and fixed steel plate rocker) at each substructure element. Adhesion test plates shall be supplied and fabricated in accordance with the following requirements:

- Be of the same type and grade of steel as the production baseplates;
- 150 x 150 mm in plan dimension and have a thickness equal to the production baseplates;
- Galvanized at the same time as the production baseplates;

- Barrier coating applied at the same time as the production baseplates; and
- Barrier coating thickness measured for compliance and fully cured prior to testing.

Adhesion testing of the barrier coating shall be completed in accordance with ASTM D3359 Method A or Method B and have a minimum classification of 4A or 4B.

The Contractor's quality control testing and inspection records and/or reports shall be submitted on a weekly basis to the Department Representative for review and acceptance. All quality control testing and inspection records and/or reports shall contain the written acceptance of the fabricator's QC manager.

8.3.8.3.1 Elastomeric Bearings

Plain elastomeric bearings shall be tested in accordance with Section 8, Bearing Testing and Acceptance Criteria, of AASHTO M251-06 (2016); however the material shall conform to the specified requirements of CSA S6-19 Table 11.5, Physical properties of polyisoprene the additional requirements for minimum mean daily temperature, T_s, of -44 °C and below. The testing specified in Subsections 8.8 and 8.9 of AASHTO M251-06 (2016) is not required for plain elastomeric bearings, unless otherwise specified in the contract documents.

Laminated elastomeric bearings shall be tested in accordance with Section 8, Bearing Testing and Acceptance Criteria, of AASHTO M251-06 (2016); however the elastomer material shall conform to the requirements specified in CSA S6-19 Table 11.5, Physical properties of polyisoprene including the additional requirements for minimum mean daily temperature, T_s, of -44 °C and below. Testing specified in Subsections 8.8.1, and 8.8.2 of AASHTO M251-06 (2016) is required for laminated bearings, unless otherwise specified in the contract documents. Testing specified in Subsections 8.8.3, 8.8.4, 8.9.1 and 8.9.2 of AASHTO M251-06 (2016) shall be performed when specified in the contract documents.

Testing in accordance with Subsection 8.8.1 of AASHTO M251-06 (2016) shall be carried out even if the maximum value for compressive strain is not provided. The increment in compressive deformation of laminated bearings shall not exceed 0.05 of the effective rubber thickness, when the bearing load is increased from an initial pressure of 1.5 MPa to the maximum pressure under the loads as described in Subsection 8.8.1 of AASHTO M251-06 (2016). If no design loads are provided the maximum pressure for testing under Subsection 8.8.1 of AASHTO M251-06 (2016)shall be taken as 14 MPa when tested in accordance with the requirements of Subsection 9.1 of AASHTO M251-06 (2016).

The load combination used to determine the maximum loading requirements for testing in accordance with Subsection 8.8.2 of AASHTO M251-06 (2016) shall be taken as the greater of the following, unless otherwise stated in the contract documents:

- Sum of factored dead load and factored live load under ULS 1 in accordance with CSA S6-19 Table 3.1, Load factors and load combinations;
- Load combination described in Subsection 8.8.2 of AASHTO M251-06 (2016);

A minimum of two bearings from the production lot of laminated bearings shall be cut and tested for shear modulus. The dimensional tolerances for each bearing shall be checked and included with the testing report.

The Contractor's bearing supplier shall produce quality control test results for all physical properties of the same batch of elastomer used for bearing fabrication in accordance with CSA S6-19 Table 11.5, Physical properties of polyisoprene upon request of the Department Representative prior to installation of the bearings.

8.3.8.3.2 Pot Bearings

Testing of elastomeric compounds shall be in accordance with of AASHTO M251-06 (2016). Testing of the completed bearings shall be in accordance with the requirements of Article 18.3.4, Sampling and Testing, of the AASHTO 2017 LRFD Bridge Construction Specifications, including all interim revisions unless otherwise specified in the contract documents. The long-term deterioration test described in Subsection 18.3.4.4.3 is not required. The proof load test described in Subsection 18.3.4.4.4 shall be completed in accordance with the long-term proof load test requirements.

8.3.8.4 Quality Assurance Inspection and Testing by the Department Representative

The Department Representative will complete visual inspection of all welds and review all quality control inspection and testing records and/or reports produced by the Contractor to verify their compliance with the Contract.

The Department Representative may complete additional quality assurance inspection and/or testing at their sole discretion. The Contractor shall provide full access to the work in accordance with Subsection 8.3.8.1, Access.

8.3.8.5 Witness Points and Hold Points

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified witness points and hold points within the ITP.

If fabrication continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Department Representative may suspend the supply and fabrication work, and the Contractor shall be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the work, as determined by and to the satisfaction of the Department Representative.

Inspection stations shall be set up by the Contractor within the fabrication facility to the satisfaction of the Department Representative for each of the specified witness points and hold points such that the associated inspection and/or testing requirements can be acceptably completed.

8.3.8.5.1 Laminated Elastomeric Bearings

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP:

- Inspection of steel laminates prior to incorporation within the elastomer (witness point);
- Dimensional checks and verification of tolerances (witness point);
- Bearing testing (witness point);
- Verification testing and inspection of bearings if fabricated outside of Canada and the United States (hold point); and
- Final inspection (hold point).

8.3.8.5.2 Pot Bearings and Steel Rocker Bearings

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP:

- After completion of machining prior to bearing assembly (witness point);

- Dimensional checks and verification of tolerances of components (witness point);
- Visual inspection of welding and completion of non destructive testing, prior to galvanizing and/or metallization (hold point – pot bearings only);
- Dimensional checks and verification of tolerances of completed bearings (witness points);
- Bearing testing (witness point – pot bearings only);
- Embrittlement testing of high strength anchor rods (witness point);
- Verification testing and inspection of bearings if fabricated outside of Canada and the United States (hold point); and
- Final inspection (hold point).

8.3.8.6 Final Inspection

The Contractor and the Department Representative shall provide written acceptance of all fabricated bearings upon the completion of fabrication. Review and acceptance of bearings by the Department Representative at the fabrication facility will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

8.3.8.7 Fabrication Outside of Canada and the United States of America

In addition to the requirements of Subsections 8.3.8.1,Access, to 8.3.8.6, Final Inspection, bearing components fabricated outside of Canada or the United States of America shall be shipped to a shop located in Canada that is certified by the CWB in accordance with CSA W47.1 to Division 1 or 2 for verification inspection and testing. The bearing components shall be in a condition that facilitates all verification inspection and testing requirements. Verification inspection and testing shall be completed in accordance with Subsection 8.3.8, Inspection. The visual welding inspector shall also inspect all bearing components for the presence of transportation damage.

Components shall not be shipped from the Canadian shop to the project site until all requirements have been met and the work has been reviewed and accepted by the Department Representative.

The Contractor shall be responsible for all verification inspection and testing costs, including all cost incurred by the Department Representative (from the Government of the Northwest Territories or consultant). The Contractor shall also be responsible for all hourly charge out rates, travel, meals and accommodation of the Department Representative inspector(s) to complete inspection and testing duties at the fabrication facility for 100% of the fabrication time. The Contractor shall also be responsible for the cost of one trip every 2 weeks for two Department Representatives to and from the fabrication facility.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

8.4 Construction

Concrete surfaces on which bearing plates, pads or shims are placed shall be finished in accordance with Subsection 4.25.8, Surface Finish under Bearings.

The Contractor shall remove all materials used to form anchor rod voids. Foreign materials on concrete surfaces, such as oils, grease or other contaminants shall be removed by sandblasting prior to installation of anchor rods.

When bearings are detailed in conjunction with grout pockets cast in the substructure, the bearing base plates shall be set accurately on galvanized steel shim plates. Galvanized steel shim plates shall be located such that a minimum of 75 mm of grout cover is provided from the shims to the edge of the grout. When grout pockets are not detailed on the Drawings, the bearing shall be set on the finished concrete surface in the specified position and have full and even bearing.

Baseplates shall be set to the positions indicated on the Drawings. Anchor rods shall be positioned in accordance with the bearing setting tables shown on the Drawings and the girder temperature at the time of grouting. Where nuts are specified on top of expansion bearing anchor rods, they shall be adjusted to permit movement. Top of the bearing sole plate shall be within a tolerance of ± 3 mm of the correct elevation prior to girder erection.

Bearing components shall not be disassembled at any time during installation.

8.4.1 Proprietary Structures Requirements

The Contractor shall be responsible for the proprietary structure requirements in accordance with Section 27.3, Supply, Fabrication and Construction.

After construction completion, the Contractor shall provide record information in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, unless otherwise specified in this Section.

8.4.2 Transportation, Handling and Storing Materials

Bearings shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage.

Bearings that become contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to installation.

Bearings shall be transported, hauled and stored on timber blocking. Timber blocking shall be located at positions that prevent damage. The ground of the storage area shall be solid and unyielding and drainage diverted away from the storage area.

Galvanized and metallized material shall be handled, stacked, bundled, transported, hauled and stored to prevent damage or wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. If damage or wet storage staining occurs, it shall be assessed and repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

8.4.2.1 Clearance to Ship

The Contractor shall provide the Department Representative a transportation schedule for bearings a minimum of 72 hours prior to shipment from the fabrication facility. Written acceptance in accordance with Subsection 8.3.8.6, Final Inspection shall be provided by both the Contractor and the Department Representative prior to the commencement of shipping.

Review and acceptance at the fabrication facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

8.4.3 Installation

8.4.3.1 Bearing Installation Procedure

The Contractor shall submit a bearing installation procedure for laminated elastomeric bearings, pot bearings and fixed steel plate rocker bearings to the Department Representative for review and acceptance 4 weeks prior to the commencement of bearing installation work. The installation procedure shall include drawings and documents necessary to describe the following:

- Details of bearing storage and protection;
- Survey information for location and elevation of shim stacks, grout pads and anchor rod voids;
- Temporary support and stability measures (hold point);
- Bearing elevation, location, grade and orientation verification (hold point);
- Setting expansion bearings for temperature (witness point);
- Schedule of anchor rod grouting;
- Methods of forming, placing, curing, and sealing of grout pads; and
- Enclosure and system of heating for grouting in cold weather.

The bearing installation procedure will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

8.4.3.2 Attachment to Sole Plates

Sole plates shall be bolted or welded to girders in accordance with the Drawings.

8.4.3.2.1 Bolting

Sole plate to girder bolt tensioning shall be completed using direct-tension-indicator (DTI) pretensioning for slip-critical connection method in accordance with the Section 6 and Section 8 of the Research Council on Structural Connections Specification for Structural Joints Using High-Strength Bolts and these specifications. An ASTM F436 washer shall be used between the bolt head and the direct-tension-indicator washer.

Pre-installation verification testing of bolts with DTI washers shall be completed in accordance with Section 7 of the Research Council on Structural Connections Specification for Structural Joints Using High-Strength Bolts and Subsection 6.3.2.4.2, Pre-Installation Verification Testing.

The Contractor and the Department Representative shall inspect and record bolt tightening of all direct-tension-indicator (DTI) pretensioning for slip-critical connections in accordance with Section 9 of the Research Council on Structural Connections Specification for Structural Joints Using High-Strength Bolts.

8.4.3.2.2 Welding

Attachment of sole plates to girders by welding shall be in the longitudinal direction along the edge of the bottom flange or shoe plate. Welding of the transverse edge will not be permitted. Transverse ends shall be sealed with Sikaflex 1a or an approved equivalent sealant.

When specified, field welding adjacent to elastomeric bearings shall be completed such that damage to the bearing does not occur. Damaged elastomeric bearings, as determined by the Department Representative, shall be replaced by the Contractor at their expense.

8.4.3.3 Grouting of Anchor Rod Voids and Bearing Grout Pads

Anchor rods and bearing grout pads shall not be grouted until erection of the entire superstructure is complete and accepted by the Department Representative, unless otherwise reviewed and accepted by the Department Representative. Unless otherwise stated, anchor rod voids and bearing grout pads shall be grouted prior to casting deck concrete.

Grout used for the grouting of anchor rod voids and bearing grout pads shall be selected from the Department's Products List, Non-Shrink Grout category.

The Contractor's proposed method of forming and placing grout shall be submitted to the Department Representative for review and acceptance. Dry-pack methods of constructing grout pads will not be accepted.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. It shall be mixed and placed in strict accordance with the manufacturer's recommendations stated on the published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout in accordance with CSA A23.2-1B. A set of compressive strength cubes shall be taken to represent each day's production or 0.25 m^3, whichever is more frequent. All test results shall be provided to the Department Representative within 3 days of testing. The average minimum compressive strength of 3 cubes at 28 days shall be 30 MPa. Failure to meet the minimum specified compressive strength will result in the grout pad being removed and replaced at the Contractor's expense.

Grout shall be wet cured for a minimum of 3 days with two layers of clean, saturated Nilex 4504 white coloured filter fabric or an approved equivalent. Water used for wet curing shall be clean and acceptable to the Department Representative.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Subsection 4.26, Type 1c Sealer.

8.4.3.4 Grouting in Cold Weather

When the daily minimum air temperature or the temperature of the girders, bearings or substructure concrete in the immediate area of the grouting is, or is expected to be below 5°C during the placing and curing period, the following additional requirements shall be included in the Contractor's bearing installation procedure:

- Before grouting, adequate preheat shall be provided to raise the temperature of the adjacent areas of the girders, bearings and substructure concrete to at least 15°C.
- Temperature of the grout during placing shall be between 10°C and 25°C.
- The grout pads shall be enclosed and kept at 15°C to 25°C for a minimum of 5 days. The enclosure shall meet the requirements of Subsection 4.20, Concreting in Cold Weather.

8.4.3.5 Inspection

After bearing installation, grouting and deck concrete placement, the Contractor and the Department Representative shall inspect the bearings for cleanliness and presence of damage. The Contractor shall provide acceptable access equipment for the Department Representative to complete the inspection.

If bearings are damaged, as determined by the Department Representative, the Contractor shall submit a damage assessment report and/or field repair procedure to the Department Representative for review and acceptance. The assessment report and/or the field repair procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Department Representative may also require that further independent inspection, non-destructive testing, and/or assessment be completed. Damage of the bearings shall be repaired to the satisfaction of the Department Representative and all costs will be the sole responsibility of the Contractor.

If at any time during the work, bearings become contaminated with dirt, road salts, slush or other contaminants, the Contractor shall commence cleaning within 3 days of it being identified by the Department Representative. Cleaning shall be completed in accordance with the recommendations of the bearing supplier and to the satisfaction of the Department Representative.

The installation inspections will be considered hold points. The Contractor and the Department Representative shall provide written acceptance of the hold points after the bearings have been acceptably installed, grouted, the completion of bridge deck concrete placement, and any cleaning if required. If the work continues without the written acceptance of the hold point by both the Contractor and the Department Representative, the Contractor will be solely responsible for all costs required for the Department Representative to provide written acceptance of the hold point. The Contractor will also be solely responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

8.5 Payment

8.5.1 Bearings

Payment for bearings will be made at the lump sum price bid for “Bearings – Supply and Fabrication, Delivery and Installation” for the type and size specified, and will be full compensation for the design; supply and fabrication; inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; assembly; installation; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

The lump sum price bid will be paid in accordance with Subsection 8.5.1.1, Supply and Fabrication, Subsection 8.5.1.2, Delivery, and Subsection 8.5.1.3, Installation. If written acceptance of the Contractor’s ITPs is not provided by the Department Representative prior to the commencement of the Work, the Work will be rejected and no payment will be made.

8.5.1.1 Supply and Fabrication

60% of the lump sum price bid for “Bearings – Supply and Fabrication, Delivery and Installation” will be paid once the bearings have been acceptably designed; supplied; fabricated; inspected; tested; stored; written acceptance within the supply and fabrication ITP has been provided by both the Department Representative and the Contractor for each specified witness point and hold point; and the Contractor has fulfilled all proprietary structure requirements. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the supply and fabrication inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for supply and fabrication of bearings for the types and size specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

8.5.1.2 Delivery

20% of the lump sum price bid for "Bearings – Supply and Fabrication, Delivery and Installation" will be paid once the bearings have been acceptably loaded; transported; hauled; unloaded; stored; cleaned and/or repaired, if required; written acceptance has been provided by both the Department Representative and the Contractor, and the Contractor has fulfilled all proprietary structure requirements. This payment will be full compensation for delivery of bearings for the types and size specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. All necessary approvals and permits, will be considered incidental to the Work and no separate or additional payment will be made.

8.5.1.3 Installation

20% of the lump sum price bid for "Bearings – Supply and Fabrication, Delivery and Installation" will be paid once the bearings have been acceptably installed; written acceptance of witness points and hold points has been provided by both the Department Representative and the Contractor, and the Contractor has fulfilled all proprietary structure requirements. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance of witness points and hold points has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for installation of bearings for the types and size specified; the supply and placement of grout; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

All costs associated with temporary supports and superstructure stabilization will be considered incidental to the Work, and no separate or additional payment will be made.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 9 DRAIN TROUGHS

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9.1 General

This specification is for the construction of concrete, heavy rock riprap, or sand bag drain troughs, including drain trough collectors, terminal protection, and all excavation, trimming and backfill, and restoration necessary to complete the work as shown on the Drawings.

Concrete drain trough components shall be constructed in accordance with Section 4, Cast-In-Place Concrete.

The slopes receiving the drain troughs shall be excavated, trimmed and backfilled to the lines and grades shown on the Drawings or as determined by the Department Representative. The subgrade shall be placed and compacted in accordance with Section 2, Backfill.

A minimum of 1 week prior to commencing the work, the Contractor shall submit a detailed layout and proposed construction methodology plan to the Department Representative for review and acceptance.

9.2 Concrete

Concrete shall be Class C concrete and in conformance with the requirements of Section 4, Cast-In-Place Concrete. Formwork shall meet the requirements of Subsection 4.10, Falsework and Formwork, except that engineered formwork drawings do not require submission to the Department Representative for review and acceptance.

9.3 Reinforcing Steel

Reinforcing steel shall be plain reinforcing and in conformance with all requirements of Section 5, Reinforcing Steel.

9.4 Heavy Rock Riprap

Heavy Rock Riprap shall be Class 1M or Class 1 and in conformance with all requirements of Section 10, Heavy Rock Riprap.

9.5 Geotextile Filter Fabric

Geotextile filter fabric shall be non-woven geotextile filter fabric and in conformance with all requirements of Section 10, Heavy Rock Riprap.

The heavy rock riprap shall be placed so that the filter fabric is fully covered.

9.6 Sand Bags

Sand bags shall be in conformance with the Specifications for Highway Construction, Edition 7, Division 4 Structures, Section 4, Sand Bag Riprap, with the exception of Clauses 4.4.4 Measurement and 4.4.5 Basis of Payment. The term Engineer in the Specifications for Highway Construction shall be replaced with Department Representative.

9.7 Site Restoration

Upon completion of drain trough work, the Contractor shall restore the site to the original condition and as determined by the Department Representative. This shall include disposing of all surplus excavated materials, backfilling as required, supplying and placement of 50 mm minimum thickness of organic material on all disturbed areas and seeding.

9.8 Measurement and Payment

Measurement for payment of drain troughs will be by the metre of drain trough acceptably constructed, measured to the nearest 0.1 m.

The quantity to be paid for will be measured as the total length from the roadway edge adjacent to the drain trough collector to the end of the terminal protection.

Payment will be made at the unit price bid for "Drain Troughs", and will be full compensation for preparation of the slopes; the supply and placement of reinforcing steel, concrete, geotextile filter fabric, heavy rock riprap and sand bags; construction of concrete drain trough collectors and terminal protection; site restoration; and all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

All costs associated with concreting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 10 HEAVY ROCK RIPRAP

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10.1 General

This specification is for the supply, delivery, and installation of heavy rock riprap. This work shall include all necessary trimming, excavation, and backfill required to satisfactorily place the heavy rock riprap, such as:

- Excavation, trimming and shaping of headslope;
- Excavation at headslope toe, and for rock apron;
- Excavation for heavy rock riprap in stream bank transition zone;
- Supply and placement of non-woven geotextile filter fabric;
- Supply and placement of gravel or granular bedding material; and
- Backfill over heavy rock riprap in stream bank transition zone to restore lines of natural bank.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

10.2 Permits

Unless otherwise provided by the Department, the Contractor shall obtain whatever permits, agreements, and authorizations are necessary, prior to commencement of the work. The Contractor shall advise the Department Representative of any special provisions required under such permits, and must provide evidence satisfactory to the Department Representative that the requirements of the permits have been fully complied with before final payment will be made.

10.3 Heavy Rock Riprap Material

Heavy rock riprap shall be hard, durable, angular in shape, and resistant to weathering and degradation from freeze-thaw and flowing water. Heavy rock riprap shall not contain overburden, spoil, sandstone, shale, shale seams, or organic material.

Greywacke, a specific type of sandstone, will not be permitted for any class of heavy rock riprap unless otherwise approved by the Department Representative. The Contractor may submit a proposal to supply durable and competent greywacke to the Department Representative for review and acceptance a minimum of 4 weeks prior to commencement of the work. The proposal shall include the following:

- A comprehensive sampling, inspection and testing program to initially evaluate the material's suitability including, but not limited to specific gravity, durability index, durability absorption ratio testing in accordance with Table 10-2, Specific Gravity, Absorption and Durability Index Requirements, petrographic analysis in accordance with CSA A23.2-15A, visual inspection by a Professional Geoscientist licensed to practice within the Northwest Territories and Nunavut, geological hammer testing, and drop testing; and
- A comprehensive sampling, inspection and testing program to continuously assess and evaluate the material's suitability throughout production including, but not limited to, visual inspection by a Professional Geoscientist licensed to practice within the Northwest Territories and Nunavut, geological hammer testing, and drop testing.

The Department Representative will be the sole judge of material suitability.

10.3.1 Performance Records and Material Testing Requirements

The Contractor shall submit performance records and test results for the proposed heavy rock riprap material to the Department Representative for review and acceptance 4 weeks prior to commencement of the work.

Performance records alone, without supporting test results, may be considered sufficient to determine acceptability of the proposed material when comprehensive performance records exist, and are determined to be acceptable by the Department Representative.

Angular fieldstone is considered to have acceptable comprehensive performance records and no further testing is required.

Sampling and testing will be required for Class 1, 2 and 3 heavy rock riprap for which limited or no acceptable performance records exist as determined by the Department Representative.

The Contractor shall collect, deliver and submit samples of the proposed material to an independent CSA certified testing laboratory for testing. A minimum 70 kg representative sample shall be provided for each proposed type and source of heavy rock riprap and contain a number of pieces ranging up to 25 kg mass. The independent CSA testing laboratory shall test the proposed material in accordance with the test methods specified in Table 10-2, Specific Gravity, Absorption and Durability Index Requirements. The Contractor shall submit test result reports from the independent CSA testing laboratory to the Department Representative for review and acceptance within 3 days of test completion. The test result reports will be considered Professional Work Products and shall be authenticated by a Professional Engineer or Professional Geoscientist licensed to practise within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp as issued by NAPEG.

All riprap shall be verified by testing as non-PAG (Potential Acid Generating) with low Metals Leaching potential.

The acceptance of performance records and/or test results will not be considered acceptance of all material from the source. Changes in the heavy rock riprap material delivered to site may require additional testing as determined by the Department Representative. Additional testing shall be completed in accordance with this Subsection and to the satisfaction of the Department Representative.

All costs associated with heavy rock riprap sampling, testing, reporting and other incidentals necessary to complete the work will be considered incidental to the Work, and no separate or additional payment will be made.

10.3.2 Gradation Requirements

Heavy rock riprap material shall meet the requirements of Table 10-1, Gradation Requirements for the specified class.

Table 10-1 Gradation Requirements

Gradation		**Heavy Rock Riprap Class**			
Required Properties(1,2)	**Units**	**1M**	**1**	**2**	**3**
Nominal Mass	kg	7	40	200	700
Nominal Diameter	mm	175	300	500	800
None greater than:	kg	40	130	700	1800
	mm	300	450	800	1100
20% to 50%	kg	10	70	300	1100
	mm	200	350	600	900
50% to 80%	kg	7	40	200	700
	mm	175	300	500	800
100% greater than:	kg	3	10	40	200
	mm	125	200	300	500

Notes:

(1) Gradation percentages are by mass. Gradation sizes are equivalent spherical diameters.

The minimum dimension of any single rock shall be not less than one third of its maximum dimension. The minimum dry unit weight of the rock shall be 2.5 t/m^3.

10.3.3 Durability Requirements

Heavy rock riprap material shall meet the requirements of Table 10-2, Specific Gravity, Absorption and Durability Index Requirements.

Table 10-2 Specific Gravity, Absorption and Durability Index Requirements

Test Method	**Requirement**
California Department of Transportation Method of Test for Specific Gravity and Absorption of Coarse Aggregates, 2011 (California Test 206)	Minimum Specific Gravity = 2.60 (1) Maximum Absorption = 2 %
California Department of Transportation Method of Test for Durability Index, 2011 (California Test 229)	Minimum Durability Index = 52 (2)

Notes:

(1) Bulk Specific Gravity – Apparent Basis
(2) The durability Index may be less than 52 if the durability absorption ratio (DAR) is greater than 23, where DAR = Durability Index / (Absorption % +1%)

10.4 Non-Woven Geotextile Filter Fabric

Where non-woven geotextile filter fabric is specified, the slope shall be graded to provide a smooth, uniform surface. All stumps, large rock, brush or other debris that could damage the fabric shall be removed. All holes and depressions shall be filled so that the fabric does not bridge them. Loose or unstable soils shall be removed and replaced with material acceptable to the Department Representative.

Non-woven geotextile filter fabric shall be used under all riprap and shall meet the minimum average roll value properties (MARV's) listed in Table 10-3, Non-Woven Geotextile Filter Fabric Requirements.

Table 10-3 Non-Woven Geotextile Filter Fabric Requirements

Required Physical Property	Test Method	Minimum MARV Required
		Class 1M, 1, 2, and 3
Grab Strength	ASTM D4632/D4632M	900 N
Elongation (Failure)	ASTM D4632/D4632M	50%
Static Puncture Strength	ASTM D6241	1925 N
Trapezoidal Tear	ASTM D4533/D4533M	350 N

The non-woven geotextile filter fabric shall be laid parallel to the slope direction. It shall be placed in a loose fashion; however, folds and wrinkles shall be avoided. The minimum non-woven geotextile filter fabric lap shall be 400 mm, except where placed underwater the minimum lap width shall be 1 m. Overlaps shall be pinned using 6 mm diameter steel pins fitted with washers and spaced at 1 m intervals along the overlaps. When placed underwater, on the headslope or banks of a watercourse, overlaps shall be shingled in the downstream direction.

The top edge of the non-woven geotextile filter fabric shall be anchored by digging a 300 mm deep trench, inserting the top edge of the non-woven geotextile filter fabric and backfilling with compacted soil.

Care shall be taken to prevent puncturing or tearing the non-woven geotextile filter fabric. Any damage shall be repaired by use of patches of the same non-woven geotextile filter fabric that extend at least 1 m beyond the perimeter of the tear or puncture.

The non-woven geotextile filter fabric shall be covered by heavy rock riprap within sufficient time so that ultraviolet damage does not occur; in no case shall this time exceed 7 days for material susceptible to ultraviolet deterioration and 14 days for ultraviolet protected and low ultraviolet susceptible polymer non-woven geotextile filter fabric.

Heavy rock riprap placement shall commence at the base of the blanket area and proceed up the slope. The height of drop of riprap shall be limited to 1 m or less, and the heavy rock riprap shall not be allowed to roll or slide down the slope. Heavy equipment will not be permitted to operate directly on the geotextile.

10.5 Placing of Heavy Rock Riprap

The heavy rock riprap shall be handled, dumped or placed into position to conform to the specified gradation and to the cross section shown on the Drawings. The finished heavy rock riprap surface shall be uniform in the opinion of the Department Representative, well graded, free from bumps or depressions, and with no excessively large cavities below or individual stones projecting above the specified surface profile.

10.6 Inspection of Heavy Rock Riprap

The Contractor shall provide a minimum of two inspection samples of heavy rock riprap of the inspection sample size specified in Table 10-4, Heavy Rock Riprap Inspection Sample Size Requirements. The riprap depth shall correspond to the depth shown on the Drawings. Inspection samples shall be constructed at the project site and/or the source or quarry. The exact location of where inspection samples shall be constructed will be determined by the Department Representative.

The Contractor shall demonstrate that inspection sample conforms to the specified gradation by direct weighing each individual piece in the inspection sample with a calibrated scale and measuring and evaluating the equivalent spherical diameter. The mass of each piece in the inspection sample shall be recorded and painted on the piece.

The inspection samples will be used by the Department Representative for frequent reference in determining the acceptability of the heavy rock riprap gradation being loaded at the source/quarry and/or placed at the project site. The Department Representative will be the sole judges of material gradation acceptability.

Table 10-4 Heavy Rock Riprap Inspection Sample Size Requirements

Heavy Rock Riprap Class	Inspection Sample Size
1M	1 m x 1 m
1	2 m x 2 m
2	3 m x 3 m
3	4 m x 4 m

The Contractor shall provide all labour, materials, and equipment determined necessary by the Department Representative to evaluate gradation and measurement of heavy rock riprap.

If, during the delivery of the material to the site, a particular load is found to be made up of pieces predominantly one size, or to be lacking in pieces of one size, it shall be dumped in a suitable location outside the area to be protected. Additional material as required to make up the deficient sizes shall be added to this load such that the combination can then be placed to conform to the specified gradation.

10.7 Measurement and Payment

Measurement for payment of heavy rock riprap will be by the cubic metre of heavy rock riprap acceptably placed, measured to the nearest 0.1 m^3.

The quantity to be paid for will be based on the thickness of heavy rock riprap specified on the Drawings multiplied by the actual measured surface area of ground covered with heavy rock riprap as determined by the Department Representative. Heavy rock riprap placed outside of the plan limits on the Drawings will not be paid for unless placement in these additional areas has been reviewed and accepted by the Department Representative prior to the Work.

Payment will be made at the unit price bid for "Heavy Rock Riprap", of the class specified, and will be full compensation for royalties; permits; sampling and testing; transportation; the preparation, weighing and inspection of sample sizes; excavation and subgrade preparation, including backfilling; the supply and placement of non-woven geotextile fabric; the supply and placement of heavy rock riprap; interim stockpiling; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

SECTION 11 DUCTS AND CONDUITS

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11.1 General

This specification is for the supply and installation of all ducts and conduits, associated hardware, junction boxes, and anchorage assemblies as shown on the Drawings.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

11.2 Material

All ducts and conduits shall be rigid PVC type DB2 meeting the requirements of CSA C22.2 No 211.1 and in accordance with the Rules of the Canadian Electrical Code, Part 1. Coupling shall be solvent bell ends (SBE).

Expansion assemblies for PVC shall be Scepter type 'O' ring expansion joints or an approved equivalent.

Rigid conduit shall be as specified on the Drawings.

11.3 Installation

Ducts and conduits shall be installed as shown on the Drawings and firmly secured to prevent displacement.

Plastic duct and conduit bank spacers used within barriers and curbs shall be IPEX interlocking duct bank spacers or an equivalent acceptable to the Department Representative. Plastic interlocking duct bank spacers shall not be located within 300 mm of barrier or curb control joints.

Continuous pull wires shall be installed in all ducts and conduits unless specified otherwise. The pull wires shall be 12 gauge galvanized steel, unspliced, extending with a tight fit through the duct end caps and terminating one metre beyond in 300 mm loops. In lieu of the galvanized pull wire, an 8 mm mono poly rope or equivalent may be substituted in ducts over 75 mm diameter. The rope shall be unspliced, with the extra length of 300 mm each end coiled up inside the duct and the duct end caps secured in place.

The installation of electrical components shall be carried out by a fully qualified electrician. All runs of ducts and conduits shall be proven in the presence of the Department Representative by passing through the entire length, a round object no less than 75% of the conduit area. Any required permits will be the responsibility of the Contractor.

11.4 Payment

All costs associated with the supply and installation of ducts and conduit will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 12 BRIDGERAIL

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12.1 General

This specification is for the supply, fabrication and installation of steel tube type bridgerail, thrie beam bridgerail, approach rail transition, pedestrian/bicycle barriers, and safety railing on top of the MSE wall coping cap. Bridgerail and pedestrian/bicycle barriers shall include all work constructed above the top of the bridge deck, curb, parapet, sidewalk, or culvert headwalls, and wing walls, and the supply and placing of anchor rod assemblies, end connection plates and connection angles. Approach rail transition shall include thrie beam or W-beam guardrail sections, W-thrie beam transition section, terminal connectors, steel or timber guardrail posts, spacers, and guardrail connection and wing end sections where specified.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

12.2 Supply and Fabrication

The Contractor shall be responsible for the work of fabricators and their sub-contractors. Contract requirements shall apply to all fabricators and their sub-contractors.

Fabrication of bridgerail components shall conform to AASHTO LRFD Bridge Construction Specifications and the AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

All welding, cutting and preparation shall be in accordance with the AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

All welding, cutting and preparation of hollow structural steel sections (HSS) shall be in accordance with and the AASHTO/AWS Bridge Welding Code D1.5M/D1.5 and the American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M. In the case of conflicting requirements between AASHTO/AWS Bridge Welding Code D1.5M/D1.5 and the American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M for HSS, the more stringent requirement shall apply.

The Contractor shall submit a supply and fabrication inspection and test plan (ITP) for bridgerail components to the Department Representative a minimum of six (6) weeks prior to commencement of the work. The Contractor's supply and fabrication ITP shall include, but not be limited to, all specified witness points, hold points, inspection and testing requirements, and the associated acceptance criteria for each component being fabricated. The Contractor's supply and fabrication ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, quality control inspection and testing, and reporting requirements.

Fabrication shall not commence until the Contractor's supply and fabrication ITP has been reviewed and accepted in writing by the Department Representative.

12.2.1 Qualifications

Bridgerail shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with CSA W47.1 to Division 1 or 2. Fabrication shall be completed within a fabrication facility that is permanent, fully enclosed, and heated to maintain a minimum temperature of 10°C.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Department Representative upon request.

12.2.2 Prefabrication Submissions

The Contractor shall submit the following information to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of fabrication unless noted otherwise:

- List of fabricators and qualifications;
- Fabrication sequence and equipment;
- Mill test reports and product data sheets;
- Welding procedures;
- Shop drawings; and
- Fabrication schedule.

Prefabrication submissions will be considered hold points and shall be included in the Contractor's supply and fabrication ITP. The Contractor and the Department Representative shall provide written acceptance of the prefabrication submission hold points in the supply and fabrication ITP prior to the commencement of fabrication.

12.2.2.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications. The Contractor shall also submit the quality control plans, proof of qualification and certifications of all fabricators and their sub-contractors.

12.2.2.2 Fabrication Sequence and Equipment

The Contractor shall submit details of the fabrication sequence and equipment that will be used to complete the work. The fabrication sequence shall include the order of fabrication, dimensional and tolerance checks, and the details of surface preparation and coating.

12.2.2.3 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. All weld procedures and weld procedure datasheets shall be accepted by the CWB. Welding procedures shall reference CSA W47.1 and either CSA W59 or AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 for plate or American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M for HSS sections. The preheat and interpass temperature, and heat input shall be in accordance with AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 except as required in Subsection 12.2.5.9, Preheat and Interpass Temperatures. Only weld procedure data sheets referenced on the shop drawings shall be submitted. Weld procedures and weld procedure datasheets will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut. The Professional Engineer shall be a welding engineer with extensive experience in welding procedures for this type of work.

12.2.2.4 Shop Drawings

When bridgerail for more than one bridge is included in the Contract, individual shop drawings shall be submitted for each bridge structure.

Shop drawings shall be provided in electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- All dimensions shall be correct at 20°C unless otherwise noted;
- Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols;
- All material splice locations shall be shown on the drawings;
- Material properties, material reference standards, and product data sheets for each component; and
- Sizes of hardware and any other material shown on the shop drawings shall be in the actual units (imperial or metric) of the material being supplied.

Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work.

The shop drawings will be reviewed by the Department Representative solely to determine general conformance with the Contract. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate final as-built conditions into shop drawings, including the actual mill test report heat numbers for each component. One unlocked electronic copy (PDF format) of as-built shop drawings shall be submitted to the Department Representative within 3 weeks of construction completion.

12.2.2.5 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided in English for all materials and welding consumables a minimum of 1 week prior to the commencement of fabrication.

Re-classification of materials using a mill test report or mill test report verification testing data will not be permitted.

Mill test reports and rotational capacity testing for fasteners shall be submitted to the Department Representative for review and acceptance 6 weeks prior to the commencement of erection, assembly or installation.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

12.2.2.6 Fabrication Schedules

The Contractor shall provide and maintain a current and complete fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors.

12.2.3 Prefabrication Meeting

A prefabrication meeting shall be held for the supply and fabrication of bridgerail.

The prefabrication meeting shall not occur until prefabrication submission hold points have been completed, reviewed and written acceptance provided by both the Contractor and the Department Representative.

The prefabrication meeting shall be coordinated by the Contractor and held at the fabricator's facility on a date and time acceptable to the Department Representative. A minimum of two (2) weeks' advance notice shall be provided to the Department Representative t prior to the date of the proposed prefabrication meeting.

The Contractor, fabricator and their sub-contractors shall be in attendance at the prefabrication meeting including project manager(s), fabrication superintendent(s), independent testing agency representatives, and all employees involved in supervision of the work.

The Department Representative will prepare the prefabrication meeting agenda and chair the meeting.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (up to 3 representatives from the Government of the Northwest Territories and consultant) to attend the prefabrication meeting(s) for bridgerail being fabricated outside the Northwest Territories.

12.2.4 Materials

12.2.4.1 Steel

All steel shall conform to the standard noted on the Drawings.

The boron content of steel to be welded shall not exceed 0.0008%.

The silicon content for structural steel, structural tubing and sections, handrail bars and baseplates shall be less than 0.04% or between 0.15% and 0.25%.

12.2.4.2 Anchor Rods

Anchor rods shall conform to the standard noted on the Drawings.

12.2.4.3 Connection Plate and Angle

Steel for connection plate and angle shall conform to CSA G40.21 Grade 300W or ASTM A36/A36M.

12.2.4.4 Grout

Grout used for the construction of bridgerail baseplate grout pads shall be selected from the Alberta Transportation's Products List, Non-Shrink Grout category, or a non-shrink grout from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

12.2.4.5 Approach Rail Transition

Thrie beam or W-beam guardrail sections, W-thrie beam transition section, terminal connectors, steel or timber guardrail posts, spacers, and guardrail connection and wing end sections shall be in accordance with Section 14, Guardrail.

12.2.5 Welding

12.2.5.1 Filler Metals and Welding Processes

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used. The deposited weld metal shall provide strength, durability, impact toughness, and corrosion resistance equivalent to base metal. The low hydrogen covering and flux shall be protected and stored as specified by AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

All electrodes, electrode/flux combinations, and electrode/shielding gas combinations shall be CSA certified and associated mill test reports and product data sheets submitted to the Department Representative in accordance with Subsection 12.2.2.5, Mill Test Reports and Product Data Sheets.

Only submerged arc welding (SAW), shielded metal arc welding (SMAW), or metal core arc welding (MCAW) shall be used in the fabrication of bridgerail.

Field welding will not be permitted.

12.2.5.1.1 Submerged Arc Welding (SAW)

All welds shall be made by a semi or fully automatic submerged arc processes acceptable to the Department Representative.

The submerged arc welding process may be used for flat and horizontal position welds.

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H8 or lower. Use of cored filler wires in the submerged arc welding process or shielding gas process will not be permitted.

12.2.5.1.2 Shielded Metal Arc Welding (SMAW)

All electrodes and fluxes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4.

12.2.5.1.3 Metal Core Arc Welding (MCAW)

All electrodes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4

12.2.5.2 Joint Preparation

Preparation of welded joints shall be as indicated on the Drawings. Weld areas shall be clean, free of mill scale, dirt, grease, paint and other contaminants prior to welding.

12.2.5.3 Tack and Temporary Welds

Tack and temporary welds will not be permitted unless they are incorporated within the final weld. Tack welds to be incorporated into final welds shall be completed using consumables compatible with the final weld. Tack welds shall have a minimum weld length at least 4 times the nominal weld size. Cracked tack welds shall be completely removed prior to final welding. Magnetic particle testing shall be completed by the Contractor to confirm complete removal of any cracked tack welds. Tack welds shall be equivalent in quality to the final weld and will be subject to the same inspection and testing requirements as final welds

12.2.5.4 Backing Bars

Backing bars shall be fitted all around the inside of the joint. The separation of faying surfaces between the backing bars and material to be welded shall not exceed 1 mm. 100% fusion shall occur into the backing bar including the corners of HSS members.

12.2.5.5 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required to acceptably complete the work. Run-off tabs shall be tack welded only to that portion of the material that will not remain part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the run-off tabs shall be removed by flame cutting. Removal of run-off tabs by breaking off will not be permitted.

12.2.5.6 Arc Strikes

Arc strikes will not be permitted. In the event of an arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.4.1.4, Hardness Test Inspection Schedule. Repair areas will be examined by the Department Representative to ensure complete removal of the metal in the affected area.

12.2.5.7 Repair Procedures

The Contractor shall submit repair procedures to the Department Representative for review and acceptance for damaged base metal, defective weldments, and any other defect, prior to commencement of the repair work. Repair procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Repair procedures incorporating arc gouging shall specify that the repair area be preheated to a minimum of 65°C prior to gouging.

The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

12.2.5.8 Grinding of Welds

Post to baseplate groove welds which are sufficiently smooth with a neat appearance and uniform profile as determined by the Department Representative will not require grinding. Groove welds at rail splice locations shall be ground smooth and flush.

Fillet welds shall be continuous with uniform size and profile. Fillet welds with unacceptable profile, as determined by the Department Representative, shall be ground to the specified profile without damage of the base metal.

Grinding shall be smooth and parallel with the line of stress. The Contractor shall take due care to prevent over grinding and damage of base metal and other components. Over grinding that results in reduced thickness of the base metal or size of the weld will not be permitted. Acceptability of the welds will be determined by the Department Representative.

12.2.5.9 Preheat and Interpass Temperatures

Preheat and interpass temperature requirements shall be performed and maintained in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5, with the exception that all post to baseplate groove welds and post to baseplate fillet welds shall be preheated to a minimum temperature of 100°C and 60°C respectively unless a higher temperature is required by AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

12.2.6 Fabrication

12.2.6.1 Rail Fabrication

Welded rail splices shall be completed using backing bars. Only one splice for each rail section will be permitted. The location of rail splices shall be clear of openings, connection holes, and acceptable to the Department Representative. All splices shall be ground flush. Rail sections shall be orientated such that the tube seam is always located at the bottom, except for rectangular tube sections which shall have the tube seam oriented towards the bottom or the outside of the bridge. Edges of holes shall be smooth and free of notches or burrs.

12.2.6.2 Rail Sleeve Fabrication

Sleeves shall be square and be properly aligned in the rail end. Corners of the sleeves shall be rounded and smooth to facilitate installation and ensure an acceptable fit. Expansion joint sleeves shall be shop bolted to the appropriate rail section after galvanizing.

12.2.6.3 Post Fabrication

12.2.6.3.1 W Posts

Posts shall be perpendicular to the baseplates, unless otherwise noted on the Drawings.

Baseplates for the posts shall be flat, have square cut edges and corners with no lips or gouges. Anchor rod holes shall be drilled accurately in size and location.

The Contractor shall complete magnetic particle inspection on 25% of all post to baseplate fillet welds. The Contractor shall inform the Department Representative five (5) business days prior to the testing to give the Department Representative the opportunity to select the welds to be tested. A copy of the test results shall be provided to the Department Representative within 1 week of the completion of testing.

12.2.6.3.2 HSS Posts

HSS posts and baseplates shall meet the requirements of Subsection 12.2.6.3.1, W Posts except as noted in this Subsection.

The tube weld seam shall be kept on the back side of the post.

Bridgerail posts shall be butt welded to the baseplate using a backing bar and a full penetration bevel groove weld. The backing bar shall be properly fitted and the post prepared to a sharp edged 45° chamfer. The groove weld shall be placed in a minimum of two passes with a root opening of 5 mm. A rod size, no greater than 4 mm, shall be used for the first pass. A reinforcing fillet weld shall be placed all around the joint.

The Contractor shall arrange to have all post to baseplate full penetration welds inspected either by ultrasonic testing or radiographic inspection methods. A copy of the test results shall be provided to the Department Representative within 1 week of the completion of testing.

Pedestrian/Cyclist barrier posts shall be fillet welded to baseplates. The Contractor shall complete magnetic particle inspection on 25% of all post to baseplate fillet welds. The Contractor shall inform the Department Representative five (5) business days prior to the testing to give the Department Representative the opportunity to select the welds to be tested. A copy of the test results shall be provided to the Department Representative within 1 week of the completion of testing.

Post caps shall be chamfered all around the top and match the contour of the post without burrs or overhang. The caps shall be attached to the posts in the shop after galvanizing. The caps shall fit tightly and include washers under the head of the cap attachment bolts.

12.2.6.4 Anchor Rods

The threaded ends of all anchor rods shall be chamfered.

All anchor rods, hardware and anchor rod templates shall be hot dip galvanized, after fabrication in accordance with Subsection 6.2.7.3, Galvanizing and Metallizing.

12.2.6.5 Tolerances

12.2.6.5.1 Sleeve to Rail

Clearance between the rail sections and the sleeves shall be sufficient to ensure an easy fit after galvanizing. The maximum radial clearance allowed around the sleeve when fitted into the rail shall be 1 mm (2 mm total) after galvanizing with the tube seam removed.

Two sleeve test samples shall be made by the fabricator from the material to be used. Both test sleeves are to be galvanized, with one being retained by the galvanizing sub-contractor and the other at the fabricator's plant. The sleeves shall be used to check the sleeve to rail fit of all rails. In the case of pedestrian/cyclist barrier panels, the test samples shall consist of a welded unit with top and bottom tube, and sleeve sections spaced to match the pedestrian/cyclist barrier.

12.2.6.5.2 Posts

Post assembly lengths shall be within 3 mm of the specified length.

12.2.6.5.3 Rails

Individual rail sections shall be straight and true with no evidence of kinks or dents and with a maximum variation from straightness not exceeding 3 mm over a 3 m length. Welded splices shall not be evident in the final product, and shall be straight, kink free and conform to the same section as the adjacent tubing. Bolted splices shall be straight with no offset due to loose fitting sleeves.

12.2.6.5.4 Anchor Rods

The rods in an anchor rod assembly shall fit in a template comprised of accurately located holes 2 mm greater in diameter than the anchor rods. The top of the rods in the assembly shall be ±3 mm from a level plane when the threaded portion is plumb. The threaded length shall not be less than specified, nor more than 15 mm greater than that specified.

12.2.6.6 Identification

Shop drawing mark numbers shall be stamped on the rails and posts. Rail mark numbers shall be stamped on the underside of the rail near the ends. Post mark numbers shall be stamped on the underside of the baseplates. The areas to be stamped shall be ground to remove mill scale. Stamps shall be a minimum of 12 mm high, between 1 mm and 2.5 mm in depth, and be legible after galvanizing.

12.2.6.7 Galvanizing

Galvanizing shall be completed in accordance with Subsection 6.2.7.3, Galvanizing and Metallizing.

12.2.6.8 Base Plate Corrosion Protection

The bottom surface of each baseplate shall be protected by a medium grey concrete colour barrier coating. The barrier coating shall be a mid coat polyamide epoxy technology coating selected from Alberta Transportation's Products List Bridge Coating Systems – Paint, or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

The galvanized surface shall be prepared and/or roughened in accordance with the barrier coating manufacturer's recommendations. The dry film thickness (DFT) of the coating shall be in accordance with the barrier coating manufacturer's published product data sheet.

12.2.7 Inspection and Testing

12.2.7.1 Access

The Contractor shall provide acceptable facilities for the inspection and testing of the work. The Department Representative shall have full access to all phases of the work at all times. When required by the Department Representative, the Contractor shall also provide labour for assistance in checking layout and performing inspection and testing duties. The Department Representative shall be provided the time needed to complete quality assurance inspection and testing requirements.

12.2.7.2 Responsibility

Quality control inspection and testing shall be completed by the Contractor. Quality control shall be the sole responsibility of the Contractor.

Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant) to inspect and test bridgerail being fabricated outside the Northwest Territories and including up to three trips to the fabrication facility by the Department Representative during the course of fabrication.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work, non conforming materials, or the Contractor's proposed modification to connection and/or splice locations not specified on the Drawings shall be paid for by the Contractor.

If the Department Representative, at their sole discretion, determines that the Contractor's quality control inspection and/or testing personnel are not meeting the minimum specified standards, the Contractor shall replace the personnel immediately and prior to continuing with the work.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative.

12.2.7.3 Quality Control Inspection and Testing by the Contractor

The Contractor's quality control plan, including visual inspection and non-destructive testing, shall be in accordance with the requirements of AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 Clause 6, except as follows:

- The Contractor's visual quality control welding inspector shall be certified by the CWB as a Level 2 or Level 3 inspector in accordance with CSA W178.2;
- Non-destructive testing (NDT) methods shall be in accordance with Subsection 6.2.8.3, Non-Destructive Testing;
- NDT technicians shall be certified to Level 2 in accordance with CAN/CGSB-48.9712 and employed by an independent testing agency certified to CSA W178.1;
- The NDT schedule shall be as follows:
    - 100% of all full penetration welded rail splices shall be inspected by radiographic or ultrasonic testing;
    - 25% of all partial penetration welded rail sleeves shall be inspected by magnetic particle testing;
    - 100% of all HSS post to baseplate full penetration groove welds shall be inspected by radiographic or ultrasonic testing;
    - 25% of post to baseplate fillet welds for each W section post shall be inspected by magnetic particle testing. The length of weld selected for testing shall be continuous; and
    - 25% of post to baseplate fillet welds for each HSS pedestrian/cyclist post shall be inspected by magnetic particle testing.
    - The Contractor shall provide a minimum of 36 hours advance notice to the Department Representative prior to the commencement of any non-destructive testing; and
- Adhesion coating testing shall be completed by an independent National Association of Corrosion Engineers (NACE) Level 2 certified coating inspector.

The Contractor shall measure the baseplate barrier coating dry film thickness of one baseplate for every 25 baseplates fabricated. Coating thickness measurements shall be completed at a minimum of 5 locations (4 corners and centre) of the baseplate in accordance with SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges.

The Contractor shall complete adhesion testing of the baseplate barrier coating application using adhesion test plates. One adhesion test plate shall be supplied and fabricated for the first 25 baseplates fabricated and then one for every 50 baseplates fabricated thereafter. Adhesion test plates shall be supplied and fabricated in accordance with the following requirements:

- Be of the same type and grade of steel as the production baseplates;
- 150 x 150 mm in plan dimension and have a thickness equal to the production baseplates;
- Galvanized at the same time as the production baseplates;
- Barrier coating applied at the same time as the production baseplates; and
- Barrier coating thickness measured for compliance and fully cured prior to testing.

Adhesion testing of the barrier coating shall be completed in accordance with ASTM D3359 Method A or Method B and have a minimum classification of 4A or 4B.

The Contractor's quality control testing and inspection records and/or reports shall be submitted on a weekly basis to the Department Representative for review and acceptance, with the exception that radiographic and ultrasonic NDT records and/or reports shall be submitted within 24 hours of completion of the testing. All quality control testing and inspection records and/or reports shall contain the written acceptance of the fabricator's QC manager.

12.2.7.4 Quality Assurance Inspection and Testing by the Department Representative

The Department Representative will complete visual inspection of all welds and review all quality control inspection and testing records and/or reports produced by the Contractor to verify their compliance with the Contract.

The Department Representative may complete additional quality assurance inspection and/or testing at their sole discretion. The Contractor shall provide full access to the work in accordance with Subsection 12.2.7.1, Access.

12.2.7.5 Witness Points and Hold Points

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified witness points and hold points within the ITP.

If fabrication continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Department Representative may suspend the supply and fabrication work, and the Contractor shall be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the work, as determined by and to the satisfaction of the Department Representative.

Inspection stations shall be set up by the Contractor within the fabrication facility to the satisfaction of the Department Representative for each of the specified witness points and hold points such that the associated inspection and/or testing requirements can be acceptably completed.

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP:

- Dimensional checks and verification of tolerances (witness point);
- Visual inspection of welding and completion of non destructive testing, prior to galvanizing and application of barrier coating (hold point);
- Barrier coating thickness and adhesion testing (witness point);
- Embrittlement testing of high strength anchor rods (witness point);
- Verification testing and inspection of bridgerail if fabricated outside of Canada and the United States (hold point); and
- Final inspection (hold point).

12.2.7.6 Final Inspection

The Contractor and the Department Representative shall provide written acceptance of all fabricated bridgerail upon the completion of fabrication. Review and acceptance of bridgerail by the Department Representative at the fabrication facility will not relieve the Contractor of their responsibility to meet the requirements of the Contract.

12.2.7.7 Fabrication Outside of Canada and the United States of America

In addition to the requirements of Subsection 12.2.7, Inspection, bridgerail fabricated outside of Canada or the United States of America shall be shipped to a shop located in Canada that is certified by the CWB in accordance with CSA W47.1 to Division 1 or 2 for verification inspection and testing. The bridgerail components shall be in a condition that facilitates all verification inspection and testing requirements. Verification inspection and testing shall be completed in accordance with Subsection 12.2.7, Inspection. The visual welding inspector shall also inspect all bridgerail components for the presence of transportation damage.

Components shall not be shipped from the Canadian shop until all requirements have been met and the work has been reviewed and accepted by the Department Representative.

The Contractor shall be responsible for all verification inspection and testing costs, including all costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant). The Contractor shall also be responsible for all hourly charge out rates, travel, meals and accommodation of the Department Representative inspector(s) to complete inspection and testing duties at the fabrication facility for 100% of the fabrication time. The Contractor shall also be responsible for the cost of one trip every 2 weeks for two Department Representatives to and from the fabrication facility.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

12.3 Construction

Anchor rod assemblies shall be accurately and securely positioned as shown on the Drawings with rigid templates prior to concrete placement.

Concrete surfaces on which bridgerail baseplates are placed shall be finished in accordance with Subsection 4.25.8, Surface Finish under Bearings and Baseplates.

12.3.1 Transportation, Handling and Storing Materials

Bridgerail shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage.

Bridgerail that becomes contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to installation.

Bridgerail shall be transported, hauled and stored on timber blocking. Timber blocking shall be located at positions that prevents marring and damage of the bridgerail. The ground of the storage area shall be solid and unyielding and drainage diverted away from the storage area.

Galvanized material shall be handled, stacked, bundled, transported, hauled and stored to prevent marring of surfaces, damage, or wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. If damage or wet storage staining occurs, it shall be assessed and repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

12.3.1.1 Clearance to Ship

The Contractor shall provide the Department Representative a transportation schedule for bridgerail a minimum of 72 hours prior to shipment from the fabrication facility. Written acceptance in accordance with Subsection 12.2.7.6, Final Inspection shall be provided by both the Contractor and the Department Representative prior to the commencement of shipping.

Review and acceptance at the fabrication facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

12.3.2 Installation

The elevation, line and grade of bridgerail shall be as shown on the Drawings.

The height and plumbness of each bridgerail post shall be adjusted to achieve the specified elevation, line and grade of the bridgerail. Final bridgerail elevations and alignment shall be set and verified by a combination of survey instrument and string line, after asphalt concrete pavement (ACP) has been placed. The accuracy of the survey instrument and overall bridgerail alignment shall be acceptable to the Department Representative.

Anchor rods shall project a minimum of 2 threads above the top anchor rod nut after tightening is complete. Anchor rods that do not meet the minimum projection requirement shall be repaired or replaced. The Contractor shall submit a repair or replacement procedure to the Department Representative for review and acceptance prior to commencement of the repair work. Repair or replacement procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

All structural bolts and anchor rod nuts shall be tightened in accordance with the Drawings.

12.3.2.1 Grouting of Base Plates

The bridgerail post alignment and railing profile over the entire bridge length shall be reviewed and accepted by the Department Representative prior to the commencement of grouting operations and will be considered a hold point.

Grout used for the grouting of bridgerail baseplates shall be selected from the Alberta Transportation's Products List, Non-Shrink Grout category, or a non-shrink grout from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

The method of forming and placing grout shall be submitted to the Department Representative for review and acceptance a minimum of 1 week prior to commencement of the work. Dry-pack methods of constructing grout pads will not be permitted.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. Grout shall be mixed and placed in strict accordance with the manufacturer's recommendations stated on their published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout in accordance with CSA A23.2-1B. A set of compressive strength cubes shall be taken to represent each day's production or 0.25 m^3, whichever is more frequent. All test results shall be provided to the Department Representative within 3 days of completion of testing. The average minimum compressive strength of 3 cubes at 28 days shall be 30 MPa. Failure to meet the minimum specified compressive strength will result in the grout pad being removed and replaced at the Contractor's expense.

Grout shall be wet cured for a minimum of 3 days with two layers of clean, saturated Nilex 4504 white coloured filter fabric or an approved equivalent. Water used for wet curing shall be clean and acceptable to the Department Representative.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Subsection 4.26, Type 1c Sealer.

12.3.2.1.1 Grouting in Cold Weather

When the air temperature is, or is expected to be below 5°C, as forecasted by the closest Environment Canada Meteorological Station or a meteorological station specified in the Special Provisions of the Contract, during the placing and curing period, or when determined by the Department Representative, a cold weather grouting plan shall be implemented. The Contractor shall submit details of their proposed cold weather grouting plan to the Department Representative for review and acceptance a minimum of 2 weeks prior to the commencement of the work.

The following minimum requirements for grouting in cold weather shall be included in the cold weather grouting plan:

- Before placing grout, pre heat shall be provided to raise the temperature of formwork, anchor rods, and substrate surfaces to between 10°C and 20°C;
- Mixing water shall be heated to a temperature of at least 20°C but not more than 65°C;
- Temperature of the grout during placing shall be between 10°C and 25°C;
- Grout shall be wet cured a minimum of 72 hours;

- The Contractor shall enclose the structure in such a way that the grout and air within the enclosure can be kept at or above 15°C for a protection period of 5 days after placing the grout. Enclosures shall be constructed with a minimum 300 mm clearance between the enclosure concrete and/or grout surfaces; and
- Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the grout. The temperature of the grout shall be gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced.

The Contractor shall demonstrate to the satisfaction of the Department Representative that the requirements of the cold weather grouting plan are met, prior to commencement of grouting.

12.3.2.2 Approach Rail Transition

The installation of the approach rail transition including thrie beam or W-beam guardrail sections, W-thrie beam transition section, terminal connectors, steel or timber guardrail posts, spacers, and hardware as shown on the Drawings shall be in accordance with Section 14, Guardrail.

12.3.2.3 Inspection

After completion of bridgerail installation, surveying, grouting, tightening of high-strength bolts and anchor rod nuts, the Contractor and the Department Representative shall inspect the bridgerail for elevation, line, grade, anchor rod projection and presence of damage.

If bridgerail is damaged, the Contractor shall submit a field repair procedure to the Department Representative for review and acceptance. The field repair procedure will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Department Representative may also require that further independent inspection, non-destructive testing, and/or assessment be completed. All costs to repair damage to the satisfaction of the Department Representative will be the sole responsibility of the Contractor.

The installation inspection will be considered a hold point. The Contractor and the Department Representative shall provide written acceptance of the hold point after the bridgerail has been acceptably installed and grouted.

12.4 Payment

Payment for bridgerail will be made at the lump sum price bid for “Bridgerail – Supply and Fabrication, Delivery and Installation” for the type specified, and will be full compensation for the supply and fabrication of bridgerail; inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; assembly; installation; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. The lump sum price bid will be paid in accordance with Subsection 12.4.1, Supply and Fabrication, Subsection 12.4.2 Delivery, and Subsection 12.4.3, Installation.

12.4.1 Supply and Fabrication

60% of the lump sum price bid for "Bridgerail– Supply and Fabrication, Delivery and Installation" will be paid once the bridgerail has been acceptably supplied; fabricated; inspected; tested; stored; and written acceptance within the supply and fabrication ITP has been provided by both the Department Representative and the Contractor for each specified witness point and hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the supply and fabrication inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for supply and fabrication of bridgerail for the types and size specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

12.4.2 Delivery

20% of the lump sum price bid for "Bridgerail – Supply and Fabrication, Delivery and Installation" will be paid once the bridgerail has been acceptably loaded; transported; hauled; unloaded; stored; cleaned and/or repaired, if required; and written acceptance has been provided by both the Department Representative and the Contractor. This payment will be full compensation for delivery of bridgerail for the types and size specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. All necessary approvals and permits, will be considered incidental to the Work and no separate or additional payment will be made.

12.4.3 Installation

20% of the lump sum price bid for "Bridgerail – Supply and Fabrication, Delivery and Installation" will be paid once the bridgerail has been acceptably installed; and written acceptance has been provided by both the Department Representative and the Contractor for each specified hold point. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for installation of bridgerail for the types and size specified; the supply and placement of grout; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 13 MISCELLANEOUS IRON

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13.1 General

This specification is for the supply, fabrication, and installation of Miscellaneous Iron. Miscellaneous Iron shall include any of the following items and those listed in the Special Provisions of the Contract:

- Steel drain troughs;
- Pier drip sheets;
- Deck buffer angles;
- Dowels;
- Connector angles;
- Anchor rod sleeves;
- Asset identification plaques / tags;
- Identification tags for culvert and overhead sign structures; and
- Bench mark tablets.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

13.2 Supply, Fabrication and Installation

Miscellaneous Iron shall be supplied, fabricated, and installed by the Contractor in accordance with Section 6, Structural Steel, the Drawings and these specifications. In the case of conflicting requirements, the requirements of this specification shall govern.

Plaques, identification tags, and bench mark tablets shall be supplied, fabricated and installed in accordance with the Drawings and standard drawings S-001, Standard Asset ID Plaque and Bench Mark Tablet and S-002, Standard Culvert Asset ID Tag.

Standard asset identification plaques, tags and bench mark tablets shall be protected from contamination at all times. Protection shall only be removed after all concrete surface finishes have been reviewed and accepted by the Department Representative.

13.3 Galvanizing

Galvanizing shall be completed in accordance with Subsection 6.2.7.3, Galvanizing and Metallizing.

13.4 Field Welding

Shielded metal arc welding (SMAW) shall be used for field welding.

Low hydrogen filler, fluxes and welding practices shall be in accordance with Subsection 6.2.5.1, Filler Metals & Welding Processes.

When the ambient air temperature is below 10°C, all material to be welded shall be preheated to 100°C for a distance of 80 mm beyond the weld and shall be sheltered from the wind. When the ambient air temperature is below 0°C, welding will not be permitted unless hoarding and heating acceptable to the Department Representative is provided.

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. All weld procedures and weld procedure datasheets shall be accepted by the CWB. Welding procedures shall reference CSA W47.1 and either CSA W59 or AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5. The preheat and interpass temperature, and heat input shall be in accordance with AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5. Only weld procedure data sheets referenced on the shop drawings shall be submitted. Weld procedures and weld procedure datasheets will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut. The Professional Engineer shall be a welding engineer with extensive experience in welding procedures for this type of work.

Tack and temporary welds will not be permitted unless they are incorporated within the final weld. Tack welds to be incorporated into final welds shall be completed using consumables compatible with the final weld. Tack welds shall have a minimum weld length at least 4 times the nominal weld size and maximum weld length of 15 times the nominal weld size. Tack welds shall be equivalent in quality to the final weld and will be subject to the same inspection and testing requirements as final welds. Tack welds with any cracking shall be removed and the location tested using magnetic particle non-destructive testing methods to confirm that the crack has been completely removed prior to final welding.

Arc strikes will not be permitted. In the event of an isolated accidental arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.4.1.4, Hardness Test Inspection Schedule. These areas will be inspected by the Department Representative to ensure complete removal of the metal in the affected area.

13.4.1 Field Welding of Structural Members

Members other than those listed in Subsection 13.4.2, Field Welding of Non-Structural Members will be considered structural members.

All welding, cutting and preparation of structural members shall be completed in accordance with the AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

Welders shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Department Representative upon request.

13.4.2 Field Welding of Non-Structural Members

The following will be considered non-structural members:

- Culvert struts; and
- Field welding of the end bulkheads on culvert liners.

Journeyman welders with Class B tickets will be permitted to perform weldments of non-structural members. Their qualification shall be current and available for examination by the Department Representative.

13.5 Payment

Payment will be made at the lump sum price bid for “Miscellaneous Iron”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

SECTION 14 GUARDRAIL

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14.1 General

This specification is for the supply, fabrication, delivery and installation of guardrail. Guardrail shall include modified thrie beam guardrail, strong post w-beam guardrail, weak post w-beam guardrail, and other approved guardrails, connections, treated timber posts, steel posts, spacers, transitions, end terminals, Department Representative approved crash-worthy end treatments, miscellaneous components and associated materials.

The supply, fabrication, delivery and installation of guardrail shall be carried out in accordance with the following specifications; as shown on the Drawings, the Specifications for Highway Construction, Edition 7, Division 7 Incidental Construction, Section 3, Supply and Installation of Steel W-Beam Guardrail, and the Standard Drawings of the Specifications for Highway Construction except as noted in these specifications. Further to Specifications for Highway Construction, Edition 7, Division 7 Incidental Construction, Section 3, Supply and Installation of Steel W-Beam Guardrail, these specifications shall also apply in analogy to thrie beam guardrail. The term Engineer in the Specifications for Highway Construction shall be replaced with Department Representative.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

14.2 Materials

14.2.1 Rails and Terminal Elements

Thrie beam/W-beam guardrail shall consist of rail sections fabricated for installation to develop the continuous beam strength with the necessary safety and feature components.

Rails shall be punched for splice and post bolts in conformity with the AASHTO Standard to the designated number of and centre to centre spacing of posts. If holes are punched after galvanizing the galvanizing around the hole shall be repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

Curved W beam rails shall be formed to the radius specified in accordance with Alberta Transportation Roadside Design Guide Reference Drawing TEB 3.54.

All welding required for the fabrication of terminal elements shall conform to the requirements of CSA W59. Only welders, welding operators and tackers approved by the Canadian Welding Bureau (CWB) in the particular category may be permitted to perform weldments.

A mill test report shall be submitted in accordance with Subsection 6.2.2.3, Mill Test Reports and Product Data Sheets, to the Department Representative for review and acceptance.

Sheet width for the thrie beam rail shall be 750 mm with a permissible tolerance of minus 3 mm.

14.2.2 Bolts, Nuts and Washers

A copy of mill test reports shall be provided to the Department Representative for review and acceptance.

14.2.3 Wood Posts

Wanes on any face shall not exceed 25 mm above ground (including blocks) or 60 mm below ground.

14.2.4 Steel Posts

Steel for posts, spacers and hardware shall conform to the requirements of CSA G40.21 Grade 350W or ASTM A36/A36M and shall be hot dip galvanized after fabrication in accordance with ASTM A123/A123M. A copy of mill test reports shall be provided to the Department Representative for review and acceptance.

14.3 Inspection of Materials

All guardrail materials shall be inspected and materials which fail to meet these specifications will be rejected and shall be replaced or repaired by the Contractor at no cost to the Government of the Northwest Territories.

14.3.1 Guardrail Materials

The thickness of finished Type II materials shall be in accordance with AASHTO Standard Specification M 180 Table 2.

14.3.2 Timber Material

Testing of the penetration of the preservative shall be carried out by the Contractor, and the test records shall be submitted to the Department Representative at a minimum five (5) days prior to installation of the components.

Warped wood posts, as determined by the Department Representative, shall be removed and replaced by the Contractor at their expense.

14.4 Installation

Guardrail posts shall only be installed after ACP has been acceptably placed and compacted.

Unsuitable material at the bottom of the holes, as determined by the Department Representative, shall be replaced with in accordance with the Specifications for Highway Construction, Edition 7, Division 7 Incidental Construction, Clause 7.3.3.2, Installation.

Guardrail post holes shall be backfilled with granular material in accordance with the Specifications for Highway Construction, Edition 7, Division 7 Incidental Construction, Section 3, Supply and Installation of Steel W-Beam Guardrail. Where posts are installed on paved surfaces, the backfill for the top 150 mm shall be compacted ACP. The supply, placement and compaction of ACP shall be in accordance with Section 17, Asphalt Concrete Pavement.

Guardrail material requiring field modifications to fit shall be submitted to the Department Representative for review and acceptance of the proposed modifications prior to the work being carried out. Modification by flame cutting method is prohibited. Modification by cold cutting method is permitted. Field guardrail modification is considered incidental to the work. Adequate edge distances of guardrail material shall be maintained during the modification process.

Metal reflectors in accordance with the Specifications for Highway Construction, Edition 7, Division 7 Incidental Construction, Section 3, Supply and Installation of Steel W-Beam Guardrail shall be supplied and attached to the top of every third guardrail post with two 50 mm ring nails.

The Contractor shall take all necessary precautions to eliminate damage to galvanizing. The Contractor shall complete repairs in accordance with the Specifications for Highway Construction, Edition 7, Division 7 Incidental Construction, Clause 7.3.3.2, Installation, to the satisfaction of the Department Representative.

14.5 Payment

Payment for the supply and installation of guardrail, excluding approach rail transitions and guardrail connections to approach rail transitions, will be made at the lump sum price bid for "Guardrail – Supply and Install", and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

Payment for approach rail transitions and guardrail connections to approach rail transitions will be made in accordance with Section 12, Bridgerail.

SECTION 15 LOAD EVALUATION

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15.1 General

This specification describes the requirements for load evaluations of structures. The Contractor shall carry out a load evaluation in accordance with the Alberta Transportation Bridge Load Evaluation Manual (BLEM) and these specifications for any construction work that temporarily changes or increases the loading on the existing structure.

15.2 Load Evaluation

The load rating evaluation vehicles shall be the Alberta Transportation's single unit vehicle (CS 28t), two-unit vehicle (CS2-49t) and vehicle train (CS3-63.5t) as well as CL-625 and CL-800 vehicles in accordance with CSA S6 unless otherwise specified in the Contract.

Notwithstanding CSA S6-19 Clause 14.9.5.3, Wind loads, winds loads shall be considered when the Contractor's containment system results in an increased wind loading on the bridge. Wind loads shall be incorporated in the evaluation with load combinations ULS3 and ULS4 in accordance with CSA S6-19, Section 3, Loads. Design wind loads may be adjusted if a written work procedure for removing the screens/containment system at projected wind speeds is developed by the Contractor, adequately demonstrated, and reviewed and accepted by the Department Representative.

Components of the structure that shall be evaluated and rated include, but are not limited to, the superstructure and bearings. Bearings shall be evaluated and rated in cases where the temporary works result in increased vertical or lateral loads or if alternate means of load transfer are imposed on the bridge. Substructure components are typically not included in the evaluation and rating but may be required at some bridge sites. When required, rating of the substructure will be specified in the Special Provisions of the Contract.

The capacity of the bridge will be considered acceptable if the Live Load Capacity Factors are greater than 1.0 and if the factored resistances exceed the factored load effects.

The Contractor shall design and detail temporary works which include temporary structural elements to strengthen components, details of the fabrication, installation and removal of the temporary structural elements.

15.3 Load Evaluation Report

The Contractor shall prepare and submit a Load Evaluation Report in accordance with the Alberta Transportation Bridge Load Evaluation Manual (BLEM) and these specifications.

The Bridge Load Evaluation Report shall clearly identify the magnitude and direction of the imposed loads, where the loads from temporary works components will be transferred to the bridge and the Contractor's Bridge Load Evaluators and the Bridge Load Evaluation Checkers assessment in the ability of the bridge to accommodate these loads.

In addition to the reporting requirements in the BLEM, the Bridge Load Evaluation Report shall also provide Live Load Capacity Factors, as described in CSA S6-19 Clause 14.15, Live load capacity factor, for all three load evaluation vehicles under the ultimate limit state ULS1

When the Contractor's temporary works result in an increased wind loading on the bridge the Bridge Load Evaluation Report shall demonstrate that the bridge capacity is adequate under the ultimate limit states of ULS3 and ULS4.

When temporary works include temporary structural elements to strengthen components, details of the fabrication, installation and removal of the temporary structural elements shall be clearly detailed in the Bridge Load Evaluation Report.

The report shall be submitted to the Department Representative for review and acceptance as part of the Contractor's work proposal.

In case of conflicting requirements between these specifications and the BLEM, these specifications will govern.

The Bridge Load Evaluation Report will be considered a Professional Work Product and shall be authenticated by both the Bridge Load Evaluator and Bridge Load Evaluator Checker. Both the Bridge Load Evaluator and Bridge Load Evaluator Checker shall be Professional Engineers licensed to practice within the Northwest Territories and Nunavut and experienced in load evaluating bridge structures similar to the one required to be evaluated. The report shall be validated with the firm's Permit to Practice stamp, as issued by NAPEG.

All costs associated with the preparation of the Bridge Load Evaluation Report will be considered incidental to the Work and no separate or additional payment will be made.

SECTION 16 WATERPROOFING

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16.1 General

This specification is for the supply and installation of hot applied asphalt waterproofing system. Waterproofing shall be carried out in accordance with the following specifications; and as shown on the Drawings.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

16.2 Materials

16.2.1 General

The materials supplied shall be able to withstand the heat generated during the waterproofing processes without affecting the performance of the material.

16.2.2 Submittals

The Contractor shall submit documentation indicating specification compliance of their proposed materials to the Department Representative for review and acceptance a minimum of 2 weeks prior to the commencement of waterproofing installation operations.

16.2.3 Sampling and Testing

The Contractor is advised that the Department Representative may carry out additional material testing to confirm compliance.

If requested by the Department Representative, the Contractor shall provide sufficient additional quantities of the asphalt membrane, rubber membrane, membrane reinforcing fabric, and/or protection board from the materials being used on the project. Requested samples and all associated costs will be considered incidental to the Work and no separate or additional payment will be made.

16.2.4 Waterproofing Materials

16.2.4.1 Asphaltic Primer

Asphaltic primer shall meet the requirements of Canadian General Standards Board (CGSB) 37 GP 9MA.

16.2.4.2 Asphalt Membrane

Asphalt membrane materials shall be supplied in cakes that are sealed and labeled by the manufacturer.

Material for the asphalt membrane shall meet the requirements of the Ontario Provincial Standard Specification OPSS 1213, Material Specification for Hot Applied Rubberized Asphalt Waterproofing Membrane.

16.2.4.3 Rubber Membrane

Rubber membrane shall consist of 1.2 mm thick butyl and ethylene propylene diene monomer (EPDM) rubber. The membrane shall meet the requirements of Canadian General Standards Board CGSB 37.52M.

16.2.4.4 Membrane Reinforcing Fabric

Membrane reinforcing fabric shall consist of spun bonded sheet structure composed of 100% continuous filament polyester fibres bonded together at their crossover points. The membrane shall be supplied in minimum widths of 300 mm.

16.2.4.5 Wick Drain

Wick drain shall consist of composite polypropylene with a total thickness of 3.6 mm, supplied in 100 mm widths. The puncture strength shall be a minimum of 45 N measured in accordance with ASTM D4833.

16.2.4.6 Waterproofing Protection Board

Waterproofing protection board shall consist of durable panels designed to provide a protective cushion between the hot mix asphaltic concrete pavement and the asphalt membrane.

The waterproofing protection board shall meet the requirements of the Ontario Provincial Standard Specifications Ontario Provincial Standard Specification OPSS 1215, Material Specification for Protection Board.

16.2.4.7 Slow Setting Anionic Emulsified Asphalt (SS-1)

Slow setting anionic emulsified asphalt (SS-1) applied to the gutter area of the top lift of ACP shall meet the requirements of the Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Clause 6.1.5 Specifications for Anionic Emulsified Asphalts. The term Engineer in the Specifications for Highway Construction shall be replaced with Department Representative.

16.3 Equipment

An approved heating and mixing kettle shall be used to heat the asphalt membrane. The kettle shall be a double boiler oil transfer type with a built in agitator and shall be equipped with permanently installed dial type thermometers with an accuracy of ± 2°C to measure the temperature of the melted compound and oil. A separate calibrated thermometer with an accuracy of ± 2°C shall be available on site to verify material temperatures.

The unit shall be capable of keeping the contents continuously agitated, free flowing and lump free until the material is drawn for application.

16.4 Installation

16.4.1 General

The Contractor shall provide the Department Representative with 48 hours advance notice prior to commencing any waterproofing operations.

Waterproofing operations shall only be carried out when the air and concrete surface temperatures are 5°C or higher.

The Contractor shall carry out the operations involved in waterproofing in sequential order, and in such a manner that there are no delays between individual operations except those necessary to meet the requirements of these specifications.

Waterproofing and asphalt concrete placement operations shall occur sequentially to the satisfaction of the Department Representative. Placement of the first asphalt concrete placement lift shall commence within 7 days of the commencement of waterproofing installation or as determined by the Department Representative.

Waterproofing operations shall commence from the low end of the bridge and proceed to the high end of the bridge unless otherwise reviewed and accepted by the Department Representative.

16.4.2 Traffic Restriction

Once surface preparation operations have commenced the Contractor shall restrict all traffic other than the construction equipment directly associated with waterproofing and bridge paving operations from traveling over the prepared areas.

These restrictions shall remain in place until such time that the asphalt concrete pavement has been placed and cooled to ambient temperature.

16.4.3 Surface Preparation

16.4.3.1 General

Concrete surfaces to receive waterproofing shall be free of dirt and debris and dry prior to the commencement of surface preparation operations. Drying of concrete surfaces by the use of torches or other means that, in the opinion of the Department Representative may be potentially harmful will not be permitted.

Concrete surfaces to receive waterproofing shall be prepared by abrasive blasting or shotblasting to expose sound, laitance free concrete for the entire installation area. Vertical surfaces of curbs and barriers shall be prepared to receive waterproofing by abrasive blasting. Concrete surfaces and bridge components adjacent to surface preparation operations shall be protected from damage.

16.4.3.2 New Bridge Construction

Concrete surfaces to receive waterproofing shall be cured a minimum of 14 days and then allowed to dry a minimum of 3 days.

16.4.3.3 Bridge Rehabilitation

Overlay concrete, partial and full depth repairs shall be wet cured for a minimum of 7 days and air dried a minimum of 3 days prior to the commencement of surface preparation.

Concrete surfaces to receive waterproofing shall be ground, scabbled, or bush hammered to achieve a surface texture of 3 mm or less prior to sandblasting or shotblasting. The depth of concrete removal to achieve the specified surface texture shall be reviewed and accepted by the Department Representative prior to the commencement of the work.

16.4.3.4 Grout Tubes

Grout tubes shall be cut flush with the concrete deck surface prior to surface preparation. If grout tubes project above the concrete after surface preparation, they shall be re cut flush with the concrete deck surface. A 450 x 450 mm piece of membrane reinforcing fabric, centred on the tube, shall be installed as described in Subsection 16.4.5, Waterproofing of Joints and Cracks.

16.4.4 Application of Asphaltic Primer

Asphaltic primer shall be applied wherever waterproofing membrane is required. Asphaltic primer and waterproofing installation shall not commence until the Department Representative has inspected and accepted the surface preparation work.

All concrete surfaces shall have less than 6% moisture prior to application of the asphaltic primer. Testing shall be completed by the Contractor using a Hygrometer or Protimeter and the results reviewed and accepted by the Department Representative.

After concrete moisture conditions have been determined acceptable by the Department Representative and immediately prior to the application of the asphaltic primer, the concrete surface shall be blown clean with oil and water free compressed air to remove all dust and other foreign material. The asphaltic primer shall be cut back with an equal volume of gasoline type solvent or an alternative cut back asphalt product compatible with the asphalt membrane.

The asphaltic primer application shall be such that the asphaltic primer will be absorbed into the concrete, resulting in a surface that is dull and black in appearance. Excess application of asphaltic primer, indicated by a shiny black surface, shall be avoided. Asphaltic primer shall be applied at an approximate rate of 0.25 L/m^2.

Waterproofing equipment or material shall not be permitted on the asphaltic primer until it has fully cured and is completely tack free.

16.4.5 Waterproofing of Joints and Cracks

The Contractor shall pay particular attention to waterproofing installation over construction joints, lift hook pockets, grout tubes, patches and cracks.

After asphaltic primer application and prior to application of the primary hot asphalt membrane, a coat of hot asphalt membrane 3 to 4 mm thick and wide enough to extend 200 mm on either side of each joint or crack shall be applied in accordance with Subsection 16.4.6, Application of Asphalt Membrane. A strip of membrane reinforcing fabric material wide enough to extend 150 mm on both sides of the construction joint, lift hook pocket, grout tubes, patch or crack shall be applied while the asphalt membrane is still hot and tacky. The membrane reinforcing fabric shall then be covered with an additional layer of water proofing 2 to 3 mm thick. Membrane reinforcing fabric shall be overlapped for a minimum of 100 mm when multiple strips are used.

For areas along curbs, barrier walls, and deck drains, the asphalt membrane shall be applied to the height of the top of the hot mix ACP surface course and 150 mm onto the deck. Rubber membrane shall be applied into the first coat of asphalt membrane while it is still hot and tacky. The rubber membrane shall extend 50 mm up the vertical face and 100 mm onto the deck surface. Rubber membrane shall be overlapped for a minimum of 100 mm where multiple strips are used. A second coat of asphalt membrane shall then be applied to fully cover the rubber membrane.

16.4.6 Application of Asphalt Membrane

Cakes of asphalt membrane shall be melted in the heating and mixing kettle to a temperature not exceeding that recommended by the membrane manufacturer.

The asphalt membrane shall not be applied until the asphaltic primer has cured completely.

The application temperature of asphalt membrane shall be within the range recommended by the manufacturer. The membrane shall be applied in a uniform film having a minimum thickness of 4 mm and a maximum thickness of 6 mm.

Application of the asphalt membrane shall be carried out in a continuous manner to the extent practicable. Where joints are unavoidable, they shall be overlapped by a minimum of 150 mm. The membrane shall be applied over all waterproofed joints and cracks, and shall extend up the face of curbs, barrier walls, and deck drains, to the height of the top of the design hot mix asphalt surface course.

The Contractor shall conduct their operations in such a manner that plugging of deck drains and/or drainage tubes is avoided. Plugged deck drains or drainage tubes shall be cleaned out by the Contractor at their expense.

16.4.7 Wick Drain Installation

Wick drains shall be installed along the full lengths of the gutters and shall be installed when the asphalt membrane is still hot and tacky. Special attention shall be given to waterproofing and wick drain modifications at deck drain pipe locations. Asphaltic primer shall not be applied to wick drains.

16.4.8 Protection Board Installation

The Contractor shall ensure that the asphalt membrane thickness meets the specified requirements prior to placing the protection board. Protection boards shall be laid on the asphalt membrane while the membrane is still hot, with the length of the board running transversely on the deck. The protection boards shall be placed with edges overlapping a minimum 12 mm and a maximum of 25 mm, both longitudinally and transversely. The protection board edge shall be within 5 mm of all wick drains, vertical faces of drains, and vertical faces of expansion joints.

Protection board shall be lapped to produce a shingling effect in both the longitudinal and transverse directions. Protection boards shall be placed such that the longitudinal (direction of traffic flow) joints are staggered a minimum of 150 mm. Boards shall be rolled using a linoleum or lawn type roller while the membrane is still warm to ensure good contact with the membrane. Holes shall be cut through the protection board to allow water to drain freely through the drainage tubes. At locations where the edges of the protection board have curled-up, the curled-up edges shall be cemented down using hot membrane material to the satisfaction of the Department Representative.

Protection boards that are warped, distorted, or damaged in any way, whether by manufacture, storage, handling or exposure to the elements shall be replaced with new material, as determined by the Department Representative.

16.5 Measurement and Payment

Measurement for payment of waterproofing will be by the square metre, measured to the nearest 0.1 m^2.

The quantity to be paid for will be based on horizontal measurement of surface areas where waterproofing has been acceptably installed. Vertical faces will not be measured.

Payment for waterproofing will be made at the unit price bid for "Waterproofing", and will be full compensation for traffic control; the preparation of concrete surfaces, including sandblasting and/or shotblasting; the supply and application of the asphaltic primer; the supply and installation of asphalt membrane, membrane reinforcing fabric, rubber membrane, wick drain, and protection board; including all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

All costs associated with waterproofing of vertical faces of curbs and barriers will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 17 ASPHALT CONCRETE PAVEMENT

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17.1 General

Asphalt Concrete Pavement (ACP) shall be mixed, placed, and compacted to the lines, grades, dimensions and cross section as shown on the Drawings and in accordance with these specifications. This specification applies to only bridge decks and adjacent roadways at the immediate bridge location and includes:

- ACP on hot applied rubberized asphalt waterproofing system as described in Section 16, Waterproofing;
- ACP on polymer waterproofing membranes; and
- ACP on approach road transitions.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

This specification shall be used in conjunction with the Specifications for Highway Construction. In areas of conflict between these specifications and the Specifications for Highway Construction, these specifications shall govern. The term Engineer in the Specifications for Highway Construction shall be replaced with Department Representative.

The Contractor shall submit an ACP mixing and placement plan for each bridge and associated approach transition for the Department Representative's review and acceptance a minimum of 2 weeks prior to commencement of paving operations. The ACP mixing and placement plan shall include but not be limited to the following:

- Surface removal plan (if applicable);
- Source location of ACP;
- Asphalt mixing plant Certificate of Calibration;
- Asphalt mix design and job mix formula;
- Asphalt mixing plant production rate, haul route and distance, number of haul trucks and load size, paver production capacity;
- Placing, spreading and compaction temperature range(s);
- Direction of ACP placement (bridges with waterproofing protection board);
- Details of placement and compaction equipment;
- Quality control and testing plan including but not limited to material testing, details of control strip method (drawing outlining control density test locations and mat density test locations), and QC personnel;
- Details of environmental protection measures, also in compliance with the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements;
- Details of bridge component protection measures for barriers/curbs/medians, deck joint concrete blockouts, paving lips, and wick drains;
- Details of ACP lift thicknesses and mat widths;
- Details of ACP longitudinal and transverse (if applicable) joint locations;
- Details of saw cut joint protection measures; and
- Schedule.

An ACP placement construction milestone meeting shall occur after waterproofing material submissions and the ACP mixing and placement plan have been reviewed and accepted by the Department Representative and prior to commencement of the work. The Contractor's project manager, paving project manager and superintendents that will supervise the work shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

17.2 Materials

The Contractor shall supply Asphalt Cement and Aggregate in accordance with Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Section 1, Supply of Asphalt.

Tack coat shall be SS 1 liquid asphalt diluted 50:50 with clean potable water. RC 30/70 may be considered an alternative tack coat to SS-1 when adverse weather conditions require its usage and determined acceptable by the Department Representative. Tack coat materials shall conform to the specifications listed in Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials.

A chemical warm mix asphalt additive from the Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List may be used in the ACP mix when haul routes are greater than one hour.

17.3 Asphalt Mix Design and Job Mix Formula

The Contractor shall prepare and submit asphalt mix designs in accordance with Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Clause 6.2.3, Mix Design that is representative of materials to be used. The job mix formula shall be provided by the Contractor and be based on the requirements of the Special Provisions of the Contract.

Any proposed modifications to asphalt cement grades shall be submitted to the Department Representative for review and acceptance with the Asphalt Mix Design and Job Mix Formula submission.

The Department Representative's approval of any materials or mixture shall in no way relieve the Contractor from his obligation to provide materials, mixtures and workmanship in accordance with the Specifications.

17.4 Sampling and Testing

17.4.1 General

During the progress of the Work, the Contractor shall carry out tests on materials and workmanship in order to ensure compliance with the requirements of the Specifications.

In addition to quality control testing completed by the Contractor described in Subsection 17.4.2, Quality Control Testing, quality assurance (QA) testing will be completed by the Department Representative. QA testing will be completed on two 6 kg samples per lift (Alberta Transportation Test Method ATT-37) to determine the uncorrected asphalt content and aggregate gradation (Alberta Transportation Test Method ATT-26). The Department Representative will use the Contractor's measured correction factor to establish the actual asphalt content. The actual asphalt content will be determined by Alberta Transportation Test Methods ATT-12 or ATT-74, and includes the correction factor for asphalt binder lost due to absorption by the aggregate or aggregate loss. An inspection to identify any areas of segregation will be completed by the Department Representative.

The Department Representative shall have access to the work at all times for taking samples. The Contractor shall provide any assistance necessary for taking samples and shall reinstate pavement lifts or other structures to the satisfaction of the Department Representative at the locations where samples have been taken. Compensation for providing assistance with sampling and for reinstatement where samples are taken will be considered incidental to the Work and no separate or additional payment will be made.

The Department Representative's review and/or acceptance of any materials or mixtures shall in no way relieve the Contractor from their obligation to provide materials, mixtures and workmanship in accordance with the specifications.

17.4.2 Quality Control Testing

Quality control testing is the responsibility of the Contractor throughout every stage of the Work from the crushing and production of aggregates to the final accepted product. Tests performed by the Department Representative will not be considered to be quality control tests. The Contractor shall provide and pay for equipment and qualified personnel to obtain all quality assurance core samples and perform all quality control testing necessary to determine and monitor the characteristics of the materials produced and incorporated into the Work, and the final product produced.

Results of all quality control tests shall be submitted to the Department Representative as they become available. In addition, the quality control test results for mix asphalt content and aggregate gradation shall be provided to the Department Representative no later than 12:00 noon of the day following placement. The Contractor shall bear the cost of all consulting services retained by him. The Contractor shall be totally responsible for production of aggregate and mixes that meet all the specified requirements.

Quality control testing shall be completed in accordance with Table 17-1, Quality Control Testing Requirements. The Contractor shall be responsible for the coordination of all quality control testing and the associated costs. All testing shall be completed by an independent third party testing agency that is prequalified by the Department Representative in the category of QA Testing Services (Grading, Base Paving). Results of all quality control tests shall be submitted to the Department Representative within 7 days of the test being completed.

Table 17-1 Quality Control Testing Requirements

Test	**Test Method[(1)]**	**Minimum Frequency**
Aggregate Production	As specified in the Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Section 2, Asphalt Concrete Pavement	
Asphalt Mix Plant Calibration	ATT-17	Once per calendar year or as requested by the Department Representative
Sample Testing		
Tack, Prime and Fog Materials	ATT-42	As determined by the Department Representative
Temperatures	ATT-30	As specified in Subsection 17.6.5
Compaction Monitoring by Nuclear Density Gauge	ATT-11	As specified in Subsection 17.6.5

Asphalt Cement	ATT-42	As determined by the Department Representative
Mix	ATT-37	Minimum of one per lift
Mix Asphalt Content	AASHTO T 164, AASHTO T 287 or ATT-12 or ATT-74	Minimum of one per lift
Correction Factors	ATT-12, Part III or ATT-74, Part II	Once per mix design
Mix Moisture Content	ATT-15	Minimum of one per lift
Aggregate Sieve Analysis (any combination of cold feed, extraction or ignition)	ATT-26	Minimum of one per lift
Marshall Briquettes	ATT-13	Minimum of one per lift
Void Calculations, Cores or Formed Specimens	ATT-36	Minimum of one per lift
Pavement Segregation	Paving Guidelines and Segregation Rating Manual	As specified in Subsection 17.6.6.2, Segregation
Coring		
Coring	ATT-5	As specified by the Department Representative and in accordance with 17.6.5
ACP Density – Percent Compaction	ATT-67, ATT-5	As determined by the Department Representative
Density Immersion Method, Saturated Surface Dry	ATT-7	As determined by the Department Representative

Note:

(1) The term "ATT" refers to Alberta Transportation Test method.

17.4.3 Quality Assurance

Quality assurance shall be as outlined in the Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Clause 6.1.3.2, Testing and Sampling unless specified otherwise.

Where it is required in these specifications that the Contractor submit samples of materials or mixtures to the Department Representative for approval, these samples shall be submitted in sufficient time for proper testing.

Where specified, random sampling procedures shall be followed, and where no specific random sampling procedure is specified the sampling procedure shall be as identified by the Department Representative in the case of acceptance testing and by the Contractor in the case of quality control testing.

The Department Representative shall have access to the Work at all times for taking samples. The Contractor shall provide any assistance necessary for taking samples and shall reinstate pavement layers or other structures to the satisfaction of the Department Representative at the positions where samples have been taken. Compensation for providing assistance with sampling and for reinstatement where samples are taken shall be included in the unit price bid for the various items of Work tested and no separate payment will be made.

The Contractor shall provide, at his own expense, sampling stands, sampling devices and other facilities which the Department Representative may require to safely obtain representative samples of the item being produced.

When required, the Contractor shall provide and prepare, to the satisfaction of the Department Representative, a suitable site for the parking of a mobile laboratory trailer. The Contractor shall provide power to the mobile laboratory trailer, at his own expense.

17.5 Equipment and Methods

17.5.1 General

Equipment and methods used shall be adequate to meet all specification requirements. Any equipment or method which, in the opinion of the Department Representative, contributes to work that does not meet specification requirements shall be immediately corrected by the Contractor to the full satisfaction of the Department Representative.

17.5.2 Asphalt Mixing Plants

Asphalt mixing plants shall be used in the production of ACP and conform to the requirements of Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Clause 6.2.4.1, Plant and Mixing Requirements. The Contractor shall provide the Department Representative with a certificate of calibration which certifies that the plant has been calibrated to produce a uniform mixture in accordance with the Job Mix Formula.

17.5.3 Transportation of ACP

ACP shall be transported from the asphalt mixing plant directly to the paver hopper in end-dump delivery trucks with smooth metal boxes capable of fully containing all materials until discharge. End-dump delivery truck boxes shall be thoroughly cleaned of hardened ACP and all other foreign materials prior to being loaded at the asphalt mixing plant. Each end-dump delivery truck shall be equipped with a tarpaulin of suitable material and of sufficient size to overhang the vehicle box when fully loaded. Tarpaulins shall be securely fastened on all sides of the truck box and only be removed immediately prior to discharging ACP into the paver hopper.

Excess truck box lubricants such as detergent or lime solutions shall not contaminate the mix. Petroleum based truck box lubricants shall not be used.

17.5.4 Pavers

Pavers (material transfer vehicles) shall be self-propelled, configured to receive ACP directly into a hopper from end-dump delivery trucks, operated to maintain required profiles, cross-falls and joint matching. For new construction, bridge structures that have more than 3 travel lanes or longer than 75 m in length shall be paved with two or more pavers operating in simultaneous echelon such that the entire width of the ACP lift is completed at one time.

17.5.5 Compaction

The Contractor shall provide sufficient self-propelled equipment to obtain the specified degree of compaction. Compaction equipment shall be of a suitable size, weight and type as acceptable to the Department Representative, such that displacement of the mat and/or disruption of underlying materials do not occur. The compaction capability of the equipment used shall equal or exceed the placing rate.

Compaction equipment shall be in proper mechanical condition and operated such that uniform and complete compaction is obtained throughout the entire width, depth and length of the ACP being constructed. Rollers shall leave a smooth, properly finished surface, true to grade and cross-section without ruts or other irregularities. All compaction equipment shall be equipped with methods of wetting the tires or drums to prevent adhesion or pickup of ACP.

At a minimum, the Contractor shall provide the following equipment for ACP compaction operations:

- One rubber tired roller (mass greater than 10 tonnes);
- One smooth steel drum type roller (mass greater than 10 tonnes);
- One compact tandem articulating smooth steel drum type roller (mass of 1 to 2 tonnes); and
- Specialized equipment to achieve adequate compaction and smoothness in tight corners at deck joints or other locations.

The compact tandem articulating roller shall be configured with a single arm full flush drum between 0.7 and 1 m in width and be solely dedicated to compacting ACP within 12 mm of barriers, curbs, deck joints and medians. The Department Representative, at their sole discretion, will determine equivalency of proposed alternate roller equipment.

Vibrators on vibratory rollers shall not be activated on bridge decks, roof and approach slabs, or any structural element within 1 m of the bridge.

17.6 Construction

17.6.1 ACP Joints

Joints shall be in accordance with Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Clause 6.2.4.8, Joints and as specified below.

All longitudinal and transverse joints shall be of the vertical butt joint type, made in a careful manner, well bonded and sealed, and shall be finished to provide a continuous, smooth profile across the joints.

Longitudinal joints of successive ACP mats shall be offset a minimum of 0.3 m, unless otherwise accepted by the Department Representative. Longitudinal joints of final lift ACP shall not be located within wheel path areas.

Transverse joints will only be permitted at location specified on the Drawings. 6 x 25 mm saw cuts shall be accurately marked and installed in straight, neat lines where specified immediately after ACP placement and filled with an approved hot pour rubberized asphalt crack sealant listed on Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

For transition and/or approach road paving, the Contractor shall saw cut construction joints between existing ACP and new ACP. The construction joint shall be saw cut to a depth of the new ACP and on a 15° left hand forward (LHF) skew to the centreline of the roadway for the full width of the roadway. The construction joint shall be protected to prevent spalling, raveling or other damage. Joints that are damaged shall be re-saw cut at the Contractor's expense to the satisfaction of the Department Representative.

17.6.2 Protection of the Environment and Bridge Components

The Contractor shall implement temporary measures to ensure no asphaltic materials are released into the environment. All deck drains and drainage components shall be adequately sealed to prevent leakage.

The Contractor shall protect all bridge components from splatter or staining from asphaltic materials. If splatter or staining occurs it shall be repaired to the full satisfaction of the Department Representative and at the Contractor's expense. Prior to completing repairs, the Contractor shall submit a repair procedure to the Department Representative for review and acceptance. In addition to removing the splatter or staining of bridge components the repair procedure shall include removing and reinstating all specified concrete finishes to the satisfaction of the Department Representative.

The Contractor shall provide temporary protection to deck joint concrete paving lips such that haul trucks, pavers and compaction equipment access does not chip or spall the concrete or damage the waterproofing membrane system or any other bridge component. Any damage caused by equipment accessing the bridge shall be immediately repaired by the Contractor to the satisfaction of the Department Representative.

17.6.3 Mix Production

Aggregate and asphalt shall be combined to produce a uniform mixture of specified gradation at an asphalt content in accordance with the approved Job Mix Formula and in which all particles of aggregate are uniformly coated.

The Contractor shall maintain the ACP temperature within specified mixing temperature and under no circumstance shall it exceed 155°C.

17.6.4 Tack Coat

After all temporary protection measures have been acceptably installed; tack coat shall be applied to all surfaces that receive ACP except bridge waterproofing wick drains. To prevent contamination, wick drains shall be covered with materials acceptable to the Department Representative during application of the tack coat.

The surface to be tacked shall be dry and free of loose or deleterious material prior to the application of the tack coat.

Tack coat shall be applied in a uniform manner at an application rate of 0.5 L/m^2 and suitable temperature. The ambient air temperature at the time of application shall be 5°C or higher.

The tack coat shall be protected from traffic or other damage. Damaged areas shall be retacked at the Contractor's expense to the full satisfaction of the Department Representative.

17.6.5 Placement, Spreading and Compaction

17.6.5.1 General

ACP shall only be placed on clean, dry, frost free substrate on which the tack coat has cured and when the ambient air temperature is 5°C or higher. Prior to placement of ACP, all surfaces shall be cleaned of loose or foreign material.

ACP shall only be placed, spread and compacted during daylight hours unless otherwise reviewed and accepted by the Department Representative.

Care shall be taken at all times to ensure that:

- ACP is not wasted over the side of the bridge or onto the adjacent surface mat;
- Damage does not occur to the waterproofing membrane, curbs, barriers, medians, concrete paving lips, manholes, or drains;
- Damage does not occur to guide posts, guardrails, signs, power conduits or any other roadside appurtenances.

Any damage shall be repaired to the full satisfaction of the Department Representative and at the Contractor's expense.

Each mat shall be placed, spread, compacted, finished and allowed to cool down to 50°C or less prior to placing subsequent lifts. Lifts of ACP shall not exceed 70 mm.

The crown of the bridge deck and approaches shall be maintained and the Contractor shall avoid operating compaction equipment on or across the crown. Compaction procedures and equipment shall be such that displacement of ACP does not occur. Compaction equipment shall be kept sufficiently wet with water to prevent ACP pickup.

17.6.5.2 Placement and Spreading

The ACP mix shall be placed and spread at a temperature sufficient to achieve the specified compaction temperatures.

The manner of placing and spreading shall ensure safe accommodation of traffic, quality control and drainage. The longitudinal and transverse edges of each mat shall be straight in alignment, uniform, and of the same thickness as the adjoining pavement mat. Measures shall be implemented to protect exposed edges throughout the work.

17.6.5.3 Compaction

ACP compaction shall be measured and monitored using the control strip method.

For each bridge structure, a control strip density shall be determined for each lift of ACP. The control strip density shall be determined on the first mat placed of each lift as follows:

- Control strip test locations shall be located every 20 m along the length of the bridge. No test location shall be located within 200 mm of any curb, barrier, median, or mat edge.

- Once the ACP has been spread by the paver and the initial pass of the breakdown roller has been made, the control strip test locations shall be marked out on the ACP surface by outlining the nuclear density gauge using chalk;
- At each of the control strip test locations a nuclear density reading shall be taken following each pass of compaction equipment. Compaction shall continue until no further increase in density is achieved. The maximum density reading from each of the control strip test locations will be averaged to determine the Control Strip Density (kg/m^3) of the lift.

After the Control Strip Density has been determined, compaction testing for all remaining mats of the lift shall be as follows:

- Each mat shall be monitored and continuously tested for compaction using the nuclear density gauge; and
- Following compaction, density readings shall be taken and recorded at a minimum frequency of one per every 10 m of bridge length or 20 m of approach road transitions for each mat placed (minimum 2 tests per mat). The average of the readings taken by the nuclear gauge shall be considered the Average Mat Density. Density results shall be provided to the Department Representative on the same day of testing.

All compaction testing shall be completed by an independent third party testing agency that is prequalified by the Department Representative in the category of QA Testing Services (Grading, Base Paving). The testing agency shall maintain a minimum of two nuclear density gauges on site during compaction operations. Only one nuclear density gauge shall be utilized for each paving day and the other stored as a backup. Both nuclear density gauges shall be in good working order and their condition and calibration verified by the Contractor prior to commencement of any ACP placement. Verification of nuclear density gauge calibration shall immediately be provided to the Department Representative upon request.

The minimum average density of each mat shall be 98% of the control strip density. If the minimum average mat density is less than 98%, but greater than 95% of the control strip density, the mat, at the sole discretion of the Department Representative, may be accepted at an adjusted price in accordance with Subsection 17.7.3, Payment Adjustment for Density.

Rejected ACP shall be removed and replaced by the Contactor at their expense to the full satisfaction of the Department Representative. The Contractor shall submit a removal and replacement procedure to the Department Representative for review and acceptance before the commencement of any ACP removal.

17.6.5.4 ACP on Hot-Applied Rubberized Asphalt Waterproofing Membrane System

The following specific requirements are in addition to those stated elsewhere within these specifications.

ACP shall be placed and compacted in two nominal 40 mm lifts. The first lift of ACP shall be spread by the asphalt paver in the direction of the protection board laps (downhill). In the event that paving cannot be carried out in the direction of the protection board laps, the Contractor shall submit a procedure to the Department Representative for review and acceptance identifying all measures that will be taken to ensure that the protection board and waterproofing membrane will not be damaged during paving operations.

The paver shall not push the delivery end-dump trucks. All equipment shall perform all turning movements off the bridge. ACP shall be dumped directly into the paver hopper. Under no circumstance shall ACP be placed onto the protection board ahead of the paver or at other locations.

The allowable ACP temperature range at the start of compaction of ACP lifts on the hot-rubberized asphalt waterproofing membrane system shall be between 95°C and 105°C for the first lift and between 128°C and 138°C for the second lift of asphalt.

17.6.5.5 ACP on Polymer Waterproofing Membrane Systems

The following specific requirements are in addition to those stated elsewhere within these specifications of ACP on polymer waterproofing membrane systems.

The ACP wearing surface shall be placed and compacted in one nominal 50 mm thickness or as specified in the Contract documents.

The paver shall not push the delivery end-dump trucks. All equipment shall perform all turning movements off the bridge. ACP shall be dumped directly into the paver hopper. Under no circumstance shall ACP be placed onto the polymer waterproofing membrane system ahead of the paver or at other locations.

The allowable ACP temperature range at the start of compaction of ACP on the polymer waterproofing membrane system shall be between 123°C and 138°C.

17.6.5.6 ACP for Approach Road Transitions

The following specific requirements are in addition to those stated elsewhere within these specifications.

ACP shall be placed as shown on the Drawings, in the Special Provisions of the Contract, or as determined by the Department Representative.

The ACP temperature at the start of compaction of ACP for approach road transitions shall be a minimum of 123°C.

17.6.5.7 Coring

When, in the opinion of the Department Representative, compaction methods and/or procedures are not achieving specification requirements and nuclear density test measurements indicate that the specified compaction has not been achieved, the Department Representative may require the Contractor to obtain cores for testing. The Contractor shall not take cores unless requested by the Department Representative. Core locations will be determined by the Department Representative. Cores shall not be taken within the first lift of ACP in which waterproofing membranes are present below.

All coring and associated testing shall be completed by a third party independent testing agency that is prequalified to provide QA, mix design, and pavement smoothness testing services on Government of the Northwest Territories projects.

The number of cores taken shall be the greater of five or one core for every 40 m^2 of ACP surface area. Cores shall have a diameter of either 100 mm or 150 mm. The Contractor shall utilize core extraction methods that result in complete and undamaged cores.

Upon completion of coring the Contractor shall repair all core holes as follows:

- Core holes shall be completely de-watered, dried and liquid asphalt applied to the bottom and sides of the core hole and allowed to cure;

- ACP shall then be placed and compacted into the core hole until level with the surface of the adjacent pavement; and
- All repaired core hole locations shall be slurry sealed 100 mm beyond the core perimeter.

The Contractor shall submit core results to the Department Representative within 3 days of core extraction.

All costs associated with ACP coring, testing and subsequent repairs shall be the responsibility of the Contractor and no additional or further payment will be made.

17.6.6 Surface Requirements and Material Tolerances

17.6.6.1 Smoothness

Except across the crown, the surface of the ACP shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the ACP. The surface of ACP shall be checked by the Contractor immediately after the final rolling. Any final lift ACP surface that does not meet the smoothness requirements shall be repaired by the Contractor to meet the requirements in a manner acceptable to the Department Representative at the Contractor's expense.

17.6.6.2 Segregation

Pavement segregation shall be classified in accordance with the Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Clause 6.2.5.1, Point 4 Pavement segregation.

During paving operations, the Contractor shall make every effort to achieve a finished surface that has a uniform closed texture and is free of segregated areas. At the end of paving each day or completion of a paving lift, the Department Representative will perform an inspection of the paving to identify areas of pavement segregation. If segregation is present, the Contractor shall take immediate corrective action to the paving process to prevent any further occurrence of segregation. The Contractor, at their expense, shall repair segregated areas of all severities as follows:

- When slight or moderate segregation is identified in the bottom lift it shall be repaired using a slurry or hot mix patch.
- When any severe segregation is identified in the bottom lift, it shall be removed and replaced. Any damage to the bridge deck waterproofing system shall be repaired by the Contractor to the full satisfaction of the Department Representative prior to subsequent paving operations. Subsequent lift(s) shall be modified to meet the specification requirements and approved by the Department Representative.
- When any slight or moderate segregation, including centre of paver streak, is identified in top or final lifts it shall be repaired using a slurry patch or hot mix patch. The extent of slight or moderate segregation will be reviewed by the Department Representative to determine if patching is acceptable or if the entire lift requires removal and replacement.
- When severe segregation is identified in the top lift, the entire lift shall be removed and replaced.

17.6.6.3 Defects

All lifts of ACP shall be smooth, true to cross section and grade, and free from ruts, depressions, bumps, or other irregularities.

The finished surface of any lift shall have a uniform closed texture and be free of areas of excess or insufficient asphalt, improper matching of longitudinal and transverse joints, roller or tire marks, cracking or tearing, or sampling locations not properly reinstated.

17.6.6.4 Asphalt Content

The average asphalt content shall not be greater than ± 0.50% from the accepted mix design.

17.6.6.5 Aggregate Gradation

For each lift of ACP, the difference between the average gradation and the Job Mix Formula gradation shall not exceed the amounts outlined in Table 17-2, Aggregate Gradation Variation.

Table 17-2 Aggregate Gradation Variation

Sieve Size (µm)	**Maximum Permissible Variation Percent by Weight Passing (1)**
5000	± 6
1250	± 4
630	± 3
315	± 3
160	± 2.5
80	± 2

Note:

(1) Average Gradation must meet the gradation requirements of the Specifications for Highway Construction, Edition 7, Division 6 Bituminous Materials, Section 2, Asphalt Concrete Pavement.

17.6.7 Repair Procedures

If any repairs, or removal and replacement are required, as determined by the Department Representative, the Contractor shall submit proposed methods of repair or removal and replacement to the Department Representative for review and acceptance a minimum of 1 week before commencement of the repair or removal and replacement Work.

All costs associated with repairs or removal and replacement shall be at the Contractor's expense.

17.6.8 ACP Surface Removal

Surface removal of ACP shall be completed in accordance with Subsection 20.3.2, Surface Removal.

17.6.9 ACP Gradeline Profiling

The gradeline will be designed by the Department Representative to provide a smooth riding surface for the finished ACP. The Contractor shall assist the Department Representative with profiling of the bridge structure and roadway approaches.

For new construction projects, profiling shall occur before and after ACP placement.

For rehabilitation projects, profiling shall occur before and after surface removal, and after ACP placement.

Gradeline profiles will be produced by the Department Representative and shall be used by the Contractor in placement of ACP. The following will be provided by the Department Representative to the Contractor:

- Three parallel profile lines the entire length of the bridge:
  - Line No. 1 will be located 1 m from curb face.
  - Line No. 2 will be located 0.3 m in from the edge of mat adjacent to the crown.
  - Line No. 3 will be located 1 m from curb face.
- The stations of Line No. 1, Line No. 2, and Line No.3 will be square to each other.
- Additional profile lines will be produced when determined necessary by the Department Representative.
- Stations will be established at the edges of deck joints and at 3 m intervals along the length of the bridge.
- At a minimum, profiles will include 30 m of roadway approach at each end of the bridge at 3 m intervals.
- Profile plots will be to the following scales:
  - Horizontal: 10 mm = 1000 mm
  - Vertical: 1 mm (normal) or 1 mm = 5 mm (minimum)
- The proposed design gradeline will be a smooth line achieving a nominal thickness as shown on the Drawings or determined necessary by the Department Representative.

The Contractor shall remove any deck surface temporary markings before placement that will adversely affect bonding of subsequently placed materials.

The Department Representative will provide the summary of the proposed ACP thickness, to the nearest mm, at each control point. The Contractor is responsible for achieving the gradeline provided by the Department Representative.

17.7 Measurement and Payment

17.7.1 Payment by Lump Sum

Payment for the supply and placement of asphalt concrete pavement will be made at the lump sum price bid for "Asphalt Concrete Pavement" for the applicable Mix Type less any applicable payment adjustments for density, and will be full compensation for preparation of the asphalt mix designs and job mix formula; protection of the environment and bridge components; surface profiling; the supply and processing of aggregate; the supply and application of tack coat; the supply of asphalt cement; processing, hauling, placing and compacting the mix; sampling and testing; construction of ACP joints; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

17.7.2 Payment by Unit Price

Measurement for payment of the supply and placement of asphalt concrete pavement will be by the tonnage of material acceptably placed, measured to the 0.1 tonne.

The quantity to be paid for will be calculated by the Department Representative using the design profile and surface area shown on the Drawings or reviewed and accepted by the Department Representative. The conversion factor from cubic metre volume to tonnage of asphalt concrete pavement will be 2.3.

Payment will be made at the unit price per tonne bid for "Asphalt Concrete Pavement" for the applicable Mix Type, less any applicable payment adjustments for density, and will be full compensation for preparation of the asphalt mix designs and job mix formula; protection of the environment and bridge components; surface profiling; the supply and processing of aggregate; the supply and application of tack coat; the supply of asphalt cement; processing, hauling, placing and compacting the mix; sampling and testing; and construction of ACP joints; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

17.7.3 Payment Adjustment for Density

The Department Representative reserves the right to reject asphalt concrete pavement that does not meet the specified requirements. The Department Representative may, at its sole discretion, accept asphalt concrete pavement that does not meet the specified density at a reduced price.

ACP will be considered acceptable at full payment or acceptable with payment reduction or rejection according to the values outlined in Table 17-3, Payment Adjustment for ACP Density (Measurement by Nuclear Gauge). Payment adjustment will be assessed for each mat of ACP placed. The Department Representative may, at its sole discretion, reject all lift mats if any mat is found to be within rejection limits. Payment adjustment will be converted from a volume to tonnage basis using a factor of 2.3 tonnes per cubic metre.

Table 17-3 Payment Adjustment for ACP Density (Measurement by Nuclear Gauge)

Average Mat Density / Control Density	**Payment Reduction for ACP Density (% of Unit Price per tonne or Lump Sum)**
≥ 98%	Full Bid Price
≥ 97% < 98%	Bid Price Less 15%
≥ 96% < 97%	Bid Price Less 30%
> 95% < 96%	Bid Price Less 45%
≤ 95%	Rejected

When coring of ACP is required by the Department Representative, ACP will be considered acceptable at full payment or acceptable with payment reduction or rejection according to the values outlined in Table 17-4, Payment Adjustment for ACP Density (Measurement by Core). Payment adjustment will be assessed for each mat of ACP placed. The Department Representative may, at its sole discretion, reject all lift mats if any mat is found to be within rejection limits. Payment adjustment will be converted from a volume to tonnage basis using a factor of 2.3 tonnes per cubic metre.

Table 17-4 Payment Adjustment for ACP Density (Measurement by Core)

Average Core Density / Marshall Briquette Density	**Payment Reduction for ACP Density (% of Unit Price per tonne or Lump Sum)**
≥ 97%	Full Bid Price
≥ 96% < 97%	Bid Price Less 15%
≥ 95% < 96%	Bid Price Less 30%

> 94% < 95%	Bid Price Less 45%
≤ 94%	Rejected

17.7.4 ACP Surface Removal

Measurement for payment of ACP surface removal will be by the square metre, based on horizontal measurements to the nearest 0.1 m^2.

Payment will be made at the unit price bid for "ACP Surface Removal" and will be full compensation for removal of the existing ACP to the depths specified; surface cleaning; disposal of debris; and all labour, equipment, tools, and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

SECTION 18 CMP AND SPCMP STRUCTURES AND TRENCHLESS INSTALLATION OF STEEL PIPE

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18.1 General

18.1.1 Scope

This specification is for the supply, fabrication, delivery and installation of:

- Corrugated Metal Pipe and Structural Plate Corrugated Metal Pipe with an equivalent diameter of 1500 mm or greater.
- Welded Steel Pipes by Pipe Jacking, Auger Boring, Pipe Ramming, Pilot Tube Guided Boring, or other approved equivalent methodologies for trenchless single pass installation with an equivalent diameter of 1500 mm or greater.

Trenchless single pass installation is defined as an installation method where the trenchless casing pipe being installed is also the primary permanent culvert pipe carrying all loads during the service life of the culvert.

Abbreviations for the various types of culverts when indicated on the Drawings or used in the Specifications are as follows:

- CSP - Corrugated Steel Pipe
- CAP - Corrugated Aluminum Pipe
- CMP - Corrugated Metal Pipe (General Term for Corrugated Steel and Aluminum Pipe)
- SPCSP - Structural Plate Corrugated Steel Pipe
- SPCMP - Structural Plate Corrugated Metal Pipe

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

18.1.2 CMP and SPCMP Structures

All work shall be carried out in accordance with these specifications, as shown on the Drawings and Standard Drawings:

- Alberta Transportation Standard Drawing S-1418, Installation of CSP and SPCSP Structures (in analogy);
- S-001, Standard Asset ID Plaque and Bench Mark Tablet, and
- S-002, Standard Culvert Asset ID Tag.

Alberta Transportation Standard Drawing S-1418, Installation of CSP and SPCSP Structures shall apply in analogy to aluminum culverts.

18.1.3 Welded Steel Pipe Trenchless Installation

18.1.3.1 General

The Contractor shall furnish all materials and equipment necessary for the supply and installation of welded steel pipes at locations shown on the Contract Drawings. Pipe shall be plain, i.e. unlined and uncoated, steel pipe for a trenchless single pass installation by Pipe Jacking, Auger Boring, Pipe Ramming, Pilot Tube Guided Boring, or approved equivalent methodology.

The Contractor's scope includes the design and construction of the shaft/excavation and thrust wall required to complete the installation.

The Contractor shall be responsible for the review of the design, geotechnical information, and existing site conditions to determine the most appropriate means and methods for the installation.

All work shall be carried out in accordance with these specifications and with the most recent relevant installation standards including the following:

- North American Society of Trenchless Technology – Pipe Jacking Good Practice Guidelines;
- North American Society of Trenchless Technology – Pipe Ramming Good Practice Guidelines;
- American Society of Civil Engineers – Manual of Practice 106 – Horizontal Auger Boring Projects;
- American Society of Civil Engineers – Manual of Practice 133 – Pilot Tube and Other Guided Boring Methods; and
- Pipe Jacking Association – Guide to Best Practice for the Installation of Pipe Jacks and Microtunnels.

Structures applicable to these specifications shall be considered proprietary structures in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, and all requirements of Section 27 shall be met, unless noted otherwise in the contract documents.

18.1.3.2 Contractor Qualifications

The Contractor shall provide information pertaining to the following qualifications and demonstrating 10 years of previous trenchless installation experience:

- A minimum of three projects of similar size and length (none smaller than 300 mm less in diameter and none less than 10 m shorter than the maximum diameter pipe to be installed under the contract). Two of the three projects must have been completed within the last five years. The installation methods shall be similar to those used for the Work.

The proposed site foreman/superintendent shall also be required to meet the following minimum experience qualification:

- Completion of three projects of similar size and length (none smaller than 300 mm less in diameter and none less than 10 m shorter than the maximum diameter pipe to be installed under the contract). Two of the three projects must have been completed within the last five years.

The Contractor shall provide the required information to the Department Representative a minimum of four weeks (20 business days) prior to commencing pipe fabrication or the trenchless installation.

18.2 Supply and Fabrication of CMP and SPCMP

18.2.1 Standards

The supply and fabrication of all galvanized, polymer coated and aluminum coated CSP including couplers and appurtenances and SPCSP shall be in accordance with the current edition of CSA G401 with additions and exceptions as described in these specifications.

The fabrication of all CAP components must also meet the requirements of ASTM 746.

Only welders, welding operators and tackers approved by the Canadian Welding Bureau (CWB) in the particular category shall be permitted to perform weldments. Their qualifications shall be current and available for examination by the Department Representative.

18.2.2 Qualification

All CMP and SPCMP shall be supplied and fabricated by a fabricator certified to CSA G401. Certification shall be completed by an independent agency accredited by the Standards Council of Canada (SCC).

18.2.3 Prefabrication Submissions

18.2.3.1 Shop Drawings

Shop drawings for SPCMP structures, beveled ends, elbows and any other component specified in the Special Provisions of the Contract shall be submitted to the Department Representative for review and acceptance a minimum of 2 weeks in advance of the commencement of fabrication. Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp. As a minimum, the following information shall be included on shop drawing submissions:

- Dimensions;
- Plate arrangements;
- Bolting details;
- Materials lists; and
- Assembly sequence.

The shop drawings will be reviewed by the Department Representative solely to ascertain general conformance with codes and specifications. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

18.2.3.2 SPCMP Plate Arrangement

For SPCMP structures, bolts in the corrugation valley of each longitudinal seam shall be closer to the visible plate edge than bolts located on the corrugation crest. Longitudinal seams shall be staggered a minimum of 2N, except where reviewed and accepted by the Department Representative.

18.2.4 Materials

All pipe materials shall be new material supplied in accordance with CSA G401. CSP and SPCSP components shall be marked according to CSA G401.

All CAP's shall conform to material specifications in ASTM B745. All Structural Plate elements shall conform to material specifications in ASTM B746.

Aluminum bolts shall meet the requirements of ASTM F468. Aluminum nuts shall meet the requirements of ASTM F467. All nuts and bolts shall be made from alloy 6061-T6.

18.2.4.1 Mill Test Reports

Mill test reports and product data sheets shall be provided in English for all materials. .

Mill test reports and product data sheets shall be submitted to the Department Representative for review and acceptance 2 weeks prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

18.2.5 Fabrication

18.2.5.1 Fabrication of CMP

18.2.5.1.1 Sloped Ends

Sloped end sections are required for each culvert unless otherwise noted on the Drawings or the culvert order. When 2:1 sloped end sections are specified by the order, the attached Figures 18-1 and 18-2 will apply unless stated otherwise.

18.2.5.1.2 Termination of Lockseams

On pipes 1500 mm diameter or larger all lockseams terminating at the cut edges of a sloped or square end section shall have a 75 mm length of fillet weld run along both sides of the lockseam (staggered 300 mm apart) at each cut edge. The weld and surrounding area shall be zinc coated in accordance with CSA G401.

18.2.5.1.3 Cut Ends

All cut edges of a sloped or square end section shall be made smooth by grinding to remove all burrs. Any damaged protective coating shall be recoated with appropriate material in accordance with CSA G401.

18.2.5.1.4 Recorrugated Ends

All Corrugated Metal Pipes shall have ends recorrugated to provide annular corrugations for the installation of couplers.

18.2.5.1.5 Couplers

Only annular corrugated couplers will be accepted unless approved by the Department Representative. The couplers for pipes 1600 mm and larger in diameter shall be a minimum of 600 mm wide. There shall be a minimum of five bolts at every joint of every coupler.

18.2.5.2 Fabrication of SPCMP

18.2.5.2.1 Sloped Ends

Sloped end sections are required for each culvert unless otherwise specified on the Drawings. When 2:1 sloped end sections are specified Figure 18-3 shall apply.

18.2.5.3 Standard Asset Identification Plaques and Tags

Standard asset identification plaques and identification tags shall be supplied and installed in accordance with Section 13, Miscellaneous Iron, and Standard Drawings S-001, Standard Asset ID Plaque and Bench Mark Tablet and S-002, Standard Culvert Asset ID Tag.

18.2.6 Shop Inspection

18.2.6.1 Inspection, Sampling and Testing

All materials shall be subject to inspection, sampling and quality assurance testing by the Department Representative. The Contractor shall provide safe, convenient access acceptable to the Department Representative for inspection and sampling of the materials and shall assist in the inspection and sampling process when requested to do so.

Any material found unacceptable by the Department Representative shall be replaced by the Contractor at their expense.

Testing, inspection and related costs incurred by the Department Representative as a result of defective work shall be paid for by the Contractor.

18.2.6.2 Notification

Prior to shipment of CMP or SPCMP, the Contractor shall notify the Department Representative a minimum of 72 hours in advance to facilitate inspection and acceptance. The Contractor shall be responsible for all costs incurred by the Department Representative to inspect CMP and SPCMP at the construction site, due to the Contractor's failure to receive the Department Representative's acceptance, prior to shipping from the fabrication facility.

18.2.7 Storage of Material

18.2.7.1 Stockpiles

All material shall be unloaded and stockpiled in a neat and orderly manner, so as to facilitate inspection and inventory, and in such a manner as to ensure preservation of their quality and suitability for the work. Stockpiled materials, accepted on delivery as to quantity and observed condition, shall be subject to testing, and shall meet the requirements of the specifications at the time they are to be used in the work.

18.2.7.2 Storage Stains

Galvanized material shall be stacked or bundled and stored to prevent wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. Light and medium wet storage stains shall be removed by brushing with a stiff-bristled nylon brush to the satisfaction of the Department Representative. Heavy and extreme wet storage stains shall be repaired by the Contractor. A repair procedure shall be submitted by the Contractor to the Department Representative for review and acceptance. Review comments shall be incorporated into the repair procedure to the satisfaction of the Department Representative prior to commencement of the work at the Contractor's expense.

18.2.8 Handling of Material

All culvert material shall be handled carefully and in such manner as to prevent bruising, scaling or breaking of the galvanized coating. Culvert material shall also be handled and unloaded without undue stress and in such a manner that the radii or dimensions of the pipes remain true. Coupling bands shall be shipped with all necessary hardware and fittings attached thereto, or in suitable shipping containers. All SPCMP bolts are to be shipped with plates. Where the material supplied is damaged, the Contractor shall immediately separate nested sections of plate or pipe to facilitate more detailed inspection by the Department Representative. Culvert material designated by the Department Representative as unacceptable, due to failure to meet specified requirements, shall be immediately repaired or replaced by the Contractor and to the satisfaction of the Department Representative at the Contractor's expense.

Where the Contractor's failure to satisfactorily stockpile, or to satisfactorily expedite repairs to damaged material, necessitates that the Department Representative require this to be done separately, the cost of such work will be at the Contractor's expense.

18.2.9 Repair of Damaged Coatings

18.2.9.1 Galvanizing

All damaged galvanized surfaces shall be repaired using a high zinc treatment in accordance with CSA G401.

18.2.9.2 Polymer

Components with damage to polymer surfaces of less than or equal to 50 mm shall be repaired as follows:

- At the fabrication facility, repairs for the outside or external side shall use RAN VAR TPC-515-7 or DENSO Butyl 35 tape. Repairs for the inside or internal side shall use DENSO Butyl 35 tape.
- At the project site, repairs for both external and internal sides shall use DENSO Butyl 35 tape.

Components with damage to polymer surfaces greater than 50 mm shall be rejected when identified by the Department Representative at the fabrication facility.

Components with damage to polymer surfaces greater than 50 mm identified at the project site will be assessed by the Department Representative. The Department Representative will determine whether the damage to the polymer surface is repairable. If damage is determined repairable the Contractor shall submit a detailed repair procedure to the Department Representative for review and acceptance. Repair work shall not commence until acceptance has been received from the Department Representative. If the damage is determined to be irreparable, new components shall be provided by the Contractor at their expense.

18.3 Design, Supply and Fabrication of Welded Steel Pipe

18.3.1 Standards

The following reference specifications, codes, and standards shall be used for the design and installation of welded steel pipe installed by trenchless installation methods:

- CSA S6 – Canadian Highway Bridge Design Code
- ASTM A139 – Specification for Electric Fusion (ARC) Welded Steel Pipe (Sizes 100 mm and Over);
- ASTM A252 – Standard Specification for Welded and Seamless Steel Pipe Piles;
- ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless;
- CSA Z245 – Steel Pipe;
- AWWA M11 – Steel Pipe – A Guide for Design and Installation;
- ASTM C150 – Standard Specification for Portland Cement; and
- ASTM C937 – Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

Only welders, welding operators and tackers approved by the Canadian Welding Bureau (CWB) in the particular category will be permitted to perform weldments. Their qualifications shall be current and available for examination by the Department Representative.

18.3.2 Design

18.3.2.1 Proprietary Structures Design

The Contractor's design shall be in accordance with the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

18.3.2.2 Welded Steel Pipe

The Contractor shall be responsible for the design of welded steel pipe in accordance with this Specification.

The welded steel pipe shall have a minimum wall thickness and nominal diameter as shown on the design drawings. Welded steel pipe shall have a minimum yield strength of 240 MPa in accordance with pipe material standards in Subsection 18.3.1, Standards.

The Contractor shall be responsible to assess the minimum wall thickness noted on the design drawings based on their installation method. If the Contractor's chosen methodology requires an increase in wall thickness based on the installation loads, the Contractor shall be responsible to provide the thicker wall pipe. No additional or separate payment will be made for additional wall thickness required for the chosen installation method. The welded steel pipe shall be specifically designed to resist installation loads during installation.

The unfactored demands (unfactored design loads) shall not exceed 50 percent of the minimum yield strength of the pipe material.

The joints of the pipe shall be watertight and designed for an internal and external hydraulic pressure based on the greatest depth of the embankment. Joint designs shall be designed with a factor of safety of 2 between unfactored demands (unfactored design loads) and unfactored capacity to withstand lubrication and grouting pressure, if used.

Pipe connections shall be completed by full penetration field butt welding or an integral machine press-fit connection (Permalok or equal). Integral machine press-fit connections shall be in accordance with the manufacturer's installation procedures and recommendations.

Grout/lubrication ports, if used, shall be provided at intervals selected by the Contractor. Ports and fittings shall not detrimentally affect the strength of the pipe. Grout holes shall be fitted with countersunk, full face rubber gaskets to prevent infiltration. The lubrication ports design, configuration and placement shaft shall be determined by the Contractor. Plugs for sealing the ports shall be capable of withstanding all external and internal pressures and loads without leaking. Seals shall be designed to withstand the same hydraulic pressure as the pipe joints.

18.3.2.3 Excavation and Support

Excavation support systems, if required, shall be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG, who has a minimum of five years' experience in the design of soil/rock retaining structures.

The Contractor is fully responsible for selection of the shaft/excavation types, sizes and method of construction. The size shall be adequate to support the method determined by the Contractor and shall fit within the site allotted.

If used, shafts shall be designed for the anticipated geotechnical and hydrogeological conditions as indicated in the geotechnical information provided in the contract documents. The Contractor shall determine the most appropriate shaft type for construction through site soils as indicated in the provided geotechnical information. Excavation support systems shall be designed by the Contractor to support earth pressure, groundwater pressure, utility loads, equipment, traffic loads, surcharge loads and bottom heave.

The Contractor shall confirm that the chosen excavation support systems shall not damage adjacent structures including buildings, pipelines, and utilities.

Excavation support systems shall include site grading, fencing, signage, construction of staging areas, design and construction of shaft excavations and excavation support systems, material disposal, control of groundwater, surface water and construction water, backfilling, abandoning shafts and site restoration.

18.3.2.4 Contact Grouting

The Contractor shall provide all equipment, materials, and personnel necessary to completely fill all voids between the outside of the pipe and the excavated bore and including any other voids.

The grout shall reach a minimum compressive strength of 1 MPa in 24 hours.

Grout shall consist of Portland cement, fluidifier as necessary and water in the proportions specified herein or as approved by the Department Representative. Up to two (2) percent bentonite by weight of cement may be added to the mix. Additional water and fluidifier, may also be added. Grout mix ratios (water/cement) shall be varied as needed to fill all voids and shall be between 1:1 and 2:1 by volume.

18.3.3 Prefabrication Submissions

Further to the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, shop drawings for design components outlined in Subsection 18.3.2, Design, and any other component specified in the Special Provisions of the Contract shall be submitted to the Department Representative for review and acceptance a minimum of 2 weeks in advance of the commencement of fabrication and installation. Review comments provided by the Department Representative shall be incorporated into the shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of fabrication and installation.

In addition to the requirements of Section 27, the proprietary design report / shop drawings shall include, as a minimum, the following information shall be included on shop drawing submissions:

- Provide sufficient detail to allow the Department Representative to determine whether the proposed equipment, materials, and procedures meet the requirements of the Contract Documents. Review of the Contractor's submittals by the Department Representative shall not be construed in any way as relieving the Contractor of their responsibilities under this Contract.
- The Contractor shall submit written descriptions of procedures and specifications used in the manufacture of the welded steel pipe. Fabrication drawings illustrating the details of the wall thickness, pipe joint, and grout/lubrication ports including tolerances shall be submitted. The Contractor shall submit joint details including details of the cross section and circumferential length. The Contractor shall submit details of the bentonite/grout ports if used.
- The Contractor shall submit written descriptions of installation procedures and specifications used for the installation of the welded steel pipe including details of the equipment, materials, and personnel required to complete the work. This includes demonstrating how the installation will be completed in accordance with the specified tolerances complete with survey and alignment control methods.
- The Contractor shall submit design calculations for the material demonstrating that the welded steel pipe is capable of supporting the maximum loads during installation with respect to the Contractor's means and methods. Design calculations shall consider ground and hydrostatic loads, installation loads, and any other loads that may be reasonably anticipated during the installation with appropriate safety factors (minimum factor of safety of two). Design calculations shall be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall clearly state all assumptions, design loads, and values used in calculating their installation loads and subsequent material selection. The Contractor shall provide manufacturer recommendations for allowable installation and ultimate loads.
- The Contractor shall submit a s Shaft/Excavation and Support Work Plan complete with Drawings, written descriptions, procedures, and manufacturer's information identifying the details of the proposed methods of construction, shaft types and dimensions, initial support system, ground improvements, equipment, materials, and the sequence of operations during construction.
- The shop drawings showing plan and section views of shaft support systems, dimensions and sizes shall include excavators, front-end loader, spoil transfer areas, spoil containment system, spoil hauling equipment, pumps, generators, tool trailers, containers, and any other required equipment.

- The Contractor shall submit design calculations for the shaft support systems demonstrating that the system is capable of supporting the maximum loads anticipated by the Contractor during shaft construction, and backfilling, consistent with the conditions defined in the Geotechnical Report. Design calculations shall consider ground and hydrostatic loads, equipment, construction loads, and any other surcharge loads that may be reasonably anticipated during shaft construction operations. Design calculations shall be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Contractor shall clearly state all assumptions and values used in their calculations.
- The Contractor shall submit a detailed safety plan for all work activities. The plan shall include details of air monitoring equipment, frequency of calibrating instruments, and procedures for lighting, ventilation, and electrical safeguards. The Contractor shall provide the name and qualifications for the site safety representative responsible for implementing the plan during the work.
- The Contractor shall submit daily records to the Department Representative for review by noon on the day following the shift for which the data or records were taken. These records shall include equipment and personnel on site, summary of daily construction tasks, geotechnical conditions, hydrogeologic conditions, groundwater leakage rate, excavated spoil volume, and problems encountered.
- The Contractor shall submit a contact grout work plan detailing methods, equipment, procedures, and sequencing of grout work. Details shall include injection methods and minimum and maximum grout pressures, monitoring and recording equipment, pressure gauge calibration data, methods of controlling grout pressure, method of transporting grouting equipment and materials, and provisions to protect the pipe, lining or shaft. Maximum grouting pressures shall be designed such that ground surface heave or adverse displacements of the pipe, shaft, or excavation support system does not occur.
- The Contractor shall submit details of grout mix proportions, admixtures, manufacturer’s information, and laboratory test data verifying strength of proposed grout mixtures (24-hour strength).
- The Contractor shall submit anticipated volumes of grout to be injected for each application.

The shop drawings will be reviewed by the Department Representative solely to ascertain general conformance with codes and specifications. The Department Representative’s review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

18.3.4 Supplier Qualifications

Welded Steel Pipe shall be supplied and fabricated, by the Contractor in accordance with Section 6, Structural Steel, the Drawings and these specifications. In the case of conflicting requirements, the requirements of this Section shall govern.

18.3.5 Quality Control

Further to the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, all work shall be performed under the review of quality control personnel with a minimum of five years’ experience.

The Contractor shall immediately notify the Department Representative, in writing, when any concerns are encountered with materials or during manufacturing of the welded steel pipe.

The Contractor shall provide documentation supporting the welded steel pipe suitability prior to delivery to site.

The Contractor shall prepare four (4) samples of each proposed grout mix and determine 24 hour strength in accordance with ASTM C39 or C109. Four samples of grout shall be provided from the nozzle of the grout injection line for each three (3) cubic metres of grout that is injected but not less than one set for each grouting shift unless directed otherwise by the Department Representative.

The Contactor shall maintain and submit daily logs of grouting operations detailing locations and times of injection, maximum and minimum pressures, volumes and grout mix details.

18.3.6 Materials

18.3.6.1 Welded Steel Pipe

Steel pipe shall be new, smooth-walled carbon steel pipe conforming to one of the following applicable standards listed in Subsection 18.3.1, Standards.

Welded steel pipe shall be furnished in lengths that are compatible with transportation requirements, shaft dimensions, allowable work areas, and the Contractor's approved work plan.

The outside circumference of the welded steel pipe shall not vary by more than one (1) percent or 20 mm of its nominal circumference, whichever is less.

The outside diameter of the pipe shall be within 5 mm of the nominal outside diameter.

Pipe shall not deviate from straight by more than five (5) millimeters per three (3) linear metres. Measurement shall be taken by measuring the gaps between the wall and a straightedge placed along any longitudinal line on the pipe's exterior surface.

Pipe ends shall be perpendicular to the straight long axis and shall not vary by more than three (3) millimeters at any point from a true perpendicular plane.

The difference between the major and minor outside diameters shall not exceed 6 mm to ensure appropriate pipe roundness.

Each pipe section shall be clearly marked on both ends to identify the manufacturer, date of manufacturer, location of plant, shift, sequence, weight per foot, and nominal diameter.

Pipe materials shall be transported, handled and stored in accordance with manufacturer's recommendations. Internal bracing shall be furnished and installed as per manufacturer recommendations. Dunnage shall be used such that the pipe sections are not placed directly on the ground.

The Contractor shall ensure that the pipe is not chipped, crushed, gouged or damaged in any way. Damaged pipe sections will be rejected and removed from the site and replaced or repaired using methods and materials approved in writing by the Department Representative and at no cost to the Department.

18.3.6.2 Mill Test Reports

Mill test reports and product data sheets shall be provided in English for all materials. .

Mill test reports and product data sheets shall be submitted to the Department Representative for review and acceptance 2 weeks prior to commencement of fabrication of the pipe. Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

18.3.6.3 Grout

Grout mix ratios (water/cement) shall be varied as needed to fill all voids and shall be between 1:1 and 2:1 by volume.

18.3.7 Standard Asset Identification Plaques and Tags

Standard asset identification plaques and identification tags shall be supplied and installed in accordance with Section 13, Miscellaneous Iron and Standard Drawings S-001, Standard Asset ID Plaque and Bench Mark Tablet and S-002, Standard Culvert Asset ID Tag.

18.4 Installation

18.4.1 Installation of CMP and SPCMP

18.4.1.1 General

Installation of CMP and SPCMP structures shall not proceed until the excavation, foundation, and bedding material placement has been reviewed and accepted by the Department Representative.

The Contractor shall install CMP and SPCMP structures to the lines and grades as shown on the Drawings and as determined by the Department Representative.

18.4.1.2 Water Management

In addition to ECO Plan submission requirements and the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements, the Contractor shall also prepare and submit a separate water management plan to the Department Representative for review and acceptance a minimum of 2 weeks prior to the preconstruction meeting. The water management plan shall outline the means and methods that will be used to control and manage water and/or ice at all times during the Work in accordance with all applicable environmental requirements and regulations. The water management plan will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The water management plan will be reviewed by the Department Representative solely to ascertain general conformance with environmental regulations, specifications, the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements, and any applicable Special Provisions of the Contract. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of their full responsibility for the design, construction, monitoring, performance, and maintenance of the water plan.

18.4.1.3 Excavation

Excavations shall be carried out to the lines and grades shown on the Drawings, or as determined by the Department Representative, and in accordance with Section 1, Excavation. Excavations shall be reviewed and accepted by the Department Representative prior to placing the bedding material.

Excavations shall be dewatered to the bottom of the excavation and remain dewatered until all backfilling is acceptably completed.

18.4.1.4 Bedding

Where the bottom of the excavation lies at 600 mm or less below the pipe invert the fill material shall be compacted by the Contractor to a minimum of 95% of Standard Proctor Density at optimum moisture content. Where the bottom of the excavation extends more than 600 mm below the pipe invert, the fill material shall be compacted at the 600 mm level to a minimum of 95% of Standard Proctor Density at optimum moisture content. The structural fill shall be placed in lifts not exceeding 150 mm, prior to compaction. The Contractor shall use whatever materials, labour, equipment and incidentals necessary to achieve a stable bed.

The Contactor shall place woven geotextile filter fabric before placing granular backfill material, as shown on Standard Drawing S-1418, Installation of CSP and SPCSP Structures.

The supply and placing of the woven geotextile filter fabric will be considered incidental to the Work and no separate or additional payment will be made.

The physical properties and minimum requirements of woven geotextile filter fabric shall be in accordance with Table 18-1, Woven Geotextile Filter Fabric Requirements.

Table 18-1 Woven Geotextile Filter Fabric Requirements

Physical Property	**Minimum Requirement**
Grab Strength (ASTM D4632/D4632M)	1275 N
Elongation (Failure)	15%
CBR Puncture Strength (ASTM D6241)	275 N
Trapezoidal Tear (ASTM D4533/D4533M)	475 N

The minimum geotextile filter fabric lap shall be 1000 mm.

The crushed aggregate material within 150 mm of the bottom of the pipe shall be placed in a loose uncompacted state. All other structural fill, including the clay seepage cutoffs, shall be compacted to a minimum of 95% of Standard Proctor Density at optimum moisture content.

The top of the bedding is that portion of the structural fill in contact with the bottom of the pipe and shall be constructed to the exact grade as shown on the Drawings. Where camber is specified, the top of the bedding shall be constructed on a gradual crest curve with no sudden breaks in the grade. Where preshaping is specified, the top of the bedding shall be constructed to the exact curvature of the bottom plates. The top of the preshaping shall be 200 mm to 300 mm below the horizontal seam which joins the sidewall to the bottom plates, or as shown on the Drawings.

18.4.1.5 Assembly

Assembly of CMP and SPCMP structures may proceed only after the excavation; foundation and bottom bedding material and shape have been reviewed and accepted by the Department Representative.

The shape of CMP and SPCMP structures shall be maintained within 2% of design dimensions. When the Contractor supplies and installs devices and/or use methods to maintain the shape of the structure, they shall be such that no local distortions of the pipe or other signs of distress occur. Horizontal strutting shall not be used unless the Contractor obtains written acceptance from the Department Representative. The Contractor shall continuously monitor the shape of the pipe during installation to ensure the specified design shape is achieved.

Assembly shall be completed in accordance with the reviewed and accepted shop drawings.

18.4.1.5.1 CMP

CMP sections shall be laid so that the ends are in close contact. Couplers shall be well fitted and evenly tightened all around the pipe. Joints shall be sealed using non-woven geotextile.

CMP couplers shall be completely wrapped with a 2 m wide layer of non-woven geotextile, adequately secured and centred over the coupler prior to backfilling.

18.4.1.5.2 SPCMP

SPCMP shall be assembled in accordance with the reviewed and accepted shop drawings and as follows:

- The pipe shall be assembled on the invert bed as shown on the Drawings and reviewed and accepted by the Department Representative;
- All bolted seams shall be properly lapped and plates shall be in contact for the full width and length of the lap. The bolts in the valley of each longitudinal seam shall be nearer to the visible edge of the plate than the bolts in the crest;
- Assembly and loose bolting of the side arc and top arc plates may proceed, starting from the upstream end of the structure and progressing towards the downstream end;
- After two complete rings have been loosely assembled, the vertical dimensions shall be checked by the Contractor and where necessary adjusted with horizontal cables and/or supports to obtain design rise dimensions;
- Each adjacent ring shall then be assembled and adjusted in a similar manner until the entire structure is loosely assembled and conforms to design geometry with nested plates;
- The vertical axis shall be upright and the longitudinal seams shall be straight. Rotation of the pipe and/or spiraling of the longitudinal seams shall not be permitted;
- Adjustments shall be made to produce design dimensions with fully nested laps. When horizontal tie cables are used for shape adjustment, adequate means shall be taken to ensure distribution of concentrated forces at the pipe walls. Distortion of the pipe side walls at the cable points will not be accepted.

- Bolts shall be torqued to not less than 200 Newton-metre (Nm) and not more than 340 Nm. This includes bolts which connect special features to the pipe. Where the supplier's specification for torque differs from this range the Contractor shall discuss with the Department Representative the appropriate course of action. . Bolts shall be tensioned only once and shall not be reused;
- Distortion of bolt holes caused by over-torqueing, or poor assembly methods will not be permitted. Proposed bolt holes additional to those shown on the shop drawings shall be reviewed and accepted by the Department Representative. Any additional holes reviewed and accepted by the Department Representative shall be drilled. Torch cutting of holes or welding on plate sections will not be permitted.

Where conflicting requirements exist between these specifications and the manufacturer's shop drawings, the specification requirements shall govern.

18.4.1.6 Backfilling

The assembly of the structure must be accepted by the Department Representative before backfilling with crushed aggregate material and/or non-granular materials as specified on the Drawings. Backfilling shall be in accordance with the current version of Alberta Transportation Standard Drawing S-1418, Installation of CSP and SPCSP Structures and Section 2 Backfill. In addition, the following requirements shall be met:

- Bedding material shall be crushed aggregate Des 2 Class 25;
- When the air temperature is below 0°C, no backfilling is allowed unless otherwise accepted by the Department Representative. If backfilling is deemed acceptable due to extenuating circumstances, the Contractor shall submit a cold weather backfilling procedure to the Department Representative for review and acceptance a minimum of 2 weeks prior to backfill placement. All backfill materials shall be in a thawed state when placed and compacted. No backfill material will be permitted to be placed on frozen substrate;
- The backfilling under the haunches shall be compacted in thin layers filling all corrugations and ensuring firm contact with the entire bottom surface of the pipe;
- The backfilling shall fill each corrugation, be free of voids and provide uniform support to the pipe. The backfill shall be placed such that the level of fill on one side of the pipe does not exceed the level of fill on the other side of the pipe by more than 300 mm;
- The backfill shall be placed and compacted by equipment moving parallel to the pipe with simultaneous handwork along the pipe. Large earth moving equipment and large compaction equipment shall not be permitted within 1 m of the pipe;
- The first 300 mm of the backfill over the pipe shall be placed, levelled and compacted without vibration. Subsequent fill over the pipe shall be placed and compacted by equipment moving perpendicular to the longitudinal axis of the pipe. The Contractor shall obtain the Department Representative's acceptance before using any equipment above the pipe;
- The Contractor shall supply suitable material for the compacted non-granular backfill. Highly plastic clays or material with high silt content will not be permitted for use as non-granular backfill. The quality of the material, and the methods of placing and compacting, shall be reviewed and accepted by the Department Representative prior to commencement of the work; and;
- Clay seal material shall be highly plastic clay with a minimum plasticity index of 40. Clay seal materials shall be classified in accordance with ASTM D2487.

18.4.1.7 Strutting for Composite Concrete/SPCMP Structure

For composite concrete/SPCMP structures strutting and scaffolding shall be supplied and installed by the Contractor as shown on the Drawings.

18.4.1.8 Installation Tolerances

The shape of CMP and SPCMP structures shall be within 2% of design dimensions during all stages of the work and at construction completion.

18.4.2 Trenchless Installation of Welded Steel Pipe

18.4.2.1 General

Further to the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, installation shall not begin until the Contractor has fulfilled the following requirements:

- All required submittals have been completed by the Contractor and reviewed and accepted by the Department Representative; and
- The Contractor has submitted all required notifications to all utility companies and has requested and received all required permits.

The Contractor shall notify the Department Representative not less than 15 days before beginning any excavation.

The Contractor shall install the steel pipe to the lines and grades as shown on the Drawings and as determined by the Department Representative.

Work shall be completed in accordance with the reviewed and accepted shop drawings.

Work shall be completed in a manner that does not damage the pipe or obstacle being crossed. In the event a section of pipe is damaged during the installation, the Contractor shall immediately inform the Department Representative and allow the Department Representative to visually inspect the damaged pipe section. Upon approval from the Department Representative, the Contractor shall temporarily repair the damaged section and shall advance the damaged section through to the retrieval shaft for removal from the pipe string. Damaged pipe shall not be used in the work unless permitted in writing by the Department Representative. Costs of replacement, repair, or installation of a new pipe shall be completed at no additional cost to the Department.

All excavated materials shall be completely contained when stockpiled on site and shall be disposed of by the Contractor at a landfill licenced to accept. The Contractor shall immediately clean up any spills.

During the installation of the pipe, the Contractor shall inspect the ground surface and excavation face. If voids are found or created by over-excavation/sloughing, the Contractor shall immediately notify the Department Representative. The Contractor shall provide a plan for remediation and protection of the obstacle being crossed.

Maximum grouting pressures shall not result in ground surface heave or adverse displacements of the pipe, shaft, or excavation support.

18.4.2.2 Excavation

The Contractor shall stake the location, elevation and excavations for culverts in accordance with the contract documents. The Contractor shall notify the Department Representative a minimum of 72 hours in advance to facilitate acceptance. The Contractor shall carry out excavation in accordance with the contract documents and to the lines and grades staked and accepted by the Department Representative.

During construction, the Contractor may be required to provide a temporary channel diversion outside the limits of the culvert. The location of the diversion and the method of construction is subject to the Department Representative's acceptance.

Excavations shall be dewatered to the bottom of the excavation and remain dewatered until all backfilling is completed in a manner acceptable to the Department Representative.

18.4.2.3 Installation by Pipe Jacking, Auger Boring, Pipe Ramming, or Pilot Tube Guided Boring

The Contractor shall complete installation in accordance with industry good practices as outlined in Subsection 18.3.1, Standards.

Grout shall be injected using pressures that will not cause damage to the pipe.

The Contractor shall be responsible to provide survey control to ensure the horizontal and vertical alignment is maintained to within a 50mm tolerance.

The Contractor shall ensure the pipe is handled in accordance with the manufacturer's recommendations during transportation, storage, handling, and bracing. The Contractor shall ensure proper bracing and support are provided during placement of the pipe onto the guide rails or jacking frame.

If a jacking method is chosen, the Contractor shall ensure the jacking frame and intermediate jacking stations are capable of uniformly distributing axial forces and minimizing eccentric loading that may arise from the jacking process to the pipe. A properly designed thrust ring shall be used to prevent damage to the pipe. All procedures shall follow recommendations of the pipe and equipment manufacturer and reviewed and accepted by the Department Representative.

If a ramming method is chosen, the Contractor shall ensure the ramming assembly includes the use of proper cone adapters to properly distribute the forces exerted on the pipe during the installation. All procedures shall follow recommendations of the pipe and equipment manufacturer and be reviewed and accepted by the Department Representative.

In the event the pipe installation does not meet the specified tolerances for line and grade, the Contractor shall correct the installation including any necessary redesign of the pipeline or structures and acquisitions of necessary land agreements, if required. Corrective work shall be completed at no additional cost to the Department and is subject to the approval of the Department Representative.

18.4.2.4 Installation Completion

The Contractor shall remove shaft / thrust walls and any associated structures. Removal must be adequate to allow construction of proposed tie-ins.

The Contractor shall remove all foreign material from the pipe and related appurtenances.

The Contractor shall provide final inspection and construction completion documentation in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

The final inspection and submission of Letters of Assurance, Record Drawings, and other deliverables in accordance with Section 27 will be considered hold points.

18.4.2.5 Installation Tolerances

The pipe shall be free from visual defects, damage, or excessive deflection. The Contractor shall repair any defective joints, pipe sections or fittings.

Unless otherwise stated on the drawings the installation shall be maintained within the following tolerances:

- Alignment (Note that this specification covers bridge-size culverts with an equivalent diameter of 1500 mm or greater, the tolerances for smaller pipes are provided for the case they are needed.)
    - For pipes 900 mm and smaller, maximum deviation from line is 150 mm.
    - For pipes 1050 mm and larger, maximum deviation from line is 50 mm per 300 mm of pipe diameter.
- Grade
    - The pipe invert elevation shall not deviate from the design elevation by more than 20 mm plus 10 mm per 300 mm of pipe diameter.

The Contractor shall provide survey documentation to demonstrate the installation was completed as shown on the design drawings to the specified tolerances.

18.5 Concrete Work

Where detailed and specified, the concrete work shall be constructed as shown on the Drawings and in accordance with Section 4, Cast-In-Place Concrete and Section 5, Reinforcing Steel.

18.6 Substrate Holders

Substrate holders shall be installed as shown on the Drawings and be fabricated in accordance with the applicable sections of the specified Standard Specifications for Bridge Construction .

18.7 Heavy Rock Riprap

Heavy rock riprap, including non-woven geotextile filter fabric, shall meet the requirements of Section 10, Heavy Rock Riprap and shall be placed as shown on the Drawings.

18.8 Measurement and Payment

18.8.1 CMP and SPCMP Structures

Payment for the following items will be made at the unit prices or lump sum prices bid:

- Traffic Accommodation or Detour Road - Construct and Maintain;
- Demolition, Disposal and Salvage of Existing Structure;
- Excavation;
- SPCMP – Supply;
- CMP with couplers – Supply;
- Backfill – Crushed Aggregate;
- Backfill – Non-Granular;
- SPCMP – Assembly;
- CMP – Assembly;
- Concrete End Treatment;

- Reinforcing Steel;
- Concrete;
- Substrate Holders;
- Heavy Rock Riprap;
- Miscellaneous Iron;
- Guardrail; and
- Roadway Work.

Such payments will be full compensation for all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

Unit price payments will be based on actual quantities acceptably completed and remaining in the Work, as determined by the Department Representative.

Payment for "SPCMP – Supply" or "CMP with Couplers – Supply" will be made to a maximum of 60% of the lump sum or unit price bid once the materials have been acceptably supplied and delivered to the project site. The remaining 40% of the lump sum or unit price bid will be made once the structure has been acceptably backfilled and installation tolerances have been measured, reviewed and accepted by the Department Representative.

All costs associated with the supply and installation of geotextile filter fabric, when specified, will be considered incidental to the Work, and no separate or additional payment will be made.

All cost associated with water management will be considered incidental to the Work, and no separate or additional payment will be made.

18.8.2 Welded Steel Pipe Trenchless Installation

Payment for the following items will be made at the unit prices or lump sum prices bid, as applicable:

- Traffic Accommodation or Detour Road - Construct and Maintain;
- Demolition, Disposal and Salvage of Existing Structure;
- Excavation;
- Trenchless Welded Steel Pipe – Design & Supply;
- Backfill – Crushed Aggregate;
- Backfill – Non-Granular;
- Trenchless Welded Steel Pipe – Installation;
- Concrete End Treatment;
- Reinforcing Steel;
- Concrete;
- Substrate Holders;
- Heavy Rock Riprap;
- Miscellaneous Iron;
- Guardrail; and
- Roadway Work.

Such payments will be full compensation for all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

Unit price payments will be based on actual quantities acceptably completed and remaining in the Work, as determined by the Department Representative.

Payment for "Trenchless Welded Steel Pipe – Design & Supply" will be made to the lump sum or unit price bid for each culvert structure, and will be full compensation for the proprietary structure design; supply and fabrication; inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; and assembly if required; including all labour, equipment, tools and incidentals necessary to complete the work in accordance with the Contract and to the satisfaction of the Department Representative.

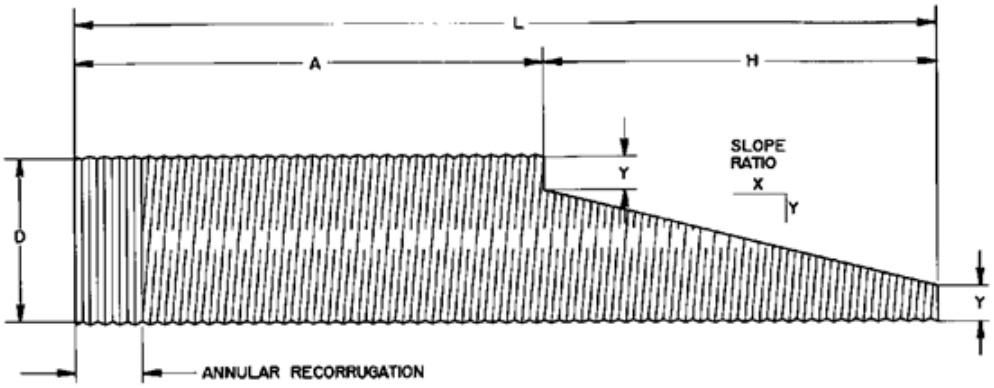
Payment for "Trenchless Welded Steel Pipe – Installation" will be made to the lump sum or unit price bid for each culvert structure, and will be full compensation for the proprietary structure documentation; installation of Welded Steel Pipe; excavation, preparation, shoring, dewatering, and base stabilization of any shafts, pits, or portals necessary to facilitate the installation of Welded Steel Pipe; and shaft, pit, or portal backfill and site restoration; and site restoration; including all labour, equipment, tools and incidentals necessary to complete the work in accordance with the Contract and to the satisfaction of the Department Representative.

All costs associated with the supply and installation of geotextile filter fabric, when specified, will be considered incidental to the Work, and no separate or additional payment will be made.

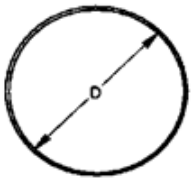
All cost associated with water management will be considered incidental to the Work, and no separate or additional payment will be made.

Figure 18-2 Details of Standard 2:1 Sloped End Sections for CMP Round Culverts

TABLE A
DETAILS OF STANDARD 2:1 SLOPED END SECTIONS
FOR CSP ROUND CULVERTS



INSIDE DIAMETER "D" mm	SLOPE RATIO X:Y	"Y" mm	"A" m	"H" m	INVERT LENGTH OF SLOPED END SECTION "L" m
1200	2:1	150	4.2	1.800	6.0
1400	2:1	200	4.0	2.000	6.0
1600	2:1	200	3.6	2.400	6.0
1800	2:1	300	3.6	2.400	6.0
2000	2:1	300	5.2	2.800	8.0
2200	2:1	300	4.8	3.200	8.0
2400	2:1	400	4.8	3.200	8.0
2700	2:1	400	6.2	3.800	10.0
3000	2:1	500	6.0	4.000	10.0
3300	2:1	500	5.4	4.600	10.0
3600	2:1	600	5.2	4.800	10.0



SECTION

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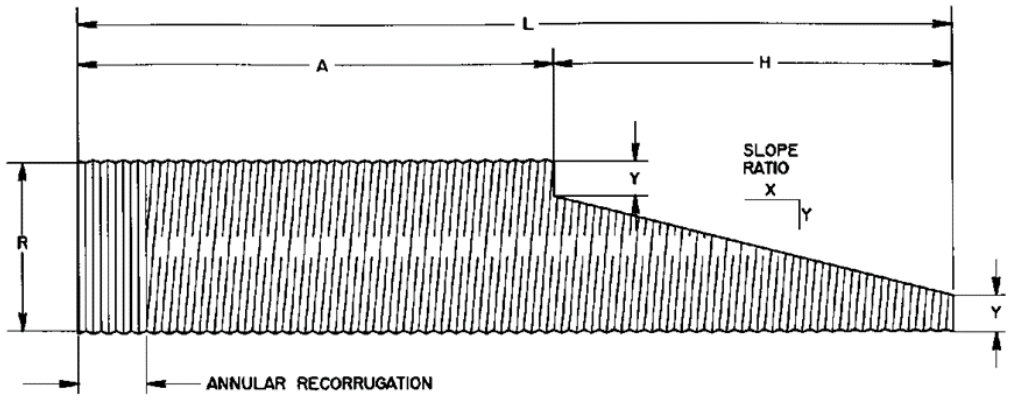
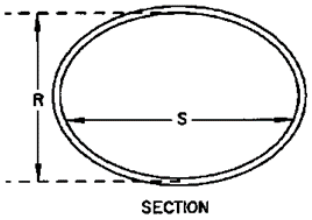
Figure 18-3 Details of Standard 2:1 Sloped End Sections for CMP Arch Culverts

TABLE B
DETAILS OF STANDARD 2:1 SLOPED END SECTIONS
FOR CSP ARCH CULVERTS





EQUIVALENT INSIDE DIAMETER "D" mm	SPAN "S" mm	RISE "R" mm	SLOPE RATIO X:Y	"Y" mm	"A" m	"H" m	INVERT LENGTH OF SLOPED END SECTION "L" m
1200	1390	970	2:1	150	4.660	1.340	6.0
1400	1630	1120	2:1	200	4.560	1.440	6.0
1600	1880	1260	2:1	250	4.480	1.520	6.0
1800	2130	1400	2:1	300	4.400	1.600	6.0

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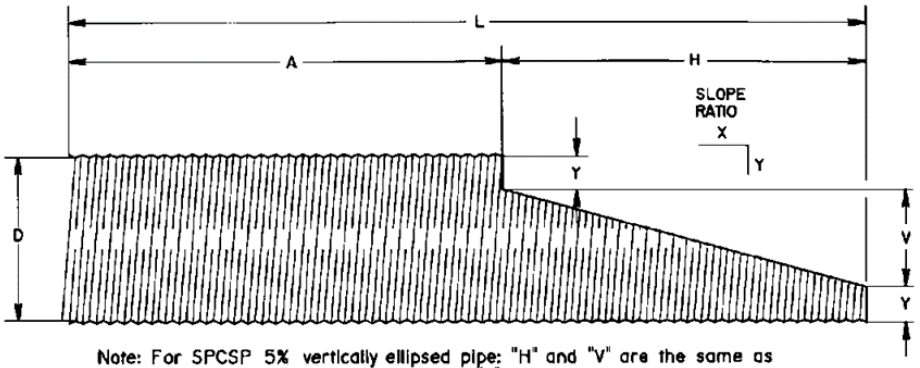
Figure 18-4 Details of Standard 2:1 Sloped End Sections for SPCMP Round Culverts

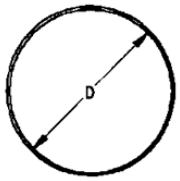
TABLE C

DETAILS OF STANDARD 2:1 SLOPED END SECTIONS FOR SPCSP ROUND CULVERTS



Note: For SPCSP 5% vertically ellipsed pipe: "H" and "V" are the same as for a round pipe of equivalent diameter; "Y" is variable with the increase in rise.

INSIDE DIAMETER "D" mm	SLOPE RATIO X:Y	"Y" mm	"H" m
1500	2:1	293	1.828
1660	2:1	373	1.828
1810	2:1	295	2.440
1970	2:1	375	2.440
2120	2:1	298	3.048
2280	2:1	378	3.048
2430	2:1	453	3.048
2590	2:1	533	3.048
2740	2:1	455	3.658
3050	2:1	610	3.658
3360	2:1	765	3.658
3670	2:1	920	3.658
3990	2:1	1080	3.658
4300	2:1	1235	3.658
4610	2:1	1390	3.658
4920	2:1	936	6.096
5230	2:1	1091	6.096
5540	2:1	1246	6.096
5850	2:1	1095	7.320
6160	2:1	1250	7.320
6470	2:1	1405	7.320
6780	2:1	1560	7.320
7090	2:1	1715	7.320
7400	2:1	1870	7.320
7710	2:1	2025	7.320
8020	2:1	2180	7.320



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SECTION 19 PAINTED ROADWAY MARKINGS

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19.5 Payment 19–1

19.1 General

This specification is for the supply of all painting materials and the painting of adjacent roadway markings on bridge decks and approach roadways at the immediate bridge location. The supply and application of painted roadway markings, including sampling, quality control and quality assurance, shall be in accordance with the Specifications for Highway Construction, Edition 7, Division 8 Miscellaneous Construction, Section 1, Supply and Application of Painted Roadway Markings, except as stated below. The term Engineer in the Specifications for Highway Construction shall be replaced with Department Representative.

19.2 Materials - Paint and Glass Beads

The Contractor shall supply paint and glass bead materials that are on Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and have been reviewed and approved by the Department Representative.

The Contractor shall advise the Department Representative of any change in paint formulation. Paint shall not be diluted or mixed with a different formulation or with any other material without the specific acceptance of the Department Representative.

19.3 Protection of Bridge Structure

The Contractor shall take due precautions to avoid damaging or disfiguring any portion of the bridge structure. The Contractor shall be extra diligent during painting procedures to negate spatters, overspray, splashes or smirches of paint or associated paint materials, and damages caused by fuel or lubricants used with their equipment.

19.4 Application

The Contractor shall paint lane lines, continuity lines, edge lines and directional arrows or dividing lines on the approach roadway and bridge deck to restore the painted markings as existed prior to the construction work, as shown on the Drawings, or as specified.

Construction and public traffic shall not be permitted to travel on the painted markings until after the paint has cured sufficiently to prevent damage or pickup.

19.5 Payment

All costs associated with the application of painted roadway markings, including the supply of materials, manufacturer's quality control test results, and quality assurance samples requested by the Department Representative for testing, will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 20 DECK OVERLAYS AND REHABILITATION OF CONCRETE COMPONENTS

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20.1 General

This specification is for concrete deck overlays and the rehabilitation of concrete components. The Work shall be completed in accordance with the requirements of these specifications, as shown on the Drawings, Section 4, Cast-In-Place Concrete, Section 5, Reinforcing Steel, and as described in the Special Provisions of the Contract.

The Work shall be completed in stages such that the lane(s) open to the travelling public have a finished roadway surface (existing or new) at all times.

Details of proposed material disposal locations shall be submitted to the Department Representative for review and acceptance prior to disposing of materials.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

20.2 Traffic Accommodation

Traffic accommodation shall be as described in the Special Provisions of the Contract.

Safety and/or bridge barrier systems shall be installed such that the travelling public is separated from the work area. The safety and/or bridge barrier system shall be reviewed and accepted by the Department Representative prior to commencement of the Work.

20.3 Surface Preparation for Deck Overlay Concrete

20.3.1 General

Surface preparation includes all work necessary to prepare the bridge for deck overlay concrete placement. This work includes, but is not limited to, the following:

- Surface removal;
- Removal and disposal of existing concrete paving lips, as applicable;
- Concrete repairs, including partial and full depth repairs;
- Abrasive blasting of concrete surfaces to be overlaid; and
- Removal and reinstallation of bridgerail, as required, to accommodate screed guide rails.

Jack hammers heavier than nominal 14 kg class and chipping hammers heavier than nominal 7 kg class shall not be used for concrete removal.

20.3.2 Surface Removal

Surface removal shall be completed in stages such that the lane(s) open to the travelling public have a finished roadway surface (existing or new) at all times.

The Contractor shall complete surface removal to the depth(s) shown on the Drawings or as described in the Special Provisions of the Contract. The Contractor shall submit details of their proposed surface removal methods to the Department Representative for review and acceptance a minimum of 1 week prior to the scheduled commencement of the work.

Surface removal shall be carried out as close as practical and without causing damage to all curbs, medians, barriers, drains, deck joints, and other bridge components. Hand operated chipping tools shall be used in these areas to complete removal. Concrete curb and deck joint paving lips within the limits of the surface removal area shall be removed, including any reinforcing steel projecting into these components unless otherwise indicated on the Drawings. For bridges that do not have formal deck joints at the abutments, the Contractor shall saw cut through the full depth and width of the wearing surface at both ends of the bridge or at the transition paving limits prior to commencing removal operations.

When the specified removal depth includes more than 5 mm of concrete removal and cold milling methods are proposed by the Contractor, small milling machines having a maximum removal width of 1.2 m shall be used. Monitoring and making adjustments to the removal depth shall be carried out by the Contractor on an ongoing, as required basis to ensure an accurate depth of material removal is maintained throughout the milling. If the Contractor removes material in excess of 5 mm from that specified without prior approval from the Department Representative, the costs associated with the additional material replacement quantities shall be at the Contractor's expense.

The Contractor shall remove milling debris from behind the cold milling machine and clean the milled surface on a continuous basis, as close to the milling machine as is safely practicable. Debris removal and surface cleaning details shall be included in the Contractor's proposed surface removal method submission.

Reinforcing steel or other bridge components damaged as a result of the Contractor's surface removal methods shall be repaired or replaced, as determined by the Department Representative, and at the Contractor's expense.

Upon completion of surface removal operations, including thorough cleaning and drying of the deck surface and removal of all equipment, the Department Representative will inspect the deck surface and identify areas of unsound concrete to be repaired. Repairs shall be carried out in accordance with Subsection 20.4, Concrete Repair.

20.3.3 Deck Surface Abrasive Blasting

Prior to deck overlay concrete placement the Contractor shall abrasive blast the concrete surfaces that will receive deck overlay concrete including, the vertical faces of curbs, medians barriers, or parapets up to a height equal to the overlay thickness. Shielding, acceptable to the Department Representative, shall be provided to prevent dust, debris and/or blasting spoil from crossing into open travel lanes.

Concrete surfaces that have been cold milled, micro milled, bushhammered, or scabbled shall be abrasive blasted to a concrete surface profile (CSP) 9 or 10. Concrete surfaces that have a Class 4 or Class 5 concrete surface finish shall be abrasive blasted to a CSP 3 or 4. Concrete surface profiles shall be uniform and in accordance with the International Concrete Repair Institute (ICRI) Guideline No. 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

After abrasive blasting, the Contractor shall clean the deck surface to the satisfaction of the Department Representative such that it is free of all abrasive material, dust and other contaminants. The Contractor shall be responsible for maintaining the cleaned deck surface in an acceptable condition until placement of deck overlay concrete. Additional preparation or cleaning, including abrasive blasting, that may become necessary during this period, as determined by the Department Representative, shall be carried out by the Contractor at their expense.

20.4 Concrete Repair

20.4.1 General

Concrete repairs will be classified as follows:

- Partial Depth Repair: A concrete repair that does not extend through the full depth of an element, as determined by the Department Representative; or
- Full Depth Repair: A concrete repair that extends through the full depth of an element, as determined by the Department Representative.

20.4.2 Concrete Removal

Repair areas and limits of concrete removal will be determined by the Department Representative.

The Contractor shall measure and record the existing concrete cover along the perimeter of the repair area prior to commencement of the concrete repairs. The perimeter of repair areas shall be saw cut to a depth of 25 mm. When concrete cover above the reinforcing steel is less than 25 mm, the depth of the saw cut shall be modified such that the saw blade does not come within 6 mm of the reinforcing steel. All saw cuts shall be made in neat and perpendicular lines. Saw cuts will not be required for concrete repairs that will be cast monolithically with the deck overlay concrete.

The Contractor shall remove areas of unsound or damaged concrete identified by the Department Representative. Removal methods and associated equipment shall be acceptable to the Department Representative. Jack hammers heavier than nominal 14 kg class and chipping hammers heavier than nominal 7 kg class shall not be used for concrete removal.

At partial depth repair locations, reinforcing steel shall be fully exposed, and concrete shall be removed beyond the existing reinforcing steel to a depth the greater of 35 mm or 1.5 times the maximum aggregate size of the repair material used for the partial depth repair. If deterioration extends beyond this depth the Contractor shall remove concrete to the depth determined by the Department Representative.

The Contractor shall contain all debris resulting from concrete removal. Methods of containment shall be acceptable to the Department Representative and not result in damage to the existing bridge or surrounding areas.

20.4.3 Surface Preparation of Concrete and Reinforcing Steel

Concrete surfaces and reinforcing steel within repair areas shall be abrasive blasted and the areas blown clean with oil-free compressed air. Reinforcing steel shall be abrasive blasted to a white metal finish and maintained in a condition acceptable to the Department Representative free of loose rust, contaminates, or other deleterious materials prior to the placement of repair material. Repair areas that are exposed for extended periods of time and develop unacceptable amounts of surface corrosion, as determined by the Department Representative, shall be re-abrasive blasted to the satisfaction of the Department Representative.

Additional reinforcing steel shall be installed at all locations where the existing reinforcing steel has greater than 20% section loss, or as determined by the Department Representative. Additional reinforcing steel shall be of the same type used in the original construction or a corrosion resistant reinforcing steel type acceptable to the Department Representative. Splicing and/or development requirements will be determined by the Department Representative.

Unless otherwise shown on the Drawings or as determined by the Department Representative, the Contractor shall re-establish the original design concrete cover at each repair location.

Once a prepared repair area has been reviewed and accepted by the Department Representative and prior to placement of concrete repair materials, concrete surfaces shall be saturated with clean water for a minimum period of 30 minutes. Immediately after being saturated, concrete surfaces shall be blown free of surface water and given sufficient time to become saturated surface dry prior to placement of concrete repair materials. Saturation and drying of concrete surfaces and placement of concrete repair materials shall occur in a continuous procedure that is acceptable to the Department Representative.

20.4.4 Sampling and Testing of Concrete Repair Materials

Sampling and testing of concrete and concrete patching products used for concrete repairs shall be completed in accordance with Subsection 4.9, Inspection and Testing and the following requirements:

- Compressive strength testing shall be completed for each 0.05 m^3 of concrete patching products. If the quantity of concrete product used is less than 0.05 m^3 a minimum of one compressive strength test shall be completed for each production day. Air content and slump testing will not be required for concrete patching products. Compressive strength testing of neat patching products shall be completed in accordance with CSA A3004-C2 or ASTM C109/C109M. Compressive strength testing of patching products extended with aggregates shall be completed in accordance with CSA A23.2-9C or ASTM C39/C39M; and
- Compressive strength testing shall be completed for each batch of concrete.

Concrete patching products shall meet the minimum 28 day compressive strength stated on the manufacturer's published product data sheet. Concrete shall meet the minimum specified 28 day compressive strengths for the applicable class of concrete.

20.4.5 Falsework and Formwork

Falsework and formwork shall meet the requirements of Subsection 4.10, Falsework and Formwork and this Subsection.

The formwork shall be positioned and secured to neatly restore the concrete to the existing lines. Formwork to be placed against existing concrete surfaces shall be secured with concrete screw anchors and/or concrete wedge anchors recessed a minimum of 40 mm below the concrete surface. Concrete screw anchors shall be completely removed. Cavities resulting from formwork anchors shall be repaired in accordance with Subsection 4.25.3, Class 2 Rubbed Surface Finish. The use of nails to secure formwork to previously hardened concrete surfaces will not be permitted.

Formwork shall not be hung or suspended from existing deck reinforcing steel.

20.4.6 Placement of Concrete Repair Materials

The type and proposed location of concrete repair materials shall be reviewed and accepted by the Department Representative prior to commencement of the repair work.

Concrete patching products shall be selected by the Contractor from the Alberta Transportation's Products List category of Concrete Patching Materials or a comparable product from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List. Concrete repairs using concrete patching products shall be completed in accordance with the product manufacturer's recommendations and these specifications. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

When the volume of concrete patching product required for a repair area exceeds the volume produced by three 25 kg bags, a rubber paddled mortar mixer of adequate size shall be used for mixing the concrete patching product. The use of free fall mixers will not be permitted.

Repair areas located on the deck, roof slab or approach slab surfaces shall be placed monolithically with deck overlay concrete unless otherwise reviewed and accepted by the Department Representative. Repair areas not poured monolithically with the deck overlay concrete shall be:

- Recast with a concrete patching product listed in the applicable category on Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List and extended with aggregates that meet the requirements of CSA A23.1 or ASTM C33/C33M. When the repair area is large enough such that placement of a concrete patching product becomes impractical, as determined by the Department Representative, concrete shall be used. Class C concrete shall be used for substructure elements and Class HPC for all other elements;
- Wet cured for a minimum of 7 days or until sufficient strength has been gained such that the concrete repair material is not adversely affected by subsequent placement of the deck overlay as determined by the Department Representative;
- Abrasive blasted in accordance with Subsection 20.3.3, Deck Surface Abrasive Blasting prior to placing deck overlay concrete.

When conditions do not permit a monolithic pour with the deck overlay concrete, as determined by the Department Representative, concrete repairs shall be placed to a depth such that once the subsequent overlay concrete has been placed the specified design overlay thickness is achieved.

The Contractor shall modify concurrent construction procedures, to the satisfaction of the Department Representative, to minimize effects of vibration on concrete repair materials throughout placement and the curing period. Modification of traffic accommodation requirements to reduce vibration during the placement and curing of concrete repair materials will be outlined in the Special Provisions of the Contract.

20.4.7 Concrete Repair Surface Finishes

Concrete repair shall receive the class of concrete surface finish in accordance with Subsection 4.25, Concrete Surface Finish.

20.4.8 Curing

Concrete repairs completed using concrete patching products shall be wet cured for a minimum of 7 days. Vertical surfaces of concrete repairs for substructure elements shall be form cured or wet cured for a minimum of 7 days.

Concrete repairs completed using concrete shall be cured in accordance with Subsection 4.23, Curing Concrete.

Concrete repair areas not poured monolithically with the overlay concrete shall be wet cured for a minimum of 7 days or until the concrete repair material has attained sufficient strength, as determined by the Department Representative, such that it will not be adversely affected by subsequent placement of the deck overlay.

20.5 Deck Overlay

20.5.1 General

Deck overlay concrete shall be placed, finished, and cured in accordance with the requirements of these specifications, as shown on the Drawings, and as determined by the Department Representative.

Screed guide rails shall be placed outside the area of concrete placement. The screed guide rails shall be set and secured horizontally and vertically. Hold down devices anchored into the existing concrete will not be permitted. Screed guide rails shall extend beyond the deck overlay concrete placement such that entire deck overlay can be finished with the concrete placing/finishing machine and that work bridges are in place prior to commencement of concrete placement.

Proposed longitudinal overlay construction joint locations shall be submitted to the Department Representative for review and acceptance prior to commencement of the work. Typically, joints shall be located as close to the crown as possible. Where the crown is located at or near the connection of two precast concrete girders, the longitudinal overlay construction joint shall be offset by a minimum of 300 mm from the connection.

The Contractor shall construct a bulkhead at each specified construction joint location to maintain horizontal and vertical alignments during concrete placing and finishing. The proposed formwork and methods of bulkhead construction shall be submitted to the Department Representative for review and acceptance prior to commencement of the work.

20.5.2 Concrete

Deck overlay concrete shall be Class HPC or Class HPC with steel fibres as specified in the Contract.

20.5.3 Gradeline Profiles/Dry Run

The gradeline will be designed by the Department Representative to provide a smooth riding surface for the finished overlay or ACP. The Contractor shall assist the Department Representative with profiling of the bridge deck, roof slab, approach slabs, and roadway approaches prior to and after surface removal. When developing the gradeline profiles, the Department Representative will consider such items as rideability, concrete/ACP thickness/quantity, dead load deflection and deck drainage. The design gradeline will be used to determine the overlay thickness and the corresponding height of the concrete placing/finishing machine screed above the existing concrete at each control point.

Gradeline profiles will be provided by the Department Representative using the following guidelines:

- A minimum of two parallel profile lines the entire length of the bridge for each stage of construction;
    - One profile line will be located 1 m from curb, barrier, or median traffic face;
    - One profile line will be located 0.3 m in from the opposite edge of the surface to be overlaid;
    - The stations of profile lines will be square to each other;
    - Additional profile lines will be provided as determined by the Department Representative;
- Stations will be established at 3 m intervals; and at the edges of existing deck joints to be retained and/or at new deck joint locations.

- Profiles will include a minimum of 30 m of approach roadway at each end of the bridge at 3 m intervals.
- Profile plots will be to the following scales:
    - Horizontal: 10 mm = 1 000 mm
    - Vertical: 1 mm (normal) or 1 mm = 5 mm (minimum)
- The proposed design gradeline will be a smooth line achieving a nominal overlay thickness as shown on the Drawings and as determined by the Department Representative.

Temporary fluorescent paint shall be used to mark profile locations on the existing deck surface, curbs and approaches. The markings shall be approximately 40 mm in diameter. The Contractor shall remove all deck surface temporary markings before overlay placement and all curb and approach temporary markings after the work is complete.

The Department Representative will provide the summary of the proposed overlay thickness, to the nearest mm, at each control point prior to the Contractor setting the screed guide rails. The Contractor shall be responsible for accurately setting the screed guide rails to the gradeline profiles provided by the Department Representative.

20.5.3.1 Dry-Run

The finishing machine shall be set-up to match the skew angle of the bridge, when the skew angle exceeds 15°. For skewed bridge structures on vertical curves this requirement may be modified to suit site constraints, as determined by the Department Representative.

The concrete placing/finishing machine shall be dry-run a minimum of 48 hours prior to commencement of the deck overlay concrete placement.

The concrete placing/finishing machine screed elevations and deck overlay thicknesses shall be recorded at each gradeline profile control point and submitted to the Department Representative for review and acceptance. The concrete placing/finishing machine and screed guide rails shall be adjusted such that the elevation of the concrete placing/finishing machine screed conforms to the gradeline profile control points provided by the Department Representative. Adjustments to the concrete placing/finishing machine or the screed guide rails will not be permitted after the dry-run has been reviewed and accepted by the Department Representative. If the finishing machine is adjusted for any reason after acceptance, the dry-run, including all checks, shall be repeated.

The dry-run shall be reviewed and accepted by the Department Representative a minimum of 24 hours prior to the commencement of concrete placement.

20.5.4 Cement/Silica Fume Slurry Grout

After all surface preparation has been completed, reviewed and accepted by the Department Representative, surfaces to be overlaid shall be continuously saturated with clean water meeting the requirements of Subsection 4.2.3, Water for a minimum of 3 hours immediately prior to concrete placement. Prior to the commencement of concrete placement, surfaces to be overlaid shall be blown free of water with compressed air, given sufficient time to become surface dry, and then receive a cement/silica fume slurry grout.

Slurry grout is not required for deck overlays with internal reinforcing steel bars or for concrete surfaces within partial/full depth concrete repair areas.

Slurry grout shall consist of 4% silica fume, 46% Type GU hydraulic cement and 50% sand (maximum 2.5 mm aggregate size) by weight, mixed with sufficient water to form a slurry. Slurry grout shall be mixed in a rubber paddled mortar mixer. The consistency of the mixed slurry grout shall be such that it does not run or puddle in low areas.

The slurry grout shall be applied in a thin, even coat and worked into prepared surfaces with stiff bristled floor brushes that are acceptable to the Department Representative. The rate of application shall be controlled to keep pace with the rate of concrete placement and be limited such that slurry grout is applied immediately ahead of concrete placement. In no case shall the slurry grout be permitted to dry before concrete placement.

Slurry grout shall be continuously mixed to prevent segregation and applied within 45 minutes of initial mixing.

The Contractor shall have a minimum of two rubber paddled mortar mixers on site during overlay placement.

20.5.5 Conveyance of Concrete on Deck Surface

Generally, vehicles and equipment will not be permitted directly on the prepared bridge deck surface. However, unless otherwise determined by the Department Representative and provided the deck surface is continually protected, concrete mixer trucks will be permitted onto the deck surface to discharge directly ahead of the finishing machine. Deck surface protection shall consist of plywood, heavy tarps or other protective devices that are acceptable to the Department Representative.

Deck surface protection shall be sufficient to protect the saturated surface from becoming contaminated with water, oil, spilled concrete and/or other detrimental substances. The deck surface protection shall remain in place for as long as practicable prior to air blasting, surface drying and slurry grout placement.

All costs associated with the provision of deck surface protection necessary for concrete mixer truck access will be considered incidental to the Work, and no separate or additional payment will be made.

20.5.6 Mixing Overlay Concrete

Deck overlay concrete shall be mixed at an acceptable concrete batch plant or at the bridge site in concrete mixer trucks.

20.5.6.1 Pre-bagging for Site Batching

Fine and coarse aggregates, hydraulic cement, steel fibres, if applicable fly ash and silica fume shall be measured and pre-mixed together in the proportions conforming to the Contractor's reviewed and accepted concrete mix design review letter prior to being packaged into suitable bags.

The bags shall be constructed of moisture proof material with lifting hooks or straps attached to the tops and have a discharge opening in the bottom of the bag with a minimum diameter of 460 mm. Bags shall be free of holes or tears, have fully sealed seams, and maintained in a condition acceptable to the Department Representative. Each bag shall have a minimum nominal 1100 kg capacity. Partially filled bags will not be permitted for use. Bags shall be securely closed after filling.

Materials shall be proportioned by weight. The accuracy of all weighing devices shall be such that successive quantities can be measured to within 1%. As a minimum, 1100 kg of dry materials, in the proportions outlined in the concrete mix design, shall be mixed together until the materials are fully dispersed before being bagged.

The Department Representative shall be provided full access to inspect all aspects of the mixing; including the supply of materials, drying of aggregates, proportioning the constituents, mixing, bagging and storage. The Contractor shall protect the bagged mixture from exposure to the elements during hauling and storage at the site.

20.5.6.2 Concrete Mixer Trucks and Water Supply for Site Batching

Pre-bagged deck overlay concrete shall be mixed at the bridge site in concrete mixer trucks.

The Contractor shall employ adequate equipment in order to mix concrete at a rate sufficient to ensure continuous concrete placement. A minimum of three concrete mixer trucks shall be brought to the site prior to each overlay pour and utilized in the mixing. Mixer trucks shall be revolving drum type, watertight, and constructed so that concrete can be mixed to ensure uniform distribution of materials. Materials for the concrete shall be loaded into the drum at the bridge site.

The Contractor shall provide a suitable water source or tank for the dedicated purpose of batching concrete. The water supply shall have sufficient capacity for each pour. The water supply shall be equipped with an accurate water measuring device calibrated in 0.1 litre increments.

The mixing procedure and sequence, and the mixing time shall be completed in accordance with the requirements of the reviewed and accepted concrete mix design review letter.

The water supply pipe shall be adequate to ensure that all remaining water addition into the mixer is completed within the first quarter of the mixing time and the outlet situated at a location within the mixer where the water will quickly mix with the entire batch.

The Contractor shall ensure that the full content of each pre-mix bag enters the mixer in a controlled and uniformly proportioned manner. Segregation, spillage and/or other loss of material will not be permitted. Particular care shall be taken to avoid the loss of cement and silica fume and increases in water to cementitious material ratio will not be permitted.

The Contractor shall maintain the mixers in good condition at all times while the work is being carried out. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar. Mixer blades which are bent or worn to the point that mixing efficiency is adversely affected shall be repaired or replaced. Concrete mixers leaking mortar or causing waste of materials through faulty charging shall be removed from service or until the equipment has been repaired to the satisfaction of the Department Representative.

The Contractor shall not load concrete mixers with more than 3 m^3 or 85% of the concrete mixer's rated capacity. The Contractor shall provide the manufacturer's certification of the mixing capacity for each concrete mixer upon request by the Department Representative. Concrete mixers shall only be operated at the speeds recommended by the manufacturer.

The Contractor shall record the bag production dates/numbers and test the air content, slump, and temperature of each batch at the mixing site. Results of all tests shall be provided to the Department Representative. In the case of an unacceptable result, the Contractor will only be allowed to adjust the quantities of superplasticizer and air entraining agent. Adding additional water to the batch will not be permitted. All batch adjustments shall be completed at the batching site and will not be permitted on the deck or at the discharge area. The Department Representative reserves the right to reject any batch in the event of confirmed unacceptability, and to require immediate removal of any concrete from a rejected batch that may have already been placed.

Concrete shall be discharged within 70 minutes after initial introduction of water to the pre-mixed material.

Discharge chutes shall be kept clean, free from hardened concrete, and wetted down prior to use. After each batch is discharged, the drum shall be thoroughly cleaned and excess water removed before a subsequent batch is mixed.

20.5.7 Inspection and Testing

Deck overlay concrete shall be sampled, inspected and tested in accordance with Subsection 4.9, Inspection and Testing.

20.5.8 Concrete Placement

20.5.8.1 General

The Contractor shall carry out their concrete placement in such a manner that smooth riding surfaces within the tolerances specified in Subsection 4.16.6, Surface Defects and Tolerances, are achieved.

The Contractor shall modify concurrent construction procedures, to the satisfaction of the Department Representative, to minimize effects of vibration during concrete placement and throughout the curing period. Modification of traffic accommodation requirements to reduce vibration during the placement and curing of concrete will be outlined in the Special Provisions of the Contract.

Lighting shall be provided in front and behind the placing/finishing machine and along the length of each curb and/or barrier. Additional portable tower light plants shall be placed at each end of the bridge and at the concrete testing area. Details of all proposed lighting and associated equipment shall be submitted as part of the Contractor's deck overlay procedure to the Department Representative for review and acceptance prior to commencement of the work.

Concrete shall be placed in such a manner that segregation of materials does not occur. The concrete finishing machine shall meet the requirements of Subsection 4.16.1, General. Concrete placement shall be carried out in a continuous procedure for the duration of the pour. No more than 5 minutes, or a period of time acceptable to the Department Representative, will be permitted to elapse between placement of consecutive batches. The width of the initial overlay section placed shall extend to the reviewed and accepted longitudinal construction joint location. Subsequent adjacent deck overlay concrete placement shall not occur until the initial concrete placement has cured a minimum of 72 hours, or as determined by the Department Representative.

In the event of concrete placing/finishing equipment breakdown or disruption to concrete delivery that results in a 60 minute or more delay, concrete placement shall be discontinued and may not resume for a minimum period of 12 hours, or as determined by the Department Representative. Concrete placement may resume on a subsequent section of the bridge deck provided a gap of a length sufficient for the finishing machine to clear the previously placed concrete is left between the two sections. Prior to continuing concrete placement at a discontinued overlay section, the Contractor shall saw cut a straight, vertical construction joint to a depth of the deck overlay. Material beyond the saw cut shall be removed and disposed of. The concrete surfaces where deck overlay concrete is removed and vertical faces of saw cut joints shall be abrasive blast cleaned in accordance with Subsection 20.3.3, Deck Surface Abrasive Blasting and to the satisfaction of the Department Representative. Concrete shall be placed in a gap section between 12 and 36 hours after suspension of the pour at the affected section.

20.5.8.2 Surface Texture

Deck overlay concrete shall receive a Class 6 surface finish when the overlay concrete is the final wearing surface or a Class 4 surface finish where a waterproofing membrane will be applied. Following surface texturing of a Class 6 surface finish, a 400 mm wide strip of deck overlay concrete adjacent to the curb or barrier shall be floated smooth and the surface left closed.

20.5.8.3 End of Deck Overlay Concrete

Concrete overlays shall terminate at deck joints or locations determined by the Department Representative. At locations where an overlay does not terminate at a deck joint, the overlay shall be extended for a distance of 300 mm beyond the required end of the overlay to a transverse bulkhead. After adequate curing time, the 300 mm over pour shall be saw cut, material removed and disposed of, and the remaining surface prepared to the satisfaction of the Department Representative.

All costs associated with installation of the bulkhead; saw cutting; and removal and disposal of concrete over pour areas will be considered incidental to the Work, and no separate or additional payment will be made.

20.5.8.4 Longitudinal and Transverse Deck Overlay Construction Joints

The vertical concrete surfaces of deck overlay concrete construction joints between stages shall be prepared by abrasive blast cleaning to the concrete surface profile specified in Subsection 20.3.3, Deck Surface Abrasive Blasting.

The top concrete edge of second stage deck overlay longitudinal construction joints shall be tooled to a depth of 12 mm and a width of 3 mm. The top edge of deck overlay concrete adjacent to curbs, barriers or medians shall not be tooled. The tooled grooves shall be filled with a proven epoxy resin type gravity flow concrete crack filler listed on Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List after the specified wet cure period followed by 3 days of air drying. Prior to epoxy application, the grooves shall be blown clean to remove all deleterious materials and the concrete contact surfaces prepared in accordance with the epoxy manufacturer's recommendations. Tooled grooves shall be completely filled with epoxy material to a level equal to the adjacent concrete and may require multiple applications of epoxy.

All costs associated with constructing longitudinal and transverse overlay construction joints including abrasive blasting, groove tooling, and application of gravity flow epoxy crack filler will be considered incidental to the Work, and no separate or additional payment will be made.

20.5.8.5 Curing Concrete

Curing of overlay concrete shall be in accordance with Subsection 4.23.3, Curing Requirements for Class HPC and Class HPC with Steel Fibres.

If the Contractor's wet curing procedures are deemed deficient in any way and/or any portion of the overlay becomes surface dry during the curing period, the overlay will be rejected, as determined by the Department Representative.

20.5.8.6 Application of Sealer

The Contractor shall supply and apply a Type 1c sealer to all surface areas where a Class 6 surface finish has been applied and along floated gutter areas.

Sealer shall be applied in accordance with Subsection 4.26, Type 1c Sealer, except that sealer may be applied after the concrete has cured for a minimum of 14 days. In the event the deck overlay concrete surface becomes contaminated with dirt, debris or other deleterious material prior to sealer application, the Contractor shall clean the affected areas to the satisfaction of the Department Representative.

All costs associated with the supply and application of sealer to deck overlay areas, including cleaning as required, will be considered incidental to the Work, and no separate or additional payment will be made.

20.5.8.7 Opening to Traffic

The concrete overlay shall not be opened to traffic until the concrete has been cured in accordance with Subsection 20.5.8.5, Curing Concrete, and has reached a minimum strength of 35 MPa.

20.6 Measurement and Payment

20.6.1 Surface Removal

Measurement for payment of surface removal will be by the square metre, based on horizontal measurements to the nearest 0.1 m^2.

Payment will be made at the unit price bid for "Surface Removal" of the type specified, and will be full compensation for removal of the existing wearing surface(s) and/or concrete to the depths specified; deck surface cleaning; disposal of debris; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

20.6.2 Concrete Repairs

Measurement for payment of concrete repair areas will be by the square metre of concrete acceptably repaired, regardless of depth, measured to the nearest 0.01 m^2.

Payment will be made at the unit prices bid for "Partial Depth Repair" or "Full Depth Repair" as applicable, for the locations identified, less any applicable payment adjustments for compressive strength, and will be full compensation for the containment and removal of concrete; abrasive blasting; disposal of debris; the supply and installation of additional reinforcing steel where required; provision and removal of all formwork, scaffolding and falsework; repair material supply, placement and testing; and all labour, materials, equipment, tools and incidentals to complete the Work to the satisfaction of the Department Representative.

80% of the unit price bid will be paid once the repair materials have been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Department Representative, that the repair materials will achieve the specified strength. Initial payment will not constitute full acceptance of the repair. The remaining 20% of the unit price bid will be made once surface finishing, as applicable, has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Department Representative.

The Department Representative reserves the right to reject repair materials that do not meet the specified requirements. The Department Representative may, at its sole discretion, accept repairs that do not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Table 20-1, .

Table 20-1 Payment Adjustment Schedule

28 Day Minimum Compressive Strength	Payment Adjustment
Equal to or greater than the specified strength	Full bid price
up to 2 MPa less than the specified strength	Bid price less $50 per square metre
between 2 MPa and 4 MPa less than the specified strength	Bid price less $100 per square metre
between 4 MPa and 5 MPa less than the specified strength	Bid price less $250 per square metre
more than 5 MPa less than the specified strength	Rejected

20.6.3 Deck Surface Abrasive Blasting

Measurement for payment of deck surface abrasive blasting will be by the square metre of deck surface acceptably prepared based on horizontal measurements to the nearest 0.1 m^2. Vertical surfaces of curbs, barriers and medians will not be measured.

Payment will be made at the unit price bid for "Abrasive Blasting – Deck Surface", and will be full compensation for abrasive blasting; cleaning of blasted areas; disposal of debris; and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

All cost associated with deck surface abrasive blasting of vertical surfaces will be considered incidental to the Work, and no separate or additional payment will be made.

20.6.4 Deck Overlay Concrete

20.6.4.1 Supply of Deck Overlay Concrete

Measurement for payment for supply of deck overlay concrete will be by the cubic metre of concrete accepted, placed, and remaining in the Work; measured to the nearest 0.01 m^3.

The quantity of concrete to be paid for will be calculated by the Department Representative using the accepted dry run values and surface area overlaid. Over pour concrete will not be paid for.

Payment will made at the unit price bid for "Deck Overlay Concrete – Supply", less any applicable payment adjustments for compressive strength, and will be full compensation for the supply and delivery of the concrete to the bridge site; sampling, inspection and testing; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

The Department Representative reserves the right to reject concrete that does not meet the specified requirements. The Department Representative may, at its sole discretion, accept concrete that does not meet the specified 28 day concrete compressive strength at a reduced price. Payment adjustment may be made in accordance with Subsection 4.27.1, Compressive Strength Test Result Payment Adjustment.

80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Department Representative, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the concrete. The remaining 20% of the unit price bid will be made once the concrete surface finishing and concrete sealer application has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Department Representative.

20.6.4.2 Placement of Deck Overlay Concrete

Measurement for payment for the placement of deck overlay concrete will be by the square metre of concrete accepted, placed and remaining in the Work, measured to the nearest 0.1 m^2.

Payment will be made at the unit price bid for "Deck Overlay Concrete – Place", and will be full compensation for falsework and formwork; supply and application of water for surface saturation; the supply and application of slurry grout; concrete placement; surface finishing and curing; the supply and application of concrete sealers; and all labour, equipment, tools and incidentals to complete the Work to the satisfaction of the Department Representative.

80% of the unit price bid will be paid once the concrete has been acceptably placed and the 7 day concrete compressive strength tests indicate, in the opinion of the Department Representative, that the concrete will achieve the specified strength. Initial payment will not constitute full acceptance of the placement. The remaining 20% of the unit price bid will be made once the concrete surface finishing and concrete sealer application has been acceptably completed, and the 28 day compressive strength test results have been reviewed and accepted by the Department Representative.

The Department Representative reserves the right to reject the concrete placement where the supply or placement of deck overlay concrete does not meet the specified requirements.

All costs associated with concreting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 21 DEMOLITION, DISPOSAL AND SALVAGE OF TRANSPORTATION STRUCTURES

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21.1 General

This specification is for the demolition, disposal and salvage of transportation structures, including but not limited to bridges, culverts, and retaining walls. The Work shall be completed in accordance with the Contract and as determined by the Department Representative.

Existing structure materials are the property of the Government of the Northwest Territories unless stated otherwise in the Special Provisions of the Contract.

Materials to be salvaged will be specified in the Special Provisions of the Contract. The location and haul requirements associated with the salvaged structures and/or materials will also be specified in the Special Provisions of the Contract.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

21.2 Demolition and Disposal

21.2.1 General

The Contractor shall remove the structure including soil and foundations in accordance with the Contract, these specifications and as determined by the Department Representative.

Unless otherwise specified in the Special Provisions of the Contract, the Contractor shall submit a detailed Demolition and Disposal Plan to the Department Representative for review and acceptance a minimum of 4 weeks prior to commencement of the work. The Demolition and Disposal Plan shall include drawings and supporting documents necessary to describe the following:

- Traffic Accommodation Strategy (TAS);
- Access to work, earth berms and work bridges;
- Temporary works and support structures;
- Temporary stabilization details and measures;
- Type and capacity of equipment;
- Sequence of operation including position of equipment and cranes;
- Position of equipment and cranes relative to substructure elements such as abutment backwalls, with details of load distribution of wheels and outriggers;
- Lifting devices and lifting points showing lifting forces;
- Demolition sequence;
- Revisions to the ECO Plan to address all environmental regulations and Contract requirements, also in compliance with the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements;
- Permitting approvals from regulatory authorities;
- Proposed disposal procedures and disposal locations;
- List of components to be salvaged, if applicable;
- Temporary supporting structures removal; and
- Site restoration.

The Demolition and Disposal Plan will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

After the Demolition and Disposal Plan has been reviewed and accepted by the Department Representative a milestone construction meeting shall occur a minimum of 1 week prior to commencement of the work. The Contractor's project manager, field superintendent, and any specialty sub-contractors shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative. A construction milestone meeting will not be required for the demolition, disposal and salvage of culverts.

When steel components containing lead paint are being demolished and deposed of, soil testing in accordance with Subsection 22.5.8, Background Contamination Levels shall be included in the Contractor's ECO Plan.

Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder, shall be an integral part of the design of the Work. The Contractor shall immediately provide the Department Representative with any documentation required by the Occupational Health and Safety Regulations upon request.

The Contractor shall continue to be fully responsible for the results obtained by the use of demolition and disposal plan, with the Professional Engineer also assuming responsibility, as the Contractor's Agent, for the results obtained.

The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of their methods or equipment, nor from completing the work in accordance with their demolition and disposal plan and these specifications. The Contractor shall not commence any Work until the Department Representative has reviewed and accepted the Demolition and Disposal Plan.

The extent of structure removal, including excavation, shall be to an elevation of 0.6 m below streambed for bridge piers and 1 m below existing ground for bridge abutments and all other bridge elements, unless otherwise specified in the Special Provisions of the Contract.

The extent of culvert removal, including excavation, shall be to the invert elevation for a width of the culvert plus 1.5 m on either side.

21.2.2 Excavation

Excavation required for the removal of structures shall be completed in accordance Section 1, Excavation.

21.2.3 Site Restoration

Upon completion of the demolition, disposal and salvage of structures, the Contractor shall restore the site to a condition similar to the natural ground, and as determined by the Department Representative. This shall include disposing of all surplus excavated materials, backfilling as required, supplying and placement of 50 mm minimum thickness of organic material on all disturbed areas and seeding.

The Contractor shall restore excavated areas to the grade shown on the Drawings, in accordance with Section 2, Backfill, and as determined by the Department Representative.

21.3 Salvage

The Contractor shall perform their Work in a manner that prevents damage to or loss of structures and/or materials listed for salvage. Where the Contractor causes damage to or loss of structures and/or materials listed for salvage, the Contractor shall repair or replace these structures and/or materials at their expense and to the satisfaction of the Department Representative.

Torch cutting to remove hardware or to dismantle structures and/or materials identified for salvage will not be permitted.

SPCMP culverts shall be dismantled to achieve lengths not exceeding 8 m. CMP culverts shall be dismantled by removing the couplers to achieve the original fabricated lengths.

Precast concrete units shall be individually removed after disconnecting the units by removing the grout from shear keys and connector pockets, connector bolts, drift pins and other hardware. Precast concrete units shall be lifted only at the designed lifting points, with the top of each unit up at all times, and shall be allowed to rest only on the designed bearing areas.

The Contractor shall transport salvaged structures and/or materials to the location designated in the Special Provisions of the Contract and in a manner that does not damage the salvaged bridge structures and/or materials in any way.

21.4 Measurement and Payment

21.4.1 Demolition and Disposal of Existing Structures

Payment for the demolition, removal and disposal of existing structures will be made at the lump sum price bid for "Demolition and Disposal of Structure" for the specified structure, and will be full compensation for demolition of the structure; breaking down, loading, hauling and disposing of debris at a location acceptable to the Department Representative; and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

The Contractor shall provide the Department Representative with written acceptance of the materials from the owner of the disposal site before payment for this Work will be made.

For bridge structures to be demolished, 50% of the lump sum price bid will be paid once the removal and disposal of the superstructure has been acceptably completed. The remaining 50% of the lump sum price bid will be made once all substructure components have been removed to the extent required, and the site has been restored to a condition acceptable to the Department Representative.

21.4.2 Salvage of Existing Materials

Payment for the removal and salvage of designated structure materials will be made at the lump sum price bid for "Salvage of Existing Materials", and will be full compensation for the removal and salvage of specified materials; loading, hauling, unloading, and stockpiling of the materials at the designated storage site(s); and all labour, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

SECTION 22 PAINTING

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22.1 General

This specification is for field painting of structural steel bridges and for shop painting of newly fabricated structural steel for bridges.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

This specification describes requirements for several different methods of preparation and for several different approved coating systems which may be applied to bridge structures. Each painting contract shall have Special Provisions and/or Drawings which delineate the applicable area of the structure and the coating system to be applied to it.

22.2 Reference Standards

- Society for Protective Coatings (SSPC) Standard Procedure for Evaluating the Qualifications of Painting Contractors, SSPC-QP1.
- SSPC Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint, SSPC-QP2.
- SSPC Guide 6, Guide for Containing Debris Generated During Paint Removal Operations.
- SSPC SP 1 Solvent Cleaning.
- SSPC SP 2 Hand Tool Cleaning.
- SSPC SP 3 Power Tool Cleaning.
- SSPC SP 5 White Metal Blast Cleaning.
- SSPC SP 6 Commercial Blast Cleaning.
- SSPC SP 7 Brush-Off Blast Cleaning.
- SSPC SP 10 Near-White Blast Cleaning.
- SSPC SP 12 Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Re-coating.
- SSPC AB1 Mineral and Slag Abrasives.
- SSPC AB2 Cleanliness of Recycled Ferrous Metallic Abrasives.
- SSPC AB3 Newly Manufactured or Re-Manufactured Steel Abrasives.
- SSPC PA Guide No.11 Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating.
- SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges.

22.3 Contractor Qualifications

One of the following four competency levels will be specified in the Special Provisions of the Contract.

CQ1 The Contractor or painting sub-contractor must have certification in good standing with the SSPC-QP2.

CQ2 The Contractor or painting sub-contractor must have certification in good standing with the SSPC-QP1.

CQ3 The Contractor or painting sub-contractor acceptance will be based on submission of documented experience which shall include but not be limited to: the names and current contact information of owners, projects and dates of previous bridge painting projects where containment and disposal of blasting spoil was implemented, copies of any relevant environmental permits and any citations for failure to comply. A list of qualified personnel responsible for the actual paint removal and application will be required. Once accepted by the Department Representative no personnel changes shall be made without the Department Representative's written acceptance. The Department Representative will have the right to interview the owners, environmental departments and personnel listed above. Falsifying information in the submission will be grounds for disqualification of the bid.

CQ4 No specific pre-qualification requirements.

Only Contractors having the specified level of competency, at the time of tender closing will be considered acceptable.

22.4 Materials

22.4.1 Supply

The Contractor or painting sub-contractor shall supply all materials to satisfactorily complete the work, as reviewed and accepted by the Department Representative.

22.4.2 Blasting Media

Contractors may choose the type of abrasive intended for use, taking into consideration the abrasive disposal and worker's health implications of each type. The abrasive selected shall comply with the applicable SSPC standard.

Blasting grit shall be free of corrosion producing contaminates and shall be free of any moisture, oils, greases or other elements which will reduce the adhesion of paint coatings. The blast cleaning abrasive used shall produce the minimum surface profile required by the paint manufacturer.

The use of pre-treatment coatings, blasting media additives or treatment of blasting spoil prior to, or subsequent to, disposal must be reviewed and accepted by the Department Representative.

22.4.3 Paint

The Contractor shall select an approved product from the Alberta Transportation's Products List Bridge Coating Systems – Paint or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List. The paint system shall be from the category specified in the Special Provisions of the Contract. The material data sheets and material safety data sheets (MSDS) of the chosen paint system shall be submitted with the Contractor's work proposal. A single paint system shall be used throughout the entire project unless specified otherwise. The Contractor shall not change to another paint system once the initial paint system has been applied to any portion of the structure.

The paint shall be delivered in sealed, original, labelled containers bearing the manufacturer's name, type of paint, brand name, colour designation, batch number and instructions for mixing and/or reducing.

For each batch of paint used on the project, the Contractor shall have an independent laboratory carry out quality control tests for colour, gloss and formulation. The results shall be submitted to the Department Representative for review and acceptance a minimum of 2 weeks prior to the commencement of painting. No paint shall be applied to the structure until quality control test results have been reviewed and accepted by the Department Representative.

Colour testing for the mixed top coat shall be carried out in accordance with ASTM D2244 with a CIE 1976 L*A*B, 2 degree observer, and a D65 illuminate.

Gloss testing for the mixed top coat shall be carried out in accordance with ASTM D523 at 60 degrees.

Infrared Spectroscopy (IR) shall be conducted on all individual components of the paint system prior to mixing, to confirm that the formulation conforms to that which was originally approved. A minimum of 32 scans shall be taken with a Fourier transform infrared spectrometer between 4000 and 400 wave-numbers (CM-1) using the salt plate sandwich technique. The salt plate may be made from potassium bromide for non-aqueous paints. If the formulation contains water; appropriate, non-water soluble plates shall be used. Plate material shall be reported with each individual spectrum. The spectra shall be taken of vehicle portion of the coating without the pigment. For single component materials, a representative sample of the material shall be centrifuged to remove pigment and then analyzed. For plural component materials, each of the individual components shall be centrifuged to remove pigment and then analyzed separately. IR analysis of the mixed components is not required. The IR plots shall be completed with transmittance (0 – 100%) on the y-axis and Wave-numbers (4000 – 400; non-linear) on the x-axis. All peaks shall be labelled with the corresponding wave-number. The spectra shall be taken such that the largest peaks are at 50 – 0%T and the baseline is greater than 80%T. Materials with IR plots indicating a change in formulation from that which was originally qualified will be rejected.

Each batch of paint may be subjected to additional quality assurance testing by the Department Representative.

When requested, the Contractor shall provide 4 x 250 ml samples of paint from a pail or barrel chosen by the Department Representative. Samples shall be placed in suitable new, clean, metal containers; and sealed to avoid contamination of the paint.

22.5 Environmental Considerations

22.5.1 General

Environmental requirements shall be in compliance with the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements.

22.5.2 Emission Levels

The percentage of blasting spoil that must be recovered and the Class of containment required shall be as specified in the Special Provisions of the Contract and detailed in the SSPC Guide 6.

The method of monitoring emissions from the enclosure and associated acceptance criteria required will be specified in the Special Provisions of the Contract. The method of monitoring shall be in accordance with Subsection 5.5 of the SSPC Guide 6.

22.5.3 Environmental Requirements

The Contractor shall ensure that existing paint being removed, and any abrasive material used to accomplish the removal, is contained and properly and safely disposed of in accordance with the applicable laws and regulations.

The Contractor shall comply with all Federal, Territorial, and Municipal, air, soil and water contamination control regulations, when cleaning and repainting the structural steel and when disposing of any waste generated, including preparing a Waste Management Plan when required. These specifications set forth minimum requirements necessary to protect the environment. The Contractor shall perform additional work to modify containment or disposal procedures to ensure compliance with all applicable laws, regulations, and guidelines, including approvals for the disposal of any hazardous wastes.

22.5.4 Fish Habitat

When working on structures over water inhabited by fish the Contractor shall conform to the requirements of federal and territorial regulations, and a fish and fish habitat protection plan will be reflected in the ECO Plan.

22.5.5 Blasting Spoil Recovery

The containment system for the blast cleaning and painting shall be installed such that the minimum specified percentage of the blast spoil and paint removed is contained, as listed in the Special Provisions of the Contract.

22.5.6 Protection of Property

During cleaning and painting procedures, the Contractor shall take necessary precautions to fully protect the environment, the workers, traffic, parked vehicles, adjacent property, and other portions of the structures from damage caused by cleaning debris, blast cleaning materials, dirt, dust, equipment oils, solvents, acids, burning matter and paint drifts, drops, or spray and spatter.

22.5.7 Quality Assurance

An Environmental Auditor may be retained by the Department Representative to assure compliance with the requirements of the Environmental Permits and ECO Plan, and to monitor the performance of the containment system in particular and that of the Contractor's work, in general.

22.5.8 Background Contamination Levels

Contamination of the environment shall be minimized at all times during the Work. The Contractor's operations may also be monitored by other agencies. This includes contamination from lead paint and other contaminants occurring during the coating operations.

The Contractor shall identify locations in which to establish background soil, water/snow, and air contamination levels in their work proposal. After the Contractor's work proposal has been reviewed and accepted by the Department Representative and prior to commencement of the work, the Contractor shall collect soil, water/snow, and air samples from the project site for baseline analysis. Samples shall be collected in the presence of the Department Representative and at locations most likely affected by the work, such as at the dust collector, recycling unit, key points along the spoil material transfer lines, and spoil material storage areas. As a minimum, three samples shall be collected by the Contractor at each location and sent to an accredited laboratory approved by the Department Representative for analysis. Analysis shall be consistent with regulatory reporting requirements and results submitted to the Department Representative within 1 week of sample collection.

The Department Representative may require the Contractor to collect additional soil, water/snow, and air samples at the site for analysis during the course of the work if contamination is suspected. If requested, the Contractor shall immediately collect samples and have them analyzed at the approved laboratory. Results shall be forwarded to the Department Representative within 1 week of collecting the samples.

The Contractor shall collect samples at all established background locations once painting operations are completed and equipment is removed from the site. As a minimum, two post construction composition tests shall be completed at each background location and results submitted to the Department Representative for review and acceptance. Analysis shall be performed at the approved laboratory using the same test methods used for initial baseline analysis. If post construction analyses show that the Contractor's work has adversely affected the environment, site remediation will be required and shall be carried out to the full satisfaction of the Department Representative.

All cost associated with soil, water/snow, and air sampling including any subsequent site remediation requirements will be considered incidental to the Work and no separate or additional payment will be made.

22.5.9 Documentation

The Contractor shall summarize all environmental considerations, test results, interpretation and reporting in a report and submit to the Department Representative for review. The Contractor shall submit the initial report detailing all environmental considerations and monitoring plans at a minimum four (4) weeks prior to starting paint removal and recoating activities to the Department Representative for review and acceptance. The Contractor shall submit the final report including all test results and monitoring activities to the Department Representative no later than two (2) weeks after the final coating activities.

22.6 Permits, Licences and Approvals

The Contractor shall obtain the necessary permits, licences and approvals, and conform to all requirements of Environmental Screening Reports, Municipal bylaws, Territorial and Federal environmental protection laws, for all work carried out. The Contractor shall be familiar with and comply with all regulations, such as, but not limited to, environmental permits, and the Northwest Territories Safety Act and Occupational Health and Safety Regulations which control the exposure of workers to chemical hazards.

22.7 Work Proposal

The Contractor shall submit their work proposal to the Department Representative for review and acceptance a minimum of two weeks prior to the pre-construction meeting. The work proposal shall include, but not be limited to:

- Schedule;

- Sequence of operations;
- Traffic accommodation strategy;
- Site lay down plan including placement of equipment;
- Proposed sampling locations for establishment of background contamination levels;
- Surface cleaning strategy;
- Storage, handling and disposal of new and contaminated blasting material;
- Methods of weighing blasting material at and away from the project site;
- Method of separating hazardous and nonhazardous blasting spoil;
- Sample documentation for tracking the disposal of hazardous waste;
- The final destination of hazardous waste;
- Selected coating system from the Alberta Transportation's Products List or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List; and
- Bridge Load Evaluation Report.

The Contractor shall submit drawings detailing containment structures, scaffolding, platforms, swing stages, and attachments for the Department Representative's review and acceptance. All containment structures, scaffolding, platforms, swing stages and material collection equipment shall be designed and operated in accordance with the authority having jurisdiction. The drawings detailing containment structures, scaffolding, platforms, swing stages, and attachments will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

22.8 Work Site Health and Safety

The Contractor is fully responsible for the protection of their employees and any sub-Contractor's personnel, from exposure to lead. A qualified person must oversee and coordinate sampling and clean–up complying with health and safety procedures. Ensure to submit the Lead Project Notification form to the Chief Safety Officer prior to starting the work and coordinate sampling procedures, debris clean–ups, and repairs with applicable health and safety procedures to prevent contaminating nearby areas. Clear working procedures and Personal Protective Equipment is required as per Working with Lead Guideline Code of Practice for Northwest Territories & Nunavut and the Occupational Health and Safety Regulations.

The Contractor shall develop and implement a Risk Exposure Control Plan and a Lead Health and Safety Plan (LHASP) if any lead is present on the structure or the paint; and the Contractor shall designate a competent Health and Safety officer, to act as the primary on site monitor of the program and to ensure that the LHASP is implemented on a daily basis and that all work on the site is in compliance with the LHASP.

The Contractor shall provide shower and change facilities for the work force in accordance with governing regulations and ordinances. The facilities shall be freely available for use by all personnel associated with the Contract.

Respirators shall be furnished by the Contractor and used when such equipment is necessary to protect the health of employees. Respirators shall be donned before entering the work area and shall not be removed until the worker has left the work area or has entered a decontamination area. Selection of the respirator type shall be based on the ability of the respirator to adequately filter air which is at the maximum air-lead level monitored in the locations where the worker may be exposed.

Extra protective clothing and clean respirators shall be available at the site for use by other personnel who are directly involved in the work, including the Department Representative and official visitors to the site.

The Contractor shall supply employees, who are potentially exposed to lead, with clean, dry, protective work clothing and equipment, and with appropriate changing facilities. Appropriate protective work clothing can include coveralls or similar full body work clothing, gloves, hats, shoes or disposable shoe coverlets, face shields or vented goggles and, if applicable, blasting helmets.

22.9 Bridge Load Evaluation Report

The Contractor shall prepare and submit a Bridge Load Evaluation Report in accordance with Section 15, Load Evaluation.

22.10 Protection of Surfaces

The Contractor shall protect and maintain the painted surfaces until the Department Representative have provided written acceptance of the entire project.

The Contractor shall take due precaution against damaging or disfiguring any portion of the bridge with blast media, spatter, spray fog, splashes, smirches of paint or associated painting materials including the fuel and lubricants used with their equipment.

Tarps, polyethylene or other covering material shall be used to protect deck, sidewalks, piers, abutments, slope protection and other portions of the structure adjacent to areas being painted and subject to paint or other damage.

Any inadvertent damage or disfigurement which may occur by reason of the Contractor's operations shall immediately be repaired to the satisfaction of the Department Representative at the Contractor's expense.

22.11 Areas Not to Be Painted

The following surfaces shall not be painted unless noted in the Special Provisions of the Contract:

- Surfaces which will be cast into concrete such as the top and sides of the top flange of girders or the side of expansion joints in contact with concrete;
- Sliding metal to metal contact bearing surfaces and mating surfaces of spherical bearings;
- Galvanized surfaces; and
- Concrete surfaces adjacent to painted steel surfaces such as sidewalks and the underside of bridge decks. Where painted items such as girder flanges are cast into concrete the paint applied to the flange may overlap the concrete by up to 25 mm on condition that this shall be a uniform straight line as produced by masking the remainder of the concrete surface. Any paint inadvertently applied to the concrete shall be removed immediately by the Contractor.

22.12 Work Execution

22.12.1 Temporary Attachments

To reduce the possibility of damaging the existing bridge components and painted surfaces, any clamps or other devices attached to the structure shall be padded or designed such that they do not mark or damage the surface to which they are attached.

No welding or tack welding to the structure will be permitted.

The removal and replacement of any bolts from the structure must be acceptable to the Department Representative. No holes may be drilled into any part or component of the structure.

22.12.2 Containment System

The containment system's purpose is to prevent the debris generated during surface preparation from entering into the environment and to facilitate the controlled collection of debris for disposal.

The containment system and its operation shall meet or exceed the class of containment specified in the Special Provisions of the Contract. When abrasive blast cleaning is used to clean and prepare the steel surfaces, the Contractor shall contain the paint chips, abrasive particles, and debris resulting from the operation. The containment system includes but is not limited to, such articles as cover panels, screens, tarps, scaffolds, supports, shrouds and ground sheets used to enclose the entire work area, and equipment to clean, transport, collect, and store blast media.

The materials used for screens shall be of a commercial brand designed specifically for the purpose of containing and facilitating collection of blasting and painting debris. If woven screens are used, the material shall contain no more than 15% voids with a mesh opening not exceeding 20 mils (500 microns). If monitoring detects leakage of dust through the woven screens, exceeding the allowable, then the screens shall be replaced with ones of a tighter weave which will meet the recovery requirements. All materials used for screens shall be adequately reinforced to prevent tearing or displacement when subjected to construction, wind or other environmental loads and their related conditions. The Contractor shall supply auxiliary lighting to improve visibility where necessary within enclosures.

For bridges located over a navigable waterway the location of platforms, scaffolding, floating booms or other equipment shall not interfere with navigation.

22.12.3 Containment System Monitoring

22.12.3.1 Abrasive Blasting

The containment system shall provide emission control effectiveness such that random escapes to the environment do not exceed 3% of the work day (e.g. 15 minutes over an 8 hour work shift). Operations shall cease immediately if the limits of emission control are exceeded. An enclosure which does not meet the specified criteria shall be modified at the Contractor's expense. Blasting shall not resume until the Contractor has modified their containment system and the modifications have been reviewed and accepted by the Department Representative.

The Contractor shall maintain a documented reporting system to provide gross weights, tare of containers and the calculated weight of the material provided to and removed from the structure. The blasting spoil shall be protected from absorbing any moisture. Contaminated blasting spoil shall be in a dry condition prior to making the recovery calculation.

If the wind velocity is too excessive to effectively contain the blast debris within the enclosure, the Contractor shall suspend blast cleaning operations and protect the existing blasting spoil from the wind.

The Contractor shall take whatever measures are necessary to prevent the release of dust or spent material from the ground tarpaulins and other components of the containment enclosure during debris removal. Debris collected on temporary work platforms, ground cloths, or walls of the containment structure, shall be removed each workday with a vacuum system equipped with high efficiency particulate air (HEPA) filters adequately sized to collect all spent material.

The Contractor shall contain all debris and waste materials as described herein and shall also provide a temporary platform located directly underneath the area enclosed for surface preparation cleaning, power tool cleaning, or blast cleaning and paint application. The platform shall be adequately sized to contain and/or filter debris, wash water and paint during the cleaning or application operation. The containment enclosure shall extend down to the level of the platform and shall be secured to prevent release of other than filtered material. The surface of the platform shall be constructed to ensure collection and filtration of spent waste materials or shall be designed to collect, funnel and discharge the spent waste materials into waste containers.

The containment system must be properly maintained while work is in progress and shall not deviate from the approved working drawings without prior acceptance of the Department Representative. If, at any time during execution of the work, the containment system fails to function properly, the Contractor shall immediately suspend surface preparation until modifications can be made to correct the deficiency.

Containment meeting these requirements may not necessarily provide adequate emission control or abrasive recovery rate. The Contractor may have to provide a higher containment standard to meet these other requirements.

22.12.3.2 Water Blasting

When High or Ultra High Pressure Water Jetting is specified the filtration or collection and treatment of water used in the cleaning shall be as specified in the Special Provisions of the Contract. The recovery of a certain volume of spoil will not be specified, but the waste water may have to be filtered through a cloth system of specified porosity and when the cleaning is completed the cloth filters shall be carefully folded to contain the debris collected and shall be disposed of as outlined in Subsection 22.16, Disposal of Blasting Spoil. The Contractor is responsible to perform additional work or to otherwise modify containment or disposal procedures to ensure compliance with all applicable laws and regulations.

22.12.4 Ventilation System

The ventilation system used shall be as specified in the Special Provisions of the Contract and described in the SSPC Guide 6. The use of the minimum ventilation system as described herein does not assure control of emissions to the required level nor will it assure worker safety. Revisions to the ventilating system may be necessary and will be required to meet the health and emission requirements.

The minimum air movement specified in the Special Provisions of the Contract, for inside the Containment system may not be adequate for visibility of the work surface and may or may not be adequate for protection of the workers from health hazards such as lead. The Contractor may have to provide a higher standard of air movement to meet these requirements.

22.12.5 Assessing Emissions

Methods for Assessing the Quantity of Emissions shall be as specified in the Special Provisions of the Contract and as described in the SSPC Guide 6.

The Contractor shall have monitoring equipment to ensure that the containment is performing to the required level.

22.13 Surface Cleaning

Prior to the commencement of any surface preparation operations, the Contractor shall carry out surface cleaning on all new and existing steel, including all hardware and other miscellaneous steel components to be coated, designated to receive a coating system and adjacent surfaces that could contaminate surfaces to be prepared. Surface cleaning shall consist of the hand removal of organic materials such as bird droppings and nests and other non-structural items adhered to the steel, and bridge washing.

Oil, grease and road tar and other contaminates shall be removed manually by solvent cleaning in accordance with SSPC SP 1. Remaining areas contaminated with residual oil or grease shall be cleaned with an approved biodegradable detergent. The detergent shall be environmentally friendly and non-toxic. The Contractor shall supply copies of the MSDS for the proposed cleaning products to the Department Representative for review and acceptance prior to use.

All areas to be coated shall be washed clean of road spatter, chlorides and other contaminates using water of sufficient pressure and volume to flush the contaminants from the structure.

Areas of cleaned steel shall be tested for chloride contaminants, soluble ferrous ions and sulphate contaminants. Chloride contamination shall be tested using Quantab Method or by Kitagawa Tube. Soluble ferrous ion contaminants shall be tested using ferrous ion test strips. Sulphate contaminates shall be tested using a barium chloride optical comparator or an alternative method reviewed and accepted by the Department Representative.

Cleaning shall result in surfaces with less than 7 $\mu g/cm^2$ of chloride ion contaminant, less than 10 $\mu g/cm^2$ of soluble ferrous ion contaminant, and less than 17 $\mu g/cm^2$ of sulphate contaminant. All testing shall be carried out by the Contractor and the results submitted to the Department Representative for review and acceptance prior to commencing surface preparation operations.

Wash water shall be captured, filtered and disposed of in compliance with all applicable laws and regulations.

22.14 Surface Preparation – Abrasive Blast Cleaning

All compressed air sources shall have oil and moisture separators, attached and functional, properly designed and sized to allow delivered air at the blasting or painting nozzle to be free of oil and moisture and of sufficient pressure to accomplish the associated work efficiently and effectively. The tanks on the air compressors and the moisture separators shall, as a minimum, be drained at the end of each working shift. Prior to abrasive blast cleaning, the Contractor shall demonstrate to the Department Representative that the air is moisture free. Air driven power tools shall be properly lubricated in accordance with the respective manufacturer's instructions, but in such a manner that lubrication is not deposited onto the surface being prepared.

Blast cleaning of new and existing steel surfaces, including all hardware and other miscellaneous steel components to be coated, in preparation for painting, shall be in accordance with the SSPC Surface Preparation Standards specified in the Special Provisions of the Contract.

Surface Preparation Standard SSPC SP 6 Commercial Blast Cleaning (NACE No. 3) requires that the cleaned surface be free of all visible oil, grease, dirt, dust, mill scale, rust and paint.

Surface Preparation Standard SSPC SP 7 Brush-off Blast Cleaning (NACE No. 4) requires the removal of all loose coating, loose rust and loose mill scale. Mill scale, rust and paint are considered to be tightly adhered if they cannot be lifted with a dull putty knife.

The anchor pattern in the blasted steel shall be that specified by the manufacturer of the coating.

As work progresses a 150 mm wide strip of uncoated blasted steel shall be left between the newly coated surface and the nonblasted surfaces of the structure.

The Contractor shall grind all burrs and sharp edges to the satisfaction of the Department Representative. This requirement shall be measured using an "L" shaped metal gauge with a 1/32" (1 mm) radius at the point of intersection of the two 90° arms. The member shall require grinding if the radius touches the member when both arms are in tight contact with the surfaces of the member.

The Contractor shall prepare only as much surface as can be coated with primer the same day. If unusual circumstances occur which prevent all prepared surfaces from being primed the same day, a light blast cleaning will be required over all un-primed surfaces prior to recommencement of painting.

Care shall be exercised to prevent contamination of blast-cleaned or coated surfaces prior to over coating. Compressed air cleaning of the members before coating application will generally be accepted. At the discretion of the Department Representative, this operation may be requested in any area before the application of any coat of paint. The degree of surface preparation specified shall exist immediately prior to the coating material being applied. Paint shall be protected from contamination by blasting debris until it has cured sufficiently. Paint contaminated with blasting grit shall be removed and re-applied.

Prepared surfaces shall be kept clean at all times, before coating and between coats.

22.15 Pack Rust

Pack rust is the term used for the condition where two areas of steel have been held tightly together by rivets or bolts, and subsequent crevice corrosion has forced these areas apart with a build-up of corrosion products between them. Pack rust that forces plates or structural sections apart to form a gap of 2 mm or greater shall be cleaned to a depth of one half of the gap width, to a maximum depth of 6 mm, treated with an approved penetrant and caulked to form a water tight seal along the top edge and the two sides of the plate involved. The bottom edge or lowest edge of the plate or member shall not be caulked.

The type of penetrant and caulking used must be compatible with the paint system used and shall be applied according to the manufacturer's instructions. No penetrant or caulking shall be used which has not been accepted by the Department Representative. When only one plate edge is exposed, a fillet of caulking shall be applied when the pack rust gap is greater than or equal to 3 mm. The fillet is not required where there is no separation of the plates due to pack rust.

Regardless of whether pack rust is evident or not, all connection plates shall be treated with an approved penetrant and caulked as described. All costs associated with the penetrant treatment and caulking will be considered incidental to the Work and no separate or additional payment will be made.

22.16 Disposal of Blasting Spoil

The collection, storage and disposal of blasting residue shall be carried out in compliance with Federal, Territorial and municipal laws.

All waste residue collected during the surface preparation process shall be stored at the site in containers acceptable to the Department Representative. The waste containers shall be stored in an acceptable area and shall be protected at all times with water-proof covers. Waste residues collected and stored in the waste containers shall be sampled and tested by the Contractor in accordance with the United States Environmental Protection Agency (USEPA) Test Method 1311, Toxic Characteristic Leachate Procedure (TCLP). The test results will characterize the waste residue as a hazardous or non-hazardous material and the Contractor shall dispose of the blast residue accordingly. The representative test results, for each batch of blasting residue collected shall be provided to both the Department Representative before disposal of waste can be undertaken.

It is the Contractor's responsibility to provide documentation to the Department Representative that all hazardous waste was disposed of in conformance with all applicable regulations governing the disposal of such materials. Acceptable documentation shall consist of a certificate of disposal that will provide information such as the quantity of material, truck manifests, way bills, and other information necessary to clearly document the transportation of, and the final disposal method and disposal site used.

22.17 Priming and Painting

22.17.1 Stripe Painting

Stripe painting is a process whereby an additional layer of paint is applied to all sharp edges of the structure being painted to increase the thickness of the coating around the sharp edge. The Contractor shall apply stripe paint along all sharp changes in steel surfaces, including but not limited to, edges of flanges, stiffeners, bracing, plates, bolts, nuts, washers, rivets, plates, and sections with sharp profile. Stripe painting may be applied prior to the prime coat or after the prime coat to aid in preservation of the blast cleaned surface. Drying times and recoat conditions must be compatible with all other coats of the paint system. Paint systems using an intermediate coat shall also be stripe painted after each intermediate coat, but not after the top coat. Stripe coats when applied over the primer or intermediate coat shall be tinted to contrast the underlying coat.

22.17.2 Paint Application

Paint shall be applied in accordance with the manufacturer's instructions. When required the coating manufacturer's representative shall be available at the site, to provide guidance and assistance, as required. .

The use of thinners will only be permitted when reviewed and accepted by the Department Representative. Thinners will only be considered for use where the Contractor has CQ1 or CQ2 qualifications. Thinners shall be supplied by the manufacturer and formulated for the coat system requiring thinning. The thinner shall only be used in accordance with and within the range stated on the manufacturers' published product data sheet. If no range is stated on the manufacturers published product data sheet, the use of thinners will not be permitted.

The initial blast cleaned surface and subsequent coats of paint shall be kept free of dust, dry spray, overspray, oil and grease prior to application of subsequent coats or shipping.

The maximum and minimum recoat time for the coating system being applied shall be observed and required conditioning agents or surface roughing between coats shall be done.

Paint shall not be applied when the air and/or steel temperatures are at or below 4°C, nor when the metal has absorbed sufficient heat (above 50°C) to cause the paint to blister and produce a porous paint film, nor when it is possible the air temperature may drop below 0°C before the paint is dry. Variances from these requirements, due to paint supplier's recommendations or requirements, require the Department Representative's review and acceptance prior to usage.

Paint shall not be applied to damp or frosty surfaces, nor applied to surfaces when there is a risk of dew. Painting shall not commence unless the dry bulb temperature exceeds the wet bulb temperature by more than 5°C and the ambient temperature is rising.

Only the anticipated quantity of paint required for 1 day's work shall be opened on that day. Left over paint shall not be exposed to the atmosphere. Any paint that becomes oxidized, thickened, ropy, lumpy or dirty shall be disposed of.

The paint shall be mixed in a manner which will ensure breaking up of all lumps, complete dispersion of settled pigment, and provide a uniform composition. The paint shall be agitated often enough during application to keep the pigment in suspension.

Paint shall not remain in spray pots, painter's buckets, etc., overnight. Multi component paints which have been mixed for the duration of the manufacturer's recommended pot life shall be discarded in a safe manner.

Paint shall be safely stored by the Contractor, in a location which keeps its temperature between 10°C to 25°C.

Paint shall be applied by spraying, brushing, rolling or a combination of these methods. On all surfaces which are inaccessible for brushes or rollers and where spraying cannot be employed, the paint may be applied with sheepskin mitts specifically manufactured for this purpose.

Finish coat paint shall not be applied over wet touched up primer.

All portions of the paint system shall be within the range of film thickness(es) stated on the Alberta Transportation's Products List Bridge Coating Systems – Paint or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List. Bolts, rivets, edges of members and other changes in surface contour shall also receive the required film thickness(es).

To ensure that the proper dry film thickness (DFT) is obtained, the wet film thickness (WFT) shall be checked and recorded by the Contractor at the time the paint is applied. The minimum WFT shall be equal to the DFT divided by the percentage (expressed as a decimal) of solids in the paint used, with the result rounded up to the next full mil. Each painter shall have their own WFT gauge and complete frequent checks of the paint film as it is applied. DFT shall be determined in accordance with SSPC-PA 2 using a calibrated Type 2 constant pressure probe magnetic gauge.

22.18 Quality Control

To ensure that the work meets the requirements of these specifications, the Contractor shall have an experienced quality control person solely dedicated to actively monitoring and correcting the work of their employees whenever cleaning, surface preparation and coating application is taking place. The experienced quality control person shall be National Association of Corrosion Engineers (NACE) certified. The Department Representative will provide a quality assurance inspector to monitor and accept the work. The Contractor shall provide the quality assurance inspector and all other representatives of the Department Representative, at their request, safe free access to all areas of the work. .There shall be no application of coating materials until the cleaning, and surface preparation have been reviewed and accepted by the Department Representative. Failure to follow this requirement will necessitate the complete removal, by blast cleaning, of all coating placed over surfaces that were not reviewed and accepted by the Department Representative. Each coat must be thoroughly dry and the mil thickness of each coat accepted by the Department Representative prior to applying an additional coat.

22.19 Authority of the Department Representative

Non-compliance with any portion of these specifications, as determined by the Department Representative, will result in the Department Representative suspending the work until the infraction has been corrected by the Contractor. There will be no alteration to the specified completion date due to this suspension of the Work. Periods of work suspension will be considered active working days on site.

22.20 Defects

Painted surfaces will be rejected, if any of the following defects are identified:

- Runs, sags, holidays or shadowing;
- Evidence of poor coverage at bolts, plate edges, lap joints, crevices, pockets, corners and re-entrant angles;
- Surfaces which have been struck, scraped, spotted by rain or otherwise damaged;
- Surfaces which exhibit an objectionable texture such as orange peel, mud cracking, fish eyes, etc.;
- Insufficient joint caulking and penetrant treatment; and
- Surfaces with over spray.

22.21 Repair

Areas requiring repair shall be cleaned of all damaged paint and the system re-applied using all coats typical to the original paint system. Each coat shall be thoroughly dry before applying subsequent coats. The Contractor shall carry out all repairs to the satisfaction of the Department Representative and at no additional cost to the Government of the Northwest Territories.

Support points for work platforms or containment structures shall be painted with the accepted paint system. Work platform designs shall consider the potential to adjust touch points so coatings can be applied as work progresses. The Contractor may submit proposed alternate paint systems and application procedures for the painting of touch points, however, any proposed alternate paint systems shall be equivalent in the protection provided, expected durability and the manner in which the system ages so visual uniformity is preserved over the life of the coating. The use of alternate materials and methods for painting support points will be at the sole discretion of the Department Representative.

22.22 Site Clean-Up

The Contractor shall leave the entire site in a neat and tidy condition with all paint cans, masking materials and other debris removed from the site and disposed of in manner acceptable to the Department Representative.

22.23 5 Year Bridge Painting Warranty

The Contractor shall warranty the Work against all defects in material and workmanship for a period of 5 years. The warranty period will commence on the date of issuance of the Contract Completion Certificate . The Contractor shall execute the form entitled, “5 Year Bridge Painting Warranty”, a sample copy of which is contained in these specifications.

During the warranty period, the Department Representative will conduct yearly inspections of the coating system. A final inspection of the coating system will be carried out a minimum of 60 days prior to the expiration of the warranty period.

The coating system will be deemed to have failed when any of the following occurs:

- De-bonding or failure of adhesion of the coating either to the structural steel or lack of inter-coat adhesion;
- The appearance of any rust stains on the structure due to loss of paint or due to leaking from joints between structural members; and
- Loss of gloss or rapid change of colour of the coating.

Damage to the coating due to vehicle impact or snow removal equipment will not constitute failure of the system.

Repair under warranty shall include, but is not limited to, all permitting, approvals, traffic accommodation, containment systems, labour, materials, equipment, tools and incidentals necessary to restore the coating to a condition acceptable to the Government of the Northwest Territories and at no cost to the Government of the Northwest Territories.

Warranty repairs shall be completed within 60 days of notification or, in the event this repair work would - occur in winter weather conditions, by June 30 of the following year.

5 YEAR BRIDGE PAINTING WARRANTY

_____
(Name of Contractor)

_____
(Contract Number)

_____
(Asset ID Number and Name)

_____
(Name of Paint Manufacturer)

_____
(Paint System Name)

The undersigned party agrees to provide a 5 year warranty for the Work. The warranty period shall commence on the date of the Contract Completion Certificate is issued and shall include all labour, materials, equipment, tools and incidentals necessary to repair all defects and restore the coating to a condition acceptable to the Department Representative and at no cost to the Government of the Northwest Territories.

CONTRACTOR:

_____ _____ _____
(Name of Company Officer) (Corporate Position) (Signature of Company Officer)

_____ _____ _____
(Name of Witness) (Signature of Witness) (Date)

22.24 Shop Coating of Structural Steel for Bridges

22.24.1 Paint or Fabrication Shops

Paint shops or areas of fabrication shops where painting is to be performed shall be well lit, free of dust and drafts and maintained at the correct temperature and relative humidity for the coating system being applied.

Compressed air for cleaning and painting shall be free of moisture and oil contamination.

22.24.2 Pre-Surface Preparation

Surfaces to be coated shall free of weld spatter, welding flux and cutting slag. All sharp corners and edges shall be lightly ground to a 1 mm chamfer to break the sharp edge and all holes shall be free of burrs and cutting chips. Oil and grease shall be solvent cleaned to meet the requirements of SSPC SP 1, prior to blast cleaning in preparation for coating.

22.24.3 Abrasives

Abrasives used in shop cleaning shall be free of chlorides and other contaminants which could affect the coating being applied and shall produce the anchor pattern required by the coating system.

22.24.4 Blast Cleaning

Unless noted otherwise, all fabricated surfaces shall be blast cleaned to meet the requirements of SSPC-SP10, which is a surface free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. The surface roughness profile shall be in accordance with the manufacturer's published product data sheet.

No coatings shall be applied until the Department Representative has reviewed and accepted the cleaned surface. Surfaces which have been coated without acceptance of the prepared surface shall have the paint removed by blast cleaning and reviewed and accepted by the Department Representative prior to reapplication of coatings.

22.24.5 Masking

All areas not to be painted shall be masked prior to applying paint. This includes portions of members within 100 mm of field weld locations. Unless noted otherwise, all faying surfaces and within 75 mm of open holes shall be masked to prevent application of coating. All clip angles and other detail material shall be applied after blast cleaning to - ensure a cleaned faying surface.

22.24.6 Paint

Unless noted otherwise, shop primer shall be an inorganic zinc rich primer from the Department's Products List Bridge Coating Systems – Paint.

22.24.7 Paint Application

Paint shall be applied in accordance with Subsection 22.17, Priming and Painting.

22.24.8 Intercoat Cleanliness

The initial blast cleaned surface and subsequent coats of paint shall be kept free of dust, dry spray, overspray, oil and grease prior to application of subsequent coats or shipping.

22.24.9 Recoat Time

The maximum and minimum recoat time for the coating system being applied shall be observed and required conditioning agents or surface roughing between coats shall be done.

22.24.10 Shipping Inspection

No product is to be shipped until the Department Representative has reviewed and accepted the coating. Subsection 22.20, Defects, shall apply. Material shipped without inspection by the Department Representative, may be inspected at the receiving point with all costs of this inspection charged to the Contractor.

22.24.11 Shipping

The coating shall be protected from damage during shipping. Any coating damage during shipping shall be repaired by the Contractor in accordance with Subsection 22.21, Repair.

22.25 Measurement and Payment

22.25.1 Protection of the Environment

22.25.1.1 General

Protection of the environment consists of all required on-site protection measures, including but not limited to:

- Measurement and monitoring of background contamination levels;
- Installation, maintenance, and removal of containment measures;
- Containment, treatment and disposal of wash water;
- Removal, containment and disposal of contaminates resulting from abrasive blast cleaning and other surface preparation operations;
- Monitoring and containment of emissions; and
- Site clean-up and restoration.

All costs associated with protection of the environment associated with work carried out in a shop or fabrication facility will be considered incidental to the Work, and no separate or additional payment will be made.

22.25.1.2 Payment by Unit Price

Payment for protection of the environment will be made at the unit price bid per span for “Protection of the Environment”, and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

60% of the unit price bid will be paid once the containment structure has been installed and the Contractor is ready to commence surface preparation and painting. The remaining 40% of the unit price bid will be paid once all surface preparation and painting has been acceptably completed; all blasting spoil has been accounted for; the blasting spoil has been removed from the bridge site and the Contractor has provided the Department Representative with written acceptance of the waste materials from the owner of the disposal site; the containment structure and equipment has been removed; and the area is returned to a condition acceptable to the Department Representative.

22.25.1.3 Payment by Lump Sum

Payment for protection of the environment will be made at the lump sum price bid for "Protection of the Environment", and will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Department Representative.

60% of the lump sum price bid will be paid once the containment structure has been installed and the Contractor commences surface preparation and painting. The remaining 40% of the lump sum price bid will be paid once all surface preparation and painting has been acceptably completed; all blasting spoil has been accounted for; the blasting spoil has been removed from the bridge site and the Contractor has provided the Department Representative with written acceptance of the waste materials from the owner of the disposal site; the containment structure and equipment has been removed; and the area is returned to a condition acceptable to the Department Representative.

22.25.2 Surface Preparation and Painting

22.25.2.1 Estimated Surface Area

The Contractor is advised that the estimated quantity of surface area to be painted as specified in the Special Provisions of the Contract are approximate and are provided for bidding and payment pro-rating purposes only.

The estimated quantities are based on as-built drawings and are considered to be representative of the actual surface areas to be prepared and painted. However, the Department Representative neither implies nor guarantees the complete accuracy of these quantities. The Contractor shall satisfy himself that the estimated quantities are representative of the Work to be carried out prior to submitting a bid; and they shall have no claim against the Government of the Northwest Territories for any inaccuracies of these quantities.

22.25.2.2 Payment

Payment will be made at the lump sum price bid for "Surface Preparation and Painting", and will be full compensation for all operations necessary to clean and prepare the surfaces for the application of coatings; the treatment of pack rust; stripe painting; the supply and application of coating systems; and all labour, equipment, tools and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

Progress payments will be based on the estimated percentage of the total surface area acceptably cleaned, prepared and coated as determined by the Department Representative. Areas will not be measured for payment until all coats of the selected coating system have been applied and the areas reviewed and accepted by the Department Representative.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 23 STRUCTURAL LUMBER

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23.1 General

This specification is for the supply and treatment of structural lumber.

All structural lumber shall be graded in accordance with the National Lumber Grading Authority (NLGA) – Standard Grading Rules for Canadian Lumber (NLGA GR) and CSA O141.

All treated structural lumber shall be pressure treated in a plant/facility that is certified in compliance with the Canadian Wood Preservation Certification Authority (CWPCA).

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

23.2 Environmental Compliance

Preservatives shall comply with all environmental requirements and regulations. The Contractor shall only use preservatives permitted by the Pest Management Regulatory Agency. Treated structural lumber for use in bridges shall be treated in accordance with the most recent version of the "Best Management Practices for Use of Wood in Aquatic and Other Sensitive Environments" from the Western Wood Preservers Institute (WWPI).

Further, the work shall be in compliance with the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements.

23.3 Supply

The Contractor shall be responsible for the work of all suppliers. Contract requirements shall apply to all suppliers.

23.3.1 List of Suppliers

The Contractor shall submit a list of all suppliers, detailing their scope of work, confirmation of qualifications and quality control plan to the Department Representative a minimum of 3 weeks prior to commencement of the work.

23.3.2 Supplier's Schedule

The Contractor shall submit details of the supplier's proposed schedule to the Department Representative a minimum of 2 weeks prior to commencement of the Work.

23.4 Materials

23.4.1 General

Structural lumber shall be in accordance with this Section unless otherwise noted on the Drawings or special provisions of the Contract.

23.4.2 Grading

All structural lumber shall be graded in accordance with the National Lumber Grading Authority (NLGA) – Standard Grading Rules for Canadian Lumber (NLGA GR).

Each element shall be marked with a grade stamp from a lumber grading agency accredited by the Canadian Lumber Standards Accreditation Board (CLSAB).

Structural lumber supplied without a grade stamp, shall have a certificate from a lumber grading agency accredited by the CLSAB that verifies the grade and species. Copies of the grading certificate shall be provided to the Department Representative upon request.

23.4.3 Superstructure Elements

23.4.3.1 Strip Deck Planks

Strip deck planks shall be rough, untreated grade No. 2 and better Douglas Fir (DFir-L), graded to NLGA "Structural Joist and Planks".

23.4.3.2 Wheelguards and Guardrail Posts

Wheelguards and guardrail posts shall be rough grade No. 2 and better, Coastal Douglas-Fir graded to NLGA "Posts and Timbers".

23.4.3.3 Hand Railing & Hand Rail Posts

Hand rails shall be grade No. 2 and better, Coastal Douglas-Fir graded to NLGA, "Structural Joists & Planks, Structural Light Framing", S4S (surfaced four sides) with eased edges.

Hand rail posts shall be grade No. 2 and better, Coastal Douglas-Fir, graded to NLGA, "Structural Joists & Planks, Structural Light Framing", or "Posts and Timbers". Posts may be Rough or S4S.

23.4.3.4 Sub-deck and Other Superstructure Elements

Sub-deck and other superstructure elements such as cleats shall be rough grade No. 2 and better Coastal Douglas-Fir, graded to NLGA, "Structural Joists and Planks".

23.4.3.5 Stringers, Floor Beams, Cross-ties, and Diaphragms

Stringers, floor beams, cross-ties and diaphragms shall be rough grade No. 1 Coastal Douglas-Fir, graded to NLGA, "Beams and Stringers".

23.4.4 Substructure Elements

23.4.4.1 Abutments

Abutment caps, sub-caps (pile caps) and associated materials shall be rough grade No. 1 Coastal Douglas-Fir, graded to NLGA, "Posts and Timbers".

Sheeting material (planks) shall be grade No. 2 or better Coastal Douglas-Fir, graded to NLGA, "Structural Joists and Planks.

23.4.4.2 Piers

Pier caps shall be rough grade No. 1 Coastal Douglas-Fir, graded to NLGA, “Posts and Timbers”.

Bracing shall be rough grade No. 1 Coastal Douglas-Fir, graded to NLGA, “Structural Joists & Planks”.

Blocking and associated elements shall be rough grade No. 2 and better Coastal Douglas-Fir.

23.4.5 Hardware, Fasteners and Metalwork

All hardware, fasteners and metalwork in contact with treated structural lumber shall be hot dip galvanized to ASTM A123/A123M, ASTM A153/A153M (Class D) or ASTM A653/A653M (G185 Coating Class).

Nails, spikes and sheet metal fasteners shall be 304 or 316 stainless steel.

Malleable iron washers shall be provided under nuts and bolt heads which bear against structural lumber.

23.5 Structural Lumber Treatment

23.5.1 Conditioning

Structural lumber shall be air-seasoned and conditioned prior to treatment in accordance with CSA O80.

23.5.2 Incising

Structural lumber shall be incised on all four sides prior to treatment by a method that will provide at least the minimum penetration specified without any damage and with the least loss of strength.

23.5.3 Preservatives and Treatment

Substructure structural lumber elements shall be treated with either Creosote(CR) or Pentachlorophenol in Type A hydrocarbon solvent (Penta) in accordance with CSA O80, Category UC4.1 unless specified otherwise.

Superstructure structural lumber elements, except as noted in these specifications, shall be treated with either Creosote (CR) or Pentachlorophenol in Type A hydrocarbon solvent (Penta) in accordance with CSA O80, Category UC4.1, unless specified otherwise.

Handrailing and Handrail Posts shall be treated with Chromated Copper Arsenate, Type C (CCA), or Ammoniacal Copper Zinc Arsenate (ACZA) in accordance with CSA O80, Category UC4.1, unless specified otherwise.

Where CCA treatment of Coastal Douglas-Fir is specified it shall be in accordance with CSA O80, and the additional requirements of the British Columbia Ministry of Forests, Lands and Natural Resource Operations and Regional Development (MFLNRORD), “Interim Process Specification for CCA Treatment of Coastal Douglas-Fir Wood”.

Strip deck planks shall be untreated, unless specified otherwise.

23.5.4 Treatment at Site

Two coats of Creosote or Copper Naphthenate (CuN) shall be applied to all cuts, holes or exposed untreated wood in accordance with CSA O80.

23.6 Inspection and Testing

23.6.1 Access

The Contractor shall provide acceptable facilities for the inspection and testing of the work. The Department Representative shall have full access to all phases of the work at all times. When required by the Department Representative, the Contractor shall also provide labour for assistance in performing inspection and testing duties. The Department Representative shall be provided the time needed to complete quality assurance inspection and testing requirements, as deemed necessary. All costs and schedule impacts associated with quality assurance testing will be considered incidental to the Work and no additional or separate payment nor completion date adjustments will be made.

23.6.2 Responsibility

Quality control inspection and testing shall be the sole responsibility of the Contractor. Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant) to inspect and test structural lumber being manufactured outside the Northwest Territories and including up to 3 trips to the manufacturing facility by the Department Representative during the course of manufacturing.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work, non conforming materials, or the Contractor's proposed modifications not specified on the Drawings, shall be paid for by the Contractor. If the Department Representative, at their sole discretion, determines that the Contractor's quality control inspection and/or testing personnel are not meeting the minimum specified standards, the Contractor shall replace the personnel immediately and prior to continuing with the work.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative.

23.6.3 Quality Control at Treatment Plant by the Contractor

A quality control program shall be implemented at the treatment plant in accordance with CSA O80, CWPCA and AWPA M3. Treated products shall be inspected in accordance with AWPA M2.

The quality control program shall maintain and properly document all records of quality control inspection reports, worksheets, checklists, testing and data verification and types of treatments.

Quality control shall include plant inspection of treated structural lumber before, during and after preservative pressure treatment to ensure the final treated wood products meet these specifications.

Copies of quality control records for treatment tests shall be made available to the Department Representative upon request.

23.6.4 Testing by Independent Testing Agency Engaged by the Contractor

Quality control shall include inspection by an independent testing agency specializing in this type of Work. The independent testing agency shall be engaged by the Contractor. Quality control inspection by the independent testing agency shall be performed at the treatment plant.

The independent inspection agency shall meet one of the following requirements:

- Accreditation by the American Lumber Standard Committee (ALSC) under their treated wood program, or;
- Previous related experience acceptable to the Department Representative.

The independent testing agency and the Department Representative shall have safe access to all parts of the treatment facility and shall be supplied information and assistance as required.

The independent testing agency shall provide an inspection report that confirms the treated structural lumber conforms to CSA O80 and where applicable WWPI Best Management Practices (BMP). Inspected material meeting these requirements shall be stamped with a certification mark. Alternatively, when acceptable to the Department Representative, the independent testing agency shall provide a certificate of compliance that confirms that the inspected material has been treated in accordance with CSA O80.

Inspection reports shall indicate both the "Use Category" and the type of preservative used. Inspection reports shall be submitted to the Department Representative prior to the material being incorporated into the work.

23.6.5 Clearance to Ship

The Contractor shall provide the Department Representative with a transportation schedule for structural lumber a minimum of 72 hours prior to shipment from the manufacturing facility. Written acceptance in accordance with Subsection 23.6.6, Final Inspection, shall be provided by both the Contractor and the Department Representative prior to the commencement of shipping.

Review and acceptance at the manufacturing facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

23.6.6 Final Inspection

The Contractor and the Department Representative shall provide written acceptance of all structural lumber upon the completion of manufacturing. Review and acceptance of structural lumber by the Department Representative at the manufacturing facility will not relieve the Contractor of their responsibility to meet the requirements of the Contract.

23.7 Construction

Structural lumber shall be accurately and securely installed as shown on the Drawings.

Dogs, hooks, peavies or other equipment shall not be used on the side surfaces of treated structural lumber. All handling of treated structural lumber with pointed tools shall be confined to end grain and shall be such as to avoid damage of the original pressure treated surface.

Subject to the approval of the Department Representative, the Contractor shall repair any superficial damage of treated structural lumber by the methods outlined in CSA O80. Treated structural lumber which, in the opinion of the Department Representative, cannot be repaired by such methods will be rejected.

Minor damage to untreated lumber shall be repaired and severely damaged pieces will be rejected.

The Contractor shall accurately measure all structural lumber requiring cutting to ensure proper and adequate fitting during installation.

Structural lumber surfaces in contact shall bear evenly and fully with no shims or open joints.

Holes for bolts shall be bored with an auger to 1.5 mm (1/16") over size. Holes for drift pins shall be the same size as the pin.

23.7.1 Transportation, Handling and Storing Materials

Structural lumber shall be protected from dirt, road salt, slush or other contaminants during transportation, handling and storage.

Structural lumber that becomes contaminated with any dirt, mud, road salts, slush or other contaminates during transportation, handling, and storage shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to installation.

Structural lumber shall be transported, hauled and stored on timber blocking. Timber blocking shall be located at positions that prevents damage of the structural lumber. The ground of the storage area shall be solid and unyielding and drainage diverted away from the storage area.

23.8 Payment

Payment for structural lumber will be made at the lump sum price bid for "Structural Lumber – Supply and Manufacturing, Delivery and Installation" for the materials specified, and will be full compensation for the supply and manufacturing of structural lumber; inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; installation; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. The lump sum price bid will be paid in accordance with Subsection 23.8.1, Supply and Manufacturing, Subsection 23.8.2, Delivery, and Subsection 23.8.3 Installation.

23.8.1 Supply and Manufacturing

60% of the lump sum price bid for "Structural Lumber – Supply and Manufacturing, Delivery and Installation" will be paid once the structural lumber has been acceptably supplied; manufactured; inspected; tested; stored; and written acceptance has been provided by both the Department Representative and the Contractor. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for supply and manufacturing of structural lumber for the materials specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

23.8.2 Delivery

20% of the lump sum price bid for "Structural Lumber – Supply and Manufacturing, Delivery and Installation" will be paid once the structural lumber has been acceptably loaded; transported; hauled; unloaded; stored; cleaned and/or repaired, if required; and written acceptance has been provided by both the Department Representative and the Contractor. This payment will be full compensation for delivery of structural lumber for the materials specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. All necessary approvals and permits, will be considered incidental to the Work and no separate or additional payment will be made.

23.8.3 Installation

20% of the lump sum price bid for "Structural Lumber – Supply and Manufacturing, Delivery and Installation" will be paid once the structural lumber has been acceptably installed; and written acceptance has been provided by both the Department Representative and the Contractor. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for installation of structural lumber for the materials as specified; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

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24.1 General

This specification is for the design, supply, fabrication, erection and all associated work related to bridge support or cantilever type overhead sign structures and sign panels.

Any underground utilities located on the Drawings are approximate and are to be confirmed by the Contractor at the project site.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

Structures applicable to these specifications shall be considered proprietary structures in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, and all requirements of Section 27 shall be met, unless noted otherwise in the contract documents.

24.2 Design

The Contractor shall complete the design of overhead sign structures and panels in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, using the information contained on the Drawings and in accordance with these specifications.

The design of overhead sign structures and panels shall be in accordance with the requirements of AASHTO 2015 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, with 2020 Interim Revisions (AASHTO Standard Specifications), unless noted otherwise in these specifications. The design equation 3-1 referenced in Article 3.8.1 of AASHTO Standard Specifications shall be modified as follows:

$P_z = 2.5qK_zC_d$, where;

q shall be determined from CSA S6-19 Table A3.1.1, Reference wind pressure, for a return period of 50 years.

The design yield strength of structural steel plate and HSS shall be limited to 300 MPa when designing for strength regardless of the material used.

The design ice thickness for ice accretion shall be the value given in CSA S6-19 Figure A3.1.4, Icing zones.

The Fatigue Importance Factors in Table 11.6-1 of the AASHTO 2015 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, with 2020 Interim Revisions shall be based on Fatigue Category I for the design of all cantilever and non cantilever type overhead sign structures.

Further to Article 11.7.1.1, Galloping, of the AASHTO 2015 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, with 2020 Interim Revisions, a dynamic analysis of the structure will not be accepted in lieu of using the equivalent static pressures provided in the specifications.

Further to Article 11.7.1.1, Galloping, of the AASHTO 2015 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, with 2020 Interim Revisions, the Department Representative will not accept the use of vibration mitigation devices in lieu of designing to resist periodic galloping forces. Furthermore, the Department Representative requires that the galloping loads be part of the fatigue design of all cantilevered type overhead sign structures regardless of their configuration.

Further to Article 11.8, Deflection, of the AASHTO 2015 Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition, with 2020 Interim Revisions, the vertical deflection for overhead sign structures shall not exceed 200 mm regardless of their configuration.

Design sign panel area shall be taken as the largest of:

- Actual sign panels shown on the drawings;
- Future sign panels shown on the drawings; and
- Area of 3.5 m x 60% of horizontal span length (span length includes portion of arm over clear zone), placed in any position along the span that will produce the most critical loading conditions in the structure.

Multisided tubular sections shall have a minimum number of sides meeting the requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Standard Specifications) Subsection 5.14.2.

Overhead sign structures shall have a minimum permanent vertical camber of L/200 under a loaded condition, where L is the span of the horizontal arm of the sign structure.

Cantilever arm lengths shall not exceed 20 m.

The minimum vertical “as constructed” clearance measured to the bottom edge of the sign panel of overhead sign structures shall be 6 m. The bottom edge of the structural framing for the sign shall be at least 0.6 m higher than the bottom edge of the sign panels.

Horizontal members greater than 12 m may have a bolted splice. Intermediate circumferential butt welds will not be permitted.

Stiffeners will not be permitted for column to baseplate and horizontal arm to flange plate connections.

Each column, arm, extension, clamp and bracket shall be fabricated from one or two piece(s) of sheet steel. Each piece of sheet steel shall be the full length of the section being fabricated. A maximum of one longitudinal seam weld shall be used when the section is fabricated from a single piece of sheet steel. A maximum of two longitudinal seam welds shall be used when the section is fabricated from two pieces of sheet steel. Laminating of plates will not be permitted.

Hand holes with cover plates on top and bottom of columns are to be provided for illuminated overhead sign structures or when specified in the Special Provisions of the Contract.

The top of the concrete foundations shall project from 700 mm to 850 mm above the adjacent ground surface on the traffic side. The exposed portion of the concrete foundation shall be of circular cross section.

24.2.1 Foundations

Any proposed adjustments to the locations of overhead sign structures foundations shall be submitted to the Department Representative for review and acceptance prior to commencement of the work.

Concrete shall be Class C, utilize Type HS or HSb hydraulic cement, and be in accordance with Section 4, Cast-In-Place Concrete.

All reinforcing steel shall be plain reinforcing steel and be in accordance with Section 5, Reinforcing Steel.

Grout pads shall be utilized under column baseplates and shall be between 50 mm and 75 mm in thickness. Grout pad recesses shall be 25 mm in depth below the top of the concrete surface.

24.2.1.1 Geotechnical Investigation

The Contractor shall undertake a geotechnical investigation to complete the foundation design of the overhead sign structure. The overhead sign structure geotechnical investigation will be considered a hold point.

The geotechnical investigation will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

24.3 Supply and Fabrication

The Contractor shall be responsible for the work of fabricators and their sub-contractors. Contract requirements shall apply to all fabricators and their sub-contractors.

Fabrication of overhead sign structures shall conform to AASHTO LRFD Bridge Construction Specifications and the AASHTO/AWS Bridge Welding Code D1.5M/D1.5.

All welding, cutting and preparation of hollow structural steel sections (HSS) shall be in accordance with the AASHTO/AWS Bridge Welding Code D1.5M/D1.5 and the American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M. In the case of conflicting requirements between AASHTO/AWS Bridge Welding Code D1.5M/D1.5 and the American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M for HSS, the more stringent requirements shall apply.

The Contractor shall submit a supply and fabrication inspection and test plan (ITP) for overhead sign structures and panels to the Department Representative a minimum of 6 weeks prior to commencement of the work. The Contractor’s supply and fabrication ITP shall include, but not be limited to, all specified witness points, hold points, inspection and testing requirements, and the associated acceptance criteria for each component being fabricated. The Contractor’s supply and fabrication ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, quality control inspection and testing, and reporting requirements.

Fabrication shall not commence until the Contractor’s supply and fabrication ITP has been reviewed and accepted in writing by the Department Representative.

24.3.1 Qualifications

Overhead sign structures and panels shall be supplied and fabricated by a fabricator certified by the Canadian Welding Bureau (CWB) in accordance with CSA W47.1 to Division 1 or 2. Fabrication shall be completed within a fabrication facility that is permanent, fully enclosed, and has a minimum temperature of 10°C.

Welders, welding operators and tackers shall be CWB approved in the applicable category. Their qualifications shall be current and available for examination by the Department Representative upon request.

24.3.2 Prefabrication Submissions

The Contractor shall submit the following information to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of fabrication unless noted otherwise:

- List of fabricators and qualifications;
- Fabrication sequence and equipment;
- Mill test reports and product data sheets;
- Design notes, independent check notes, and shop drawings;
- Welding procedures; and
- Fabrication schedule.

Prefabrication submissions will be considered hold points and shall be included in the Contractor's supply and fabrication ITP. The Contractor and the Department Representative shall provide written acceptance of the prefabrication submission hold points in the supply and fabrication inspection and test plan prior to the commencement of fabrication.

24.3.2.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications. The Contractor shall also submit the quality control plans, proof of qualification and certifications of all fabricators and their sub-contractors.

24.3.2.2 Fabrication Sequence and Equipment

The Contractor shall submit details of the fabrication sequence and equipment that will be used to complete the work. The fabrication sequence shall include the order of fabrication, details of shop assembly, and surface preparation and coating. The details of shop assembly shall also include the method of assembly, support point locations, and dimensional and tolerance checks.

24.3.2.3 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided in English for all materials and welding consumables a minimum of 1 week prior to the commencement of fabrication.

Re-classification of materials using a mill test report or mill test report verification testing data will not be permitted.

Mill test reports and rotational capacity testing for fasteners shall be submitted to the Department Representative for review and acceptance 6 weeks prior to the commencement of erection, field assembly or installation.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

24.3.2.4 Proprietary Structures Design

The Contractor's design shall be in accordance with the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

In addition to the requirements of Section 27, the proprietary design report shall include, as a minimum, analysis and design calculations for the following:

- Moment, shear and axial force envelopes for serviceability and fatigue criteria of all components;
- Columns;
- Horizontal arm or truss;
- Column or arm flange bolted connections;
- All welded connections, stiffeners, etc.;
- Anchor rods; and
- Foundations (including the geotechnical investigation report).

In addition to the requirements of Section 27, the shop drawings shall include, as a minimum, the following information:

- Asset ID numbers, and project name;
- Design criteria meeting the requirements of Subsection 24.2, Design, for each individual overhead sign structure, including:
    - AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Standard Specifications) latest Edition and Interims;
    - Any other design codes and standards used;
    - Material specifications;
    - Initial sign panel area and/or minimum design sign panel area;
    - Design wind pressure;
    - Fatigue category and fatigue loadings;
    - Design ice thickness;
    - Other dead loads;
    - Vertical camber in loaded and unloaded conditions;
    - Design temperature range;
    - The minimum number of sides for all components conforms to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Standard Specifications)
    - Foundation soils parameters and foundation drawings; and
    - Critical anchor rod forces.
- Each individual shop fabricated section or assembly shall be shown separately with complete and clearly identified welded or bolted details;

- Number, spacing and locations of the aluminum T sections required for each sign panel(s);
- Weld procedure identification shall be shown on the shop drawings in the tail of the weld symbols;
- All material splice locations shall be shown on the drawings;
- Material properties, material reference standards, and product data sheets for each component;
- Location and details of identification marks;
- Complete material list including fasteners and accessories;
- Erection procedure including any temporary supports, tightening procedure for anchor rod nuts and grouting of baseplates; and
- Assembly and mounting details of panel.

The Contractor shall submit shop drawings for overhead sign structure panels. As a minimum, the following information shall be included on sign panel shop drawing submissions:

- Number, spacing and locations of the aluminum T sections required for each sign panel(s);
- Assembly and mounting details;
- Method of attaching sign panels to the sign support; and
- Location and number of slip arrest bolts.

The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the sole responsibility for completing the Work in accordance with the Contract requirements.

24.3.2.5 Welding Procedures

Welding procedures, including welding procedure datasheets, shall be submitted for each type of weld proposed. All weld procedures and weld procedure datasheets shall be accepted by the CWB. Welding procedures shall reference CSA W47.1 and either CSA W59 or AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 for plate or American Welding Society (AWS) Structural Welding Code - Steel D1.1/D1.1M for HSS sections. The preheat and interpass temperature, and heat input shall be in accordance with AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 except as required in Subsection 24.3.5.5, Preheat and Interpass Temperatures. Only weld procedure data sheets referenced on the shop drawings shall be submitted. Weld procedures and weld procedure datasheets will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut. The Professional Engineer shall be a welding engineer with extensive experience in welding procedures for this type of work.

24.3.2.6 Fabrication Schedule

The Contractor shall provide and maintain a current and complete fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors.

24.3.3 Prefabrication Meeting

A prefabrication meeting shall be held for the supply and fabrication of overhead sign structures and panels.

The prefabrication meeting shall not occur until prefabrication submission hold points have been completed, reviewed and written acceptance provided by both the Contractor and the Department Representative.

The prefabrication meeting shall be coordinated by the Contractor and held at the fabricator's facility on a date and time acceptable to the Department Representative. A minimum of 2 weeks advance notice shall be provided to the Department Representative prior to the date of the proposed prefabrication meeting.

The Contractor, fabricator and their sub-contractors shall be in attendance at the prefabrication meeting including project manager(s), fabrication superintendent(s), independent testing agency representatives, and all employees involved in supervision of the work.

The Department Representative will prepare the prefabrication meeting agenda and chair the meeting.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (up to 3 representatives from the Government of the Northwest Territories and consultant) to attend the prefabrication meeting(s) for overhead sign structures and panels being fabricated outside the Northwest Territories.

24.3.4 Materials

All materials shall be new. No reclaimed material shall be incorporated into the work.

Steel materials including hardware and anchor rod assemblies shall be hot dip galvanized.

The use of aluminum and aluminum alloy in overhead sign structures will not be permitted.

24.3.4.1 Structural Steel

Structural steel plate material shall conform to CSA G40.21 Grade 300W or 350W or ASTM A572/A572M Grade 50.

All other structural steel shapes, except hollow structural sections (HSS), shall be in accordance with CSA G40.21 Grade 300W or 350W or ASTM A572/A572M Grade 50.

HSS shall conform to CSA G40.21 Grade 300W or 350W Class H.

Silicon content for all structural steel shall be less than 0.04% or within the range of 0.15% to 0.25%.

Steel shafts, structural flange plates, baseplates, HSS and any steel material to be welded shall have a Charpy V-Notch minimum average absorbed energy of 20 Joules (J) at -20°C. Bolted HSS members that are not main load carrying members will not require a Charpy V-Notch minimum average value. The Contractor shall perform Charpy V-Notch testing in accordance with CSA G40.20 on a per plate frequency.

The boron content of steel to be welded shall not exceed 0.0008%.

Re-classification of steel using mill test report or mill test report verification data is not permitted.

24.3.4.2 Bolts

All bolts shall conform to ASTM F3125/F3125M Grade A325/A325M Type 1 heavy hex style. Nuts shall be heavy hex style and shall conform to the requirements of ASTM A563M. Hardened washers shall conform to the requirements of ASTM F436/F436M.

Rotational capacity testing and reporting shall be performed in accordance with ASTM F3125/F3125M for each assembly lot of bolts, nuts and washers.

24.3.4.3 Anchor Rods

Anchor rods shall be manufactured from smooth rods conforming to the requirements of ASTM F1554 Grade 55 (Fy = 380 MPa) including supplementary requirement S4. The anchor rod assembly shall consist of anchor rods complete with nuts and washers, top temporary templates c/w clamping nuts, bottom anchor plates c/w anchor nuts and clamping nuts.

24.3.4.4 Panels

Extruded aluminum panels for major signs, shall be Alcan Shape #73247 with anodize treatment and shall conform to ASTM B221M, "Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes", Alloys 6061-T6 or 6063-T5 except as noted otherwise in these specifications.

Reflective sheeting materials used on all overhead sign structure panels with sign illumination shall meet or exceed the minimum requirements as specified in ASTM-D4956 for Type IX or Type XI Unmetallized Cube Corner Microprismatic Retroreflective Element Material. Reflective sheeting materials used on all overhead sign structure panels without sign illumination shall meet or exceed the minimum requirements as specified in ASTM-D4956, Performance Requirements Type III or Type IV, High Intensity Retroreflective Sheeting.

24.3.5 Welding

24.3.5.1 Filler Metals

Low hydrogen filler, fluxes and low hydrogen welding practices shall be used throughout. All electrodes and fluxes used in the Shielded Metal Arc Welding (SMAW) and Metal Core Arc Welding (MCAW) processes shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H4. All electrodes and fluxes used in the Submerged Arc Welding process (SAW) shall conform to the diffusible hydrogen requirements of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 filler metal hydrogen designator H8 or lower. The low hydrogen covering and flux shall be protected and stored as specified by AASHTO/AWS Bridge Welding Code D1.5M/D1.5. The deposited weld metal shall provide strength, durability, and impact toughness and corrosion resistance equivalent to the base metal.

All electrodes, electrode/flux combinations, and electrode/shielding gas combinations shall be CSA certified and associated mill test reports and product data sheets submitted to the Department Representative for review and acceptance in accordance with Subsection 24.3.2.3, Mill Test Reports and Product Data Sheets.

Field welding will not be permitted.

24.3.5.2 Cleaning Prior to Welding

Weld areas must be clean, free of mill scale, dirt, grease, and other contaminants prior to welding.

For multi-pass welds, previously deposited weld metal shall also be thoroughly cleaned prior to depositing subsequent passes.

24.3.5.3 Longitudinal Seams

All longitudinal seams shall be made by an approved semi or fully automatic submerged arc or metal core welding process.

24.3.5.4 Weld Penetration

The column to baseplate and flange to horizontal arm full penetration welds shall be completed using backing bars. All other full penetration welds shall be made by using backing bars or backgouged to sound metal. Backing bars in full penetration groove welded connections shall have dimensions conforming to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Standard Specifications) Subsection 5.14.5. Backing bars shall be acceptably fitted, as determined by the Department Representative, and welded all around, including top and bottom of the member. The groove weld shall be placed in a minimum of two passes. A reinforcing fillet weld shall be placed all around the joint. The Contractor shall indicate on their ITP whether non-destructive testing (NDT) of the full penetration groove weld will be completed before or after the backing bar is welded to the inner wall of the tube. The access hole in the baseplate shall be sufficiently sized to facilitate welding of the backing bar to the inner wall of the tube and to facilitate subsequent welding inspection and testing.

The longitudinal seams shall have a minimum 60% penetration. Backing bars will not be allowed for longitudinal seam welds.

The following welds shall have 100% penetration:

- Column to baseplate;
- Horizontal arm to flange plate;
- Longitudinal seam welds within 150 mm of circumferential welds and 150 mm beyond hand holes (when provided) shall be full penetration groove welds. Transition between full and partial penetration welds shall be ground smooth;
- Backing bar splices; and
- Flange plate to gusset plate.

24.3.5.5 Preheat and Interpass Temperatures

Preheat and interpass temperatures shall be in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5. All full penetration welds shall be preheated and interpass temperature maintained to a minimum of 100°C unless a higher temperature is required by Table 12.3 of AASHTO/AWS Bridge Welding Code D1.5M/D1.5 for the material thickness. The preheat temperature shall be measured 75 mm from the point of welding.

24.3.5.6 Tack and Temporary Welds

Tack and temporary welds will not be permitted unless they are incorporated within the final weld. Tack welds to be incorporated into final welds shall be completed using consumables compatible with the final weld. Tack welds shall have a minimum weld length at least 4 times the nominal weld size. Cracked tack welds shall be completely removed prior to final welding. Magnetic particle testing shall be completed by the Contractor to confirm complete removal of any cracked tack welds. Tack welds shall be equivalent in quality to the final weld and will be subject to the same inspection and testing requirements as final welds

24.3.5.7 Run-off Tabs

Run-off tabs shall be used at the ends of all welds that terminate at the edge of a member. The thickness and shape of the tabs shall replicate the joint detail being welded and shall be a minimum of 100 mm long unless greater length is required to acceptably complete the work. Run-off tabs shall be tack welded only to that portion of the material that will not remain part of the structure, or where the tack will be welded over and fused into the final joint. After welding, the run-off tabs shall be removed by flame cutting. Removal of run-off tabs by breaking off will not be permitted.

24.3.5.8 Repair Procedures

The Contractor shall submit repair procedures to the Department Representative for review and acceptance for damaged base metal, defective weldments, and any other defect, prior to commencement of the repair work. Repair procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Repair procedures incorporating arc gouging shall specify that the repair area be preheated to a minimum of 65°C prior to gouging.

The Contractor shall not complete any repairs until written acceptance of the repair procedure has been provided by the Department Representative.

24.3.5.9 Arc Strikes

Arc strikes will not be permitted. In the event of an arc strike, a repair procedure shall be submitted in accordance with Subsection 6.2.5.7, Repair Procedures. At a minimum, the repair procedure shall include the complete grinding out of the crater produced by the arc strike. The repair procedure shall also include MPI and hardness testing of the affected area. Hardness of the repaired area shall conform to the requirements of Subsection 6.2.8.4.1.4, Hardness Test Inspection Schedule. Repair areas will be examined by the Department Representative to ensure complete removal of the metal in the affected area.

24.3.5.10 Plug and Slot Welds

Plug welds or slot welds will not be permitted.

24.3.6 Fabrication

24.3.6.1 Overhead Sign Structures

Columns, arms, extensions and clamps shall be brake press formed or roll formed. The brake press knife shall have a radius suitable for the thickness of the material and nature of the bend. The minimum bend radius for all cold formed sections shall be 100 mm.

All plates and structural sections shall be free of notches and gouges.

The depth or projection of any imperfections on the inner or outer surfaces shall not exceed 15% of wall thickness. Any depth or projection up to 33% of wall thickness may be repaired by welding. Any excessive projecting weld metal shall be removed.

The diameter of bolt holes in baseplates shall be sized in accordance with CSA S6-19 Clause 10.18.4.2, Hole size, (a). The nominal diameter of all other bolt holes shall be 2 mm greater than the nominal bolt size.

Punching of full size holes will not be permitted. The holes shall be circular and perpendicular to the member and shall be deburred to ensure a proper faying surface.

Hand holes, when specified, shall be stiffened by providing a reinforcing rim with semi-circular ends. The rim shall be welded to the member with a full penetration groove weld supplemented with an all-around fillet weld.

Once the components of each overhead sign structure are acceptably fabricated, the assembly flange plates and/or baseplates shall be stamped with permanent identification marks acceptable to the Department Representative. Only low stress stamps shall be used for identification marks.

24.3.6.1.1 Cutting of Plate

All plate material for main members and any plate material welded to the main member shall be flame cut using an automatic cutting machine. Shearing will not be permitted.

Corners of plates and structural sections shall be ground to a 1 mm chamfer.

24.3.6.1.2 Dimensional Tolerances

Dimensional tolerances shall be measured and recorded by the fabricator.

24.3.6.1.2.1 Straightness

The straightness tolerance shall not exceed the overall length divided by 300 from the surface at any point. The straightness shall be measured with a straight line and the surface shall then be measured to determine the straightness.

24.3.6.1.2.2 Twisting

The twist in the overall length of any column, arm, or extension shall not exceed 7 degrees.

24.3.6.1.2.3 Length

The specified length of any item shall be within 0 to +60 mm or 0 to + 5% (whichever is less) with the exception of sign bridge spans which shall be within 5 mm of the specified dimensions in an unloaded condition. The tolerance for height shall be 0 to +60 mm.

24.3.6.1.2.4 Across the Flat Dimensions

Regular Polygonal Cross-sections: The average of all across the flat dimensions from a given cross section shall be within 1% of the specified dimension. In addition, the ratio of the maximum to minimum across the flat dimensions shall be less than or equal to 1.05.

Irregular Polygonal Cross-sections: The across the flat dimensions of the minor and major axis shall be within 2% of the specified dimensions, and the sum of the minor and major axis across the flat dimensions must be within 1% of the specified dimensions.

24.3.6.1.2.5 Flatness Tolerance of Column Base Plates and Flange Plates

Surfaces of column baseplates shall be flat to within 3 mm tolerance in 305 mm, and to within 5 mm tolerance overall. Faying surfaces of flange plates shall be flat to within 2 mm tolerance overall for each surface.

24.3.6.1.2.6 Arm Rise

The minimum arm rise (vertical camber) shall be within a tolerance of ± 15 mm from the theoretical design value for the unloaded condition.

24.3.6.1.3 Pre Assembly

After welding and fabrication, but prior to galvanizing, the Contractor shall pre-assemble all overhead sign structures, including welded sign clamps, to check the fit and geometry. The pre-assembled overhead sign structures will require inspection, review and acceptance by the Department Representative and the Contractor's engineer of record. Prior to galvanizing, overhead sign structures shall be disassembled after the Department Representative and the Contractor's engineer of record have reviewed and accepted the work.

24.3.6.1.4 Flame Straightening and Heat Curving

Flame straightening and heat curving will not be permitted without the written acceptance of the Department Representative. If flame straightening and heat curving is considered acceptable by the Department Representative, the Contractor shall submit a detailed flame straightening or heat curving procedure including the proposed locations, temperatures and cooling rates to the Department Representative for review and acceptance prior to commencement of the work. The flame straightening and heat curving procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. In addition, the Contractor's engineer of record of the proprietary structure in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, shall review the flame straightening and heat curving procedure and supply a signed and sealed letter stating acceptance of the procedure as being an adequate repair method, Flame straightening or heat curving shall only be performed in the presence of the Department Representative and the Contractor's engineer of record.

If the heat treatment of any structural steel component is required as determined by the Department Representative or the Contractor's engineer of record, the Contractor shall submit a heat treatment procedure to the Department Representative and the acceptance letter by the Contractor's engineer of record a minimum of 2 weeks prior to the anticipated commencement of the work. The heat treatment procedure will be considered Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The heat treatment procedure shall include heat treatment charts outlining the temperature, time and material. Upon the completion of the heat treatment, all the mechanical properties, including notch toughness, shall be verified by a certified independent laboratory in Canada by testing the material to the specified material standards. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

24.3.6.1.5 Galvanizing

Galvanizing shall be completed in accordance with Subsection 6.2.7.3, Galvanizing and Metallizing.

24.3.6.1.6 Base Plate Corrosion Protection

The bottom surface of each baseplate shall be protected by a medium grey concrete colour barrier coating. The barrier coating shall be a mid coat polyamide epoxy technology coating selected from the Alberta Transportation's Products List Bridge Coating Systems – Paint or the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

The galvanized surface shall be prepared and/or roughened in accordance with the barrier coating manufacturer's recommendations. The dry film thickness (DFT) of the coating shall be in accordance with the manufacturer's published product data sheet.

24.3.6.2 Overhead Sign Structure Panels

24.3.6.2.1 Backing

Each panel shall be fabricated from a number of rows of extruded aluminum sections bolted together. Each row of a panel shall be fabricated from a single piece of extruded aluminum up to a maximum length of 6 m. Sign panels with a length in excess of 6 m may be split into multiple sections with a vertical joint that runs the vertical distance of the panel. The location of the vertical joint shall be chosen to minimize the number of letters/symbols split between the two sections. The number of sections for a panel shall be minimized.

A 1.0 x 2.5 cm slot shall be located on both edges of the extruded aluminum panels. The slotting shall be centred on the identification groove running longitudinally with the first slot centred 76 mm from the end of the section. The slotting shall be spaced on 152 mm centres for the entire length of the section.

24.3.6.2.2 Extruded Aluminum Preparation

The extruded aluminum panels shall be clean of dust, dirt and/or grease. The method used for cleaning must not damage the anodized finish of the extruded aluminum panels or prevent the adhesion of the sheeting material to the extruded aluminum sections.

The ends of the extruded aluminum sections shall be checked to ensure that they are cut square to create flush joints between both panels and sections of a panel. The maximum allowable gap between two adjacent sections or panels shall be 5 mm. All excess material found along the slots and edges of the panels shall be removed.

The joint between two sections of a single panel shall be connected together with a T stiffener when installed on the sign support structure. The Contractor shall determine the vertical joint location to avoid conflicts between the joint T stiffeners and the T stiffeners used to attach the sign panels to the sign support structure.

Adjacent sign panels shall not be connected together by a joint T stiffener or the T stiffener used to attach the sign panel to the sign support structure.

24.3.6.2.3 Application of Sheeting Materials

The sheeting material (lettering, symbols, borders, background, etc.) shall be applied to the extruded aluminum sections as required by the sheeting manufacturer and as shown on the Drawings. The horizontal line of lettering/copy across a joint between panels, or sections of a sign panel, shall be less than 8 mm.

Each panel shall be fabricated as an individual piece to facilitate future modifications. Large individual panels may be fabricated in multiple pieces as noted herein.

For sign panels where the background sheeting material is green and/or yellow, the sheeting is to be wrapped securely around the top and bottom horizontal edges of each extruded aluminum sub panel section. The outer edges of sheeting are to be neatly trimmed flush with the vertical edges of the sign panel.

24.3.7 Inspection and Testing

24.3.7.1 Access

The Contractor shall provide full facilities for the inspection and testing of the work. The Department Representative shall have full access to all parts of the work at all times. When required by the Department Representative, the Contractor shall provide labour for assistance in checking layout and performing inspection and testing duties. The Department Representative shall be provided the time needed to complete quality assurance inspection and testing requirements.

24.3.7.2 Responsibility

Quality control inspection and testing shall be completed by the Contractor. Quality control shall be the sole responsibility of the Contractor. Quality control shall be in accordance with the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant) to inspect and test overhead sign structures being fabricated outside the Northwest Territories and including up to three trips to the fabrication facility by the Department Representative during the course of fabrication.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work or non conforming materials shall be paid for by the Contractor.

If the Department Representative, at their sole discretion, determines that the Contractor's quality control inspection and/or testing personnel are not meeting the minimum specified standards, the Contractor shall replace the personnel immediately and prior to continuing with the work.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative. The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

24.3.7.3 Quality Control Inspection and Testing by the Contractor

The Contractor's quality control plan, including visual inspection and non-destructive testing, shall be in accordance with the requirements of AASHTO/American Welding Society (AWS) Bridge Welding Code D1.5M/D1.5 Clause 6, except as follows:

- The Contractor's visual quality control welding inspector shall be certified by the CWB as a Level 2 or Level 3 inspector in accordance with CSA W178.2;

- Non-destructive testing (NDT) methods shall be in accordance with Subsection 6.2.8.3, Non-Destructive Testing;
- NDT technicians shall be certified to Level 2 in accordance with CAN/CGSB-48.9712 and employed by an independent testing agency certified to CSA W178.1;
- Visual inspection and the NDT schedule shall be completed in accordance with Subsection 24.3.7.3.1, Welds;
    - Ultrasonic NDT procedures shall be prepared by a Professional Engineer certified to Level 3 in accordance with CAN/CGSB-48.9712 and employed by an independent testing agency certified to CSA W178.1. Ultrasonic procedures will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. Calibration blocks shall be prepared for each thickness of material and used for ultrasonic methods to establish sensitivity levels and acceptance criteria. Proposed acceptance criteria shall be reviewed and accepted by the Department Representative. Acceptance criteria for welds inspected using Ultrasonic testing shall be in accordance with AASHTO/AWS Bridge Welding Code D1.5M/D1.5 Subsection 6.26.3 and Table 6.3.
    - The Contractor shall provide a minimum of 36 hours advance notice to the Department Representative prior to the commencement of any non-destructive testing; and
- Adhesion coating testing shall be completed by an independent National Association of Corrosion Engineers (NACE) Level 2 certified coating inspector.

The Contractor shall measure the baseplate barrier coating dry film thickness of each baseplate. Coating thickness measurements shall be completed at a minimum of 10 locations that are acceptable to the Department Representative in accordance with SSPC PA 2 Measurement of Dry Coating Thickness with Magnetic Gauges.

The Contractor shall complete adhesion testing of the baseplate barrier coating application using adhesion test plates. One adhesion test plate shall be supplied and fabricated for each overhead sign structure. Adhesion test plates shall be supplied and fabricated in accordance with the following requirements:

- Be of the same type and grade of steel as the production baseplates;
- 150 x 150 mm in plan dimension and have a thickness equal to 13mm;
- Galvanized at the same time as the production baseplates;
- Barrier coating applied at the same time as the production baseplates; and
- Barrier coating thickness measured for compliance and fully cured prior to testing.

Adhesion testing of the barrier coating shall be completed in accordance with ASTM D3359 Method A or Method B and have a minimum classification of 4A or 4B.

The Contractor's quality control testing and inspection records and/or reports shall be submitted on a weekly basis to the Department Representative for review and acceptance, with the exception that NDT records and/or reports shall be submitted within 24 hours of completion of the testing. All quality control testing and inspection records and/or reports shall contain the written acceptance of the fabricator's QC manager and the Contractor's engineer of record.

24.3.7.3.1 Welds

The Contractor shall visually inspect 100% of all welds.

The Contractor shall test and inspect all full penetration welds by ultrasonic or radiographic methods. In addition, full penetration groove welds at tube to transverse plate connection details having a constant amplitude fatigue threshold (CAFT) of 69 MPa or less, shall be ultrasonically inspected for toe cracks after galvanizing as required by Subsection 5.15.5 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

The Contractor shall test and inspect partial penetration seam welds by ultrasonic method. The frequency of partial penetration welds shall be three random locations per weld acceptable to the Department Representative. The length of ultrasonic inspection at each location shall be 200 mm at each weld. Testing and inspection results for partial penetration welds shall also include the percentage of weld penetration.

The Contractor shall inspect 25% of all fillet welds by magnetic particle testing.

24.3.7.4 Quality Assurance Inspection and Testing by the Department Representative

The Department Representative will complete visual inspection of all welds and review all quality control inspection and testing records and/or reports produced by the Contractor to verify their compliance with the Contract.

The Department Representative may complete additional quality assurance inspection and/or testing at their sole discretion. The Contractor shall provide full access to the work in accordance with Subsection 24.3.7.1, Access.

24.3.7.5 Witness and Hold Points

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified witness points and hold points within the ITP.

If fabrication continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Department Representative may suspend the supply and fabrication work, and the Contractor shall be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the work, as determined by and to the satisfaction of the Department Representative.

Inspection stations shall be set up by the Contractor within the fabrication facility to the satisfaction of the Department Representative for each of the specified witness points and hold points such that the associated inspection and/or testing requirements can be acceptably completed.

The following witness points and hold points shall be included in the Contractor's supply and fabrication ITP:

- Backing bar complete joint penetration weld testing (hold point);
- Fitting of backing bar (hold point);
- Tube to flange plate and/or baseplate complete joint penetration weld testing (hold point);
- Visual welding inspection and non-destructive testing prior to shop pre-assembly (witness point);
- Pre-assembly and dimensional tolerance checks (witness point);
- Galvanizing (witness point);
- Ultrasonic non-destructive testing of complete joint penetration tube to flange plate and/or baseplate weld toes after galvanizing (witness point);
- Base plate barrier coating application and testing (witness point);

- Verification testing and inspection of overhead sign structures if fabricated outside of Canada and the United States (hold point); and
- Final inspection (hold point).

24.3.7.6 Final Inspection

The Contractor's engineer of record and the Department Representative shall provide written acceptance of all fabricated overhead sign structures and panels upon the completion of fabrication. Review and acceptance of overhead sign structures and panels by the Department Representative at the fabrication facility will not relieve the Contractor and the Contractor's engineer of record of their sole responsibility to meet the requirements of the Contract.

24.3.7.7 Fabrication Outside of Canada or the United States of America

In addition to the requirements of Subsection 24.3.7, Inspection, overhead sign structures and panels fabricated outside of Canada or the United States of America shall be shipped to a shop located in Canada that is certified by the CWB in accordance with CSA W47.1 to Division 1 or 2 for verification inspection and testing. The overhead sign structure and panel components shall be in a condition that facilitates all verification inspection and testing requirements. Verification inspection and testing shall be completed in accordance with Subsection 24.3.7, Inspection. The visual welding inspector shall also inspect all overhead sign structure and panel components for the presence of transportation damage.

Components shall not be shipped from the Canadian shop to the project site until all requirements have been met and the work has been reviewed and accepted by the Department Representative.

The Contractor shall be responsible for all verification inspection and testing costs, including all costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant). The Contractor shall also be responsible for all hourly charge out rates, travel, meals and accommodation of the Department Representative inspector(s) to complete inspection and testing duties at the fabrication facility for 100% of the fabrication time. The Contractor shall also be responsible for the cost of one trip every 2 weeks for two Department Representatives to and from the fabrication facility.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

24.4 Construction

The Contractor shall meet the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

The Contractor shall coordinate the placement and/or relocation of utilities and conduit such that there is no conflict with overhead sign structure foundations.

Grout pad recesses shall be 25 mm deep and the total grout thickness shall be as shown on the Drawings.

Anchor rods shall be installed true and plumb in one complete assembly as shown on the Drawings. The assembly shall be accurately positioned and secured to prevent movement or displacement during concreting procedures. Welding to secure anchor rods assemblies will not be permitted.

The Contractor shall not erect the overhead sign structure until the foundation concrete has been cured a minimum of 3 days and achieved 80% of the 28 day specified concrete strength requirement.

Concrete surfaces on which baseplates are placed shall be finished in accordance with Subsection 4.25.8, Surface Finish under Bearings.

Softeners shall be used at all times where chains, flange hooks, restraint systems, or any other tie down devices are or may come in direct contact with the overhead sign structures and panels during transportation, handling, storage, assembly, erection and installation. Softener components shall be durable for the intended use and constructed of materials that will prevent damage to the overhead sign structure and panel components. Steel or other alloys will not be permitted for use as softeners. Handling and lifting devices shall not mark, damage, or distort members. The use of steel chains as slings will not be permitted.

24.4.1 Foundations

The foundations of overhead sign structures shall be completed in accordance with Section 3, Foundation Piles, Section 4, Cast-In-Place Concrete, Section 5, Reinforcing Steel, and the reviewed and accepted shop drawings.

The construction of foundation piles will be considered a hold point. The Contractor and the Department Representative shall provide written acceptance of the foundation construction hold point prior to the commencement of overhead sign structure erection.

24.4.2 Transportation, Handling and Storing Materials

Overhead sign structures and panels shall be transported, handled and stored to prevent damage.

Overhead sign structures and panels shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage. Overhead sign structures and panels that become contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to installation.

Overhead sign structures and panels shall be transported, hauled and stored on timber blocking. Timber blocking shall be located at positions that prevents marring and damage of materials. The ground of the storage area shall be solid and unyielding and drainage diverted away from the storage area.

Galvanized material shall be handled, stacked, bundled, transported, hauled and stored to prevent marring of surfaces, damage, or wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. If damage or wet storage staining occurs, it shall be assessed and repaired in accordance with Subsection 6.2.7.3.3, Repair of Galvanized and Metallized Material.

24.4.2.1 Clearance to Ship

The Contractor shall provide the Department Representative a transportation schedule for overhead sign structures and panels a minimum of 1 week prior to shipment from the fabrication facility. Written acceptance in accordance with Subsection 24.3.7.6, Final Inspection shall be provided by both the Contractor's engineer of record and the Department Representative t prior to the commencement of shipping.

Review and acceptance at the fabrication facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

24.4.2.2 Inspection

Upon arrival at the site, after cleaning if required, and a minimum of 24 hours prior to erection, the Contractor and the Department Representative, shall inspect materials for cleanliness and presence of damage. The Contractor shall provide an area and acceptable space between components and access equipment for the Department Representative to complete their inspection. Assembly, erection, and installation shall not commence until the Department Representative has provided written acceptance of transportation, handling, and storage inspection results to the Contractor.

Overhead sign structures and panels that become contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to inspection, assembly, erection or installation. Cleaning, if determined necessary by the Department Representative, shall be completed in accordance with Subsection 6.3.1.4, Cleaning.

If overhead sign structure components or panels are identified as damaged during the transportation, handling, and storage inspection, the Contractor shall submit an assessment report and/or field repair procedure to the Department Representative for review and acceptance prior to commencement of the work. The submission shall include a signed and sealed statement by the engineer of record of the proprietary structure that the assessment report and/or field repair procedure are acceptable. The assessment report and/or field repair procedure will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The Department Representative may also require that further independent inspection, non-destructive testing, and/or assessment be completed. Field repairs shall be completed by the Contractor and reviewed and accepted by the Department Representative prior to erection, assembly or installation. All costs to repair damage to the satisfaction of the Department Representative will be the sole responsibility of the Contractor.

The transportation, handling, and storage inspection will be considered a hold point. The Contractor and the Department Representative shall provide written acceptance of the hold point after cleaning and/or repairs, if required. If assembly, erection, or installation commences without the written acceptance of the transportation, handling, and storage inspection by both the Contractor and the Department Representative, the Department Representative will have cause to suspend assembly, erection, and installation work. The Contractor shall also be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

24.4.3 Erection

The Contractor shall maintain the stability, safety and integrity of the overhead sign structure and panels until grout pads have achieved the specified strength and anchor rod nuts are fully tightened.

If overhead sign structure erection commences without the written acceptance of the geotechnical investigation, the foundation design notes and check notes, or foundation construction hold points by both the Contractor and the Department Representative, the Department Representative will have cause to suspend the erection work. The Contractor shall also be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder shall be an integral part of the Work. The Contractor shall immediately provide the Department Representative with any documentation required by the Occupational Health and Safety Regulations upon request.

Traffic accommodation strategy requirements for overhead sign structure erection shall be submitted to the Department Representative for review and acceptance a minimum of 1 week prior to commencement of the erection work.

After the top temporary template for the anchor rod assembly and clamping nuts are completely removed, the overhead sign structure shall be set accurately on galvanized steel shim plates placed directly on top of the concrete foundation. Shim plates shall be located such that a minimum of 75 mm of grout cover is provided from shim plates to the grout edge.

24.4.3.1 Assembly of Overhead Sign Structures

Assembly of components and completion of bolted joints/connections shall be completed in accordance with Subsection 6.3.2.4, Assembly. Hand hole bolts shall be coated with anti-seize lubricant.

24.4.3.1.1 Assembly of Overhead Sign Structure Panels

The Contractor shall assemble, erect and install panels onto the overhead sign structures as shown on the Drawings to ensure that the signs are located correctly over the indicated lanes and that the correct vertical clearance is maintained.

The Contractor shall provide the T stiffeners, J clips, bolts, flat washers, nylon insert lock nuts, slip arresting bolts and all of the necessary hardware to securely assemble the sign and connect the sign panels to the overhead sign structure as detailed by the Contractor on the accepted shop drawings.

Individual extruded aluminum sign sub panels shall be fastened together using stainless steel 10 mm diameter x 25 mm long bolts, nylon insert lock nuts, and with a washer under both the bolt head and the nut. The last slot of each joint between sections shall be bolted.

The bolting of the joint between the extruded aluminum sections shall be staggered between the rows of slots, except for the last slots at either end of the section or panel.

Sign panels shall be attached to the T stiffeners using J clip assemblies. The J clip assembly consists of a J clip bolt whose square head fits into the channels that run along either edge of an extruded aluminum section, a J clip, a washer and a nylon insert lock nut. J clip assemblies shall be placed where the edge/joint of the extruded aluminum sections meets a T stiffener. The J clip assemblies shall alternate sides of the T stiffeners.

19 mm diameter x 38 mm long stainless steel slip arresting bolts shall be provided with each sign in accordance with Table 24-1, Slip Arresting Bolts Requirements.

Table 24-1 Slip Arresting Bolts Requirements

Number of Standard Height Sub Panels in Sign	Overall Maximum Sign Height (mm)	Number of Slip Arresting Bolts Per Each End of Each Sign
< 9	2745	2
10-13	3965	4
14-17	5185	6

Stainless steel slip arresting bolts and nuts shall meet the requirements of ASTM F593 Type 316 Grade 593H and ASTM F594 Type 316 Grade 594H respectively with a minimum yield strength of 310 MPa and a minimum tensile strength of 585 MPa. A stainless steel washer shall be provided under the nut side of the bolt. Slip arresting bolts shall have nuts tightened to a torque of 181 Nm.

All joiner bolts and J clip nuts must be tightened to a torque of 26.5 Nm within a tolerance of ± 0.5 Nm.

The face of the sign panels shall be cleaned to the satisfaction of the Department Representative immediately prior to erection.

24.4.3.2 Grout Pads

The method of forming and placing the grout shall be submitted to the Department Representative for review and acceptance a minimum of 3 days prior to commencement of the work. Dry-pack methods of constructing grout pads will not be permitted.

The top of finished grout pads shall be to the underside of the overhead sign structure baseplate.

Grout used for the grouting of baseplates shall be selected from Alberta Transportation's Products List, Non-Shrink Grout category, or a non-shrink grout from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List.

Grout shall be packaged in waterproof containers with the production date and shelf life of the material shown. The grout shall be mixed and placed in strict accordance with the manufacturer's recommendations stated on their published product data sheet.

The Contractor shall utilize experienced ACI or CSA certified testers to test the compressive strength of the grout in accordance with CSA A23.2-1B. A set of compressive strength cubes shall be taken to represent each day's production or 0.25 m^3, whichever is more frequent. All test results shall be provided to the Department Representative within 3 days of completion of testing. The average minimum compressive strength of 3 cubes at 28 days shall be 30 MPa. Failure to meet the minimum specified compressive strength will result in the grout pad being removed and replaced at the Contractor's expense.

Grout shall be wet cured for a minimum of 3 days with two layers of clean, saturated Nilex 4504 white coloured filter fabric or an approved equivalent. Water used for wet curing shall be clean and acceptable to the Department Representative.

Sealer shall be applied to the exposed grout pad surfaces in accordance with Subsection 4.26, Type 1c Sealer.

24.4.3.2.1 Grouting in Cold Weather

When the air temperature is or is expected to be below 5°C as forecasted by the closest Environment Canada Meteorological Station or a meteorological station specified in the Special Provisions of the Contract during the placing and curing period, or when determined by the Department Representative, a cold weather grouting plan shall be implemented. The Contractor shall submit details of their proposed cold weather grouting plan to the Department Representative for review and acceptance a minimum of 2 weeks prior to any grout placement. The following minimum requirements for grouting in cold weather shall be included in the cold weather grouting plan:

- Before placing grout, pre heat shall be provided to raise the temperature of formwork, anchor rods, baseplate, and substrate surfaces to between 10°C and 20°C;
- Mixing water shall be heated to a temperature of at least 20°C but not more than 65°C;
- Temperature of the grout during placing shall be between 10°C and 25°C;
- Grout shall be wet cured a minimum of 72 hours;
- The Contractor shall enclose the structure in such a way that the grout and air within the enclosure can be kept at or above 15°C for a protection period of 5 days after placing the grout. Enclosures shall be constructed with a minimum 300 mm clearance between the enclosure concrete and/or grout surfaces; and
- Protection and heating, when used, shall be withdrawn in such a manner so as not to induce thermal shock stresses in the grout. The temperature of the grout shall be gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air. To achieve this, in an enclosure, the heat shall be slowly reduced.

The Contractor shall demonstrate to the satisfaction of the Department Representative and the Contractor's engineer of record that the requirements of the cold weather grouting plan are met prior to the commencement of grouting.

24.4.3.3 Anchor Rod Nut Tightening

Anchor rod nuts shall be tightened using the turn of nut method described in Subsection 6.3.2.4.5, Turn-of-Nut Method, except that anchor rod nuts shall be tightened to 1/3 turn past the snug-tight condition after the grout has attained sufficient strength regardless of anchor bolt length or diameter.

The top anchor rod nuts shall be in full contact with the top of the column baseplate.

Nuts will not be permitted under baseplates. All voids including the slots and annular space around anchor rods in the baseplate shall be filled with a corrosion inhibiting paste acceptable to the Department Representative.

24.4.3.4 Final Inspection

In addition to the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, the Contractor and the Department Representative shall provide written acceptance of overhead sign structure and panels upon completion of erection. The Contractor shall provide specialized access equipment for the Department Representative to complete their inspection.

The Contractor shall provide final inspection documentation in accordance with Section 27 during and after construction.

The final inspection and submission of Letters of Assurance, Record Drawings, and other deliverables in accordance with Section 27 will be considered hold points.

24.5 Measurement and Payment

24.5.1 Overhead Sign Structures

Payment for Overhead sign structures will be made at the lump sum price bid for "Overhead Sign Structure – Supply and Fabrication, Foundations, Delivery and Erection", for each sign structure identified by its asset ID number, and will be full compensation for the proprietary structure design; supply and fabrication; inspection; testing; storage; loading; transporting; hauling to the project site; unloading; cleaning and/or repair if required; assembly; erection; installation; including all labour, equipment, tools and incidentals necessary to complete the work in accordance with the Contract and to the satisfaction of the Department Representative.

The lump sum price bid will be paid in accordance with Subsection 24.5.1.1, Supply and Fabrication, Subsection 24.5.1.2, Foundations, Subsection 24.5.1.3, Delivery, and Subsection 24.5.1.4, Erection.

24.5.1.1 Supply and Fabrication

50% of the lump sum price bid for "Overhead Sign Structure – Supply and Fabrication, Foundations, Delivery and Erection" will be paid once the overhead sign structure has been acceptably designed; supplied; fabricated; inspected; tested; stored; written acceptance within the supply and fabrication ITP has been provided by both the Department Representative and the Contractor for each specified witness point and hold point; and the Contractor has fulfilled all proprietary structure requirements, as determined by the Department Representative. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work where written acceptance within the supply and fabrication inspection and test plan has not been provided. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for supply and fabrication of overhead sign structure; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

24.5.1.2 Foundations

20% of the lump sum price bid for "Overhead Sign Structure – Supply and Fabrication, Foundations, Delivery and Erection" will be paid once the overhead sign structure foundations have been acceptably designed, including a geotechnical investigation; constructed; written acceptance of the specified hold points has been provided by both the Department Representative and the Contractor; ; and the Contractor has fulfilled all proprietary structure requirements, as determined by the Department Representative. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. The Contractor shall also be responsible for all costs required for utility coordination, protection and relocation. Payment will be full compensation for foundation design and construction; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

24.5.1.3 Delivery

10% of the lump sum price bid for "Overhead Sign Structure – Supply and Fabrication, Foundations, Delivery and Erection" will be paid once the overhead sign structure has been acceptably loaded; transported; hauled; unloaded; stored; cleaned and/or repaired, if required; inspected; written acceptance of the specified hold point has been provided by both the Department Representative and the Contractor; and the Contractor has fulfilled all proprietary structure requirements, as determined by the Department Representative. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for delivery of overhead sign structure; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative. All necessary approvals and permits, will be considered incidental to the Work and no separate or additional payment will be made.

24.5.1.4 Erection

20% of the lump sum price bid for "Overhead Sign Structure – Supply and Fabrication, Foundations, Delivery and Erection" will be paid once the overhead sign structure has been acceptably assembled; erected; installed; and written acceptance has been provided by both the Department Representative the Contractor for each specified hold point; and the Contractor has fulfilled all proprietary structure requirements, as determined by the Department Representative. The Contractor shall be responsible for all additional costs incurred by the Department Representative to evaluate, inspect, test and verify the acceptability of the Work and compliance with a hold point not accepted in writing by the Department Representative. The Contractor shall also be responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative. Payment will be full compensation for the assembly, erection, and installation of overhead sign structures; the supply and placement of grout; including all labour, equipment, tools and incidentals necessary to complete the Work in accordance with the Contract and to the satisfaction of the Department Representative.

All costs associated with grouting in cold weather, when required, will be considered incidental to the Work, and no separate or additional payment will be made.

24.5.2 Sign Panels

Measurement for payment of sign panels will be by the square metre of panel installed, measured to the nearest 0.1 m^2.

Payment will be made at the unit price bid for "Sign Panels – Extruded Aluminum – Supply and Install", for the applicable sign panels, and will be full compensation for the design, supply and fabrication; storage; delivery; cleaning and/or repair if required; assembly, erection and installation; and all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

SECTION 25 MECHANICALLY STABILIZED EARTH WALLS

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25.1 General

This specification is for the design, supply, fabrication and construction of single stage mechanically stabilized earth (MSE) retaining walls with precast concrete fascia panels or rock-filled gabion baskets. MSE retaining walls shall include, but not be limited to, excavation for the wall, concrete leveling pads, precast concrete fascia panels or rock-filled gabion baskets, compacted granular backfill, soil reinforcement, inspection wires, perforated drain pipe complete with filter fabric sock, geotextiles, geomembranes, surface drains, cast-in-place concrete wall coping cap, permanent safety railing, hardware and all associated materials.

Two stage MSE retaining walls are not permitted.

The precast concrete fascia panels, rock-filled gabion baskets, soil reinforcement, connections, inspection wires, hardware and associated materials shall be supplied from a single MSE wall supplier.

Any underground utilities located on the Drawings are approximate and are to be confirmed by the Contractor at the project site.

Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. In the case of conflicting requirements, the more stringent requirements shall apply, as determined by the Department Representative.

Structures applicable to these specifications shall be considered proprietary structures in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, and all requirements of Section 27 shall be met, unless noted otherwise in the contract documents.

25.2 Design

25.2.1 General

Location, layout, geometry control, short and long term global stability, allowable rate of fill placement, and allowable bearing capacity requirements shall be as specified in the Contract documents.

The Contractor shall complete the design of MSE walls in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, using the information contained on the Drawings and in accordance with these specifications. The Contractor's design responsibility shall include internal and external stability (sliding and overturning), tensile resistance, pullout resistances, and all other elements for a complete MSE wall system. The Contractor shall confirm the global stability design using actual soil properties of the backfill that will be used in the work.

If the wall system selected by the Contractor requires modification to any component of the project, the Contractor shall be solely responsible for all associated costs required to complete the change. Proposed changes shall be submitted to the Department Representative for review and acceptance a minimum of 3 weeks prior to commencement of detailed design.

The most stringent requirements of the following standards shall be met:

- GNWT Standards and Design Documents;
- CSA S6 – Canadian Highway Bridge Design Code (CHBDC);
- AASHTO LRFD Bridge Construction Specifications; and

The Federal Highway Administration (FHWA) Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes - Volumes 1 and 2 FHWA-NHI-10_024 and FHWA-NHI-10_025, is a recommended design reference.

MSE wall embedment depths shall not be less than provided in Table C11.10.2.2.1, Guide for Minimum Front Face Embedment Depth, of the AASHTO 2014 LRFD Bridge Design Specifications, and in addition shall not be less than 1 m.

The design life for all MSE wall system components shall be 100 years.

25.2.2 Drainage

All galvanized steel soil reinforcement shall be protected from exposure to roadway de-icing salt by an impermeable geomembrane placed above the top layer of soil reinforcement. This shall include soil reinforcement directly below a roadway, as well as immediately adjacent to the roadway for a minimum of 5 m measured perpendicular from the outer edge of the roadway shoulder. In addition, for MSE walls that run parallel to the roadway, impermeable geomembrane shall be provided to intercept any drainage from the roadway base layer and direct it away from all MSE walls.

Geomembranes shall be sloped at a minimum of 5% to drain away from the bridge and wall and be connected to an outlet beyond the MSE soil mass. A non-woven geotextile filter fabric layer shall be placed below and above the geomembrane to prevent puncture. In all cases the geomembrane material shall be made continuous and water-tight and shall extend a minimum of 500 mm beyond the extent of the steel soil reinforcement. Any necessary seams shall be shingled in the direction of drainage and welded or bonded to prevent leakage. Specific designs may warrant the use of roughened surface impermeable geomembranes.

Weep drains consisting of flexible perforated 150 mm diameter pipe complete with filter sock shall be provided near the front and the back bottom corner of the MSE soil mass. Weep drains shall be day lighted or connected to an outlet to establish positive drainage.

Downspouts shall be provided for deck joint and deck wick drain drainage directly in front of the MSE wall precast concrete fascia panels or rock-filled gabion baskets. Downspouts shall be rigid PVC type DB2 conduit meeting the requirements of CSA C22.2 No 211.1. Couplers shall be solvent bell ends (SBE). Downspouts shall have a vertical slip joint with a dished top drain inlet cast into the cast-in-place wall coping cap. Downspouts shall not be directed through the MSE soil mass. Down spouts shall be recessed full height in a chase formed into the front of precast concrete fascia panels or by using special fascia panels and covered with a 10-gauge or 2.6 mm thick steel plate. The plate shall be shop painted with a system selected from the SF2, SS1 or SS2 category of the Alberta Transportation's list of approved coating systems. Surface preparation shall be in accordance with the selected coating systems published product data sheet. The colour of top-coat shall match the colour of the MSE wall precast concrete fascia panel completed surface finish and be acceptable to the Department Representative.

Grassed swales with a non-degradable erosion control mat shall be provided behind the top of MSE cast-in-place concrete wall coping cap, beyond the footprint of the bridge deck, and shall have a minimum width of 600 mm, a minimum depth of 150 mm, and a minimum longitudinal (parallel to the face of the wall) slope of 0.5%.

Concrete swales of the same dimension as grassed swales shall be provided behind the top of MSE cast-in-place concrete wall coping cap within the footprint of the bridge deck. Closed cell foam of adequate thickness to accommodate thermal movements shall be provided between concrete swales and integral concrete bridge abutments. The closed cell foam shall be of a density that will not cause damage to adjoining components and meet all design service life requirements. A 10 mm thick asphalt impregnated fibre board shall be placed between the concrete swale and semi-integral or conventional concrete bridge abutments. Swales shall have a bottom liner of impervious geomembrane.

25.2.3 Geometric Requirements

All MSE walls shall be designed so that in the final position, they will be battered back against the retained soil from a vertical plumb line by a ratio of 50 vertical units to 1 horizontal unit. MSE precast concrete fascia panels or rock-filled gabion baskets shall be fully supported by compacted backfill without voids on the non-exposed side.

The geometry of MSE walls, including associated headslopes and embankments, shall be sloped so that all drainage is directed away from bridge abutments.

MSE wall backfill shall extend a minimum of 0.5 m beyond the end of the soil reinforcement.

Concrete leveling pads shall be used and project a minimum of 75 mm beyond both sides of the precast concrete fascia panels. Precast concrete fascia panels shall be centred on the concrete leveling pad. For stepped leveling pads, the maximum elevation difference between adjacent steps shall not exceed 1250 mm. The minimum length of each stepped section shall be 2500 mm.

Acute corners less than 70° (measured between backfill sides of precast concrete fascia panels) are not permitted. Special corner panels shall be used to maintain the 20 mm nominal design joint gap along the front face of panels on either side of the bend line.

Soil reinforcing details shall be designed to accommodate the requirements in Subsection 25.5.5, Backfilling, for overlapping reinforcing.

25.2.4 Vertical Slip Joints

For situations where a continuous length of MSE wall cannot be built all at the same time as a result of an existing obstruction (e.g. existing bridge, or existing roadway, etc.), the continuous length of MSE wall may be divided into multiple sections and some or all of the sections constructed at different times. For these occurrences, a full height vertical slip joint, acceptable to the Department Representative, shall be provided between adjacent MSE wall sections. This method of staging MSE wall construction shall not be confused with two stage MSE wall construction, which is not permitted.

The cast-in-place concrete wall coping cap shall be designed with vertical joints in line with the precast concrete fascia panel joints, and with horizontal reinforcement in the cap to be discontinuous at these vertical joints.

25.2.5 Obstructions

Obstructions within the MSE soil mass, such as foundation piles and associated casings, casings for future pile installations, or other obstructions, shall be accommodated with acceptable arrangement of soil reinforcing around such obstructions. For those MSE wall systems that splay the soil reinforcement, the splay angle shall not exceed 15° from the perpendicular of the precast concrete fascia panel. For other MSE wall systems, coverage ratios of soil reinforcement shall be specifically developed for each wall location within the Contract and design calculations included in the design notes and check note submissions.

25.2.6 Precast Concrete Fascia Panels

Precast concrete fascia panels shall have a minimum thickness of 140 mm, excluding any additional thickness required for aesthetic surface treatments. The minimum cover to reinforcing steel shall be 50 mm from all faces, and steel reinforcing bars shall be electrically isolated from steel connection hardware and/or steel soil reinforcement.

Joints between panels shall have a lip and recess (ship lap) configuration. Butt joints may be used if a precast Class HPC concrete backing block with filter fabric is designed and installed along the joint to prevent soil infiltration. Backing blocks shall overlap adjacent panels a minimum of 150 mm and have a minimum thickness of 140 mm.

Precast concrete fascia panels shall be designed to accommodate a differential settlement of 100 mm in 10 m of length along the wall. The gap spacing between adjacent precast concrete fascia panels shall be designed to be 20 mm nominal.

To facilitate construction of the cast-in-place concrete wall coping cap pre-formed holes in precast concrete fascia panels are permitted provided the holes are located a minimum of 100 mm above the cast-in-place wall coping cap soffit.

A minimum 300 mm wide strip of filter fabric shall be installed behind all precast concrete fascia panel joints. Adhesive shall be used to hold the fabric securely against the panels centred on the vertical and horizontal joints. Details proposed by the Contractor shall be submitted to the Department Representative for review and acceptance prior to commencement of the work. At MSE wall corners, the fabric shall be installed in one piece crossing the corner joint.

25.2.7 Cast-In-Place Concrete Wall Coping Cap

A cast-in-place concrete wall coping cap is required on the top of all MSE walls, unless the section of MSE wall requires a cast-in-place concrete barrier slab.

The top of the cast-in-place wall coping cap shall be smooth, have no steps or abrupt changes in height, and a 3% wash slope towards the MSE soil mass. Control joints and drip grooves shall be detailed in accordance with the Drawings. Control joints shall be located at the centerline of the precast concrete fascia panel joints, perpendicular to the wall direction and in no case exceed 4 m spacing. At control joints, longitudinal reinforcing in the cast-in-place wall coping caps shall be discontinuous and have a 50 mm concrete cover measured from the centre of the joint.

The MSE wall and cast-in-place wall coping cap shall be designed to fully resist the loads specified on the Drawings that are applied to the roadway barriers, railings or any attachments.

25.2.8 Gabion Basket Facades

Gabion basket cages shall have a minimum box dimension of 1000 mm long x 1000 mm wide x 300 mm high and be arranged in uniform sizes. No cage shall exceed 6000 mm in length or 1000 mm in height. Boxes placed on top of each other are to be recessed back a minimum of 150 mm from the lower front face, creating a staggered facade.

Diaphragms shall be installed at a minimum of 1000 mm intervals in boxes that exceed 1000 mm in length. All buried gabion faces are to be wrapped in filter fabric which is to be securely fixed in place and lapped a minimum of 300 mm with adjacent layers.

All gabion walls are to be founded on well engineered, compacted material designed to withstand the overall gravity loads specified in the drawings.

25.2.9 Inspection Components

An inspection access walkway shall be provided full width of the bridge superstructure in front of the abutment seat and on top of MSE abutment walls. The inspection access walkway shall have a minimum vertical clearance of 1200 mm under the girders and a minimum clear width of 1000 mm.

Galvanized steel inspection wires shall be provided in all MSE wall systems in addition to the soil reinforcement design requirements. One inspection wire shall be provided for each 25 m^2 of wall area. Inspection wires shall be placed in vertically distributed sets of 2 or 3 depending on the wall height. Two locations shall be provided where the wall height is less than 6 m and three locations provided where the wall height is greater than 6 m. Vertical distribution shall be such that a single inspection wire is placed within the centre of the bottom wall precast concrete fascia panel, centre of the top wall precast concrete fascia panel, and in the centre wall precast concrete fascia panel when three locations are required. Sets of inspection wires shall be evenly distributed along the length of the wall.

Inspection access ports, wire removal and centring devices shall be detailed in accordance with the California Department of Transportation Standard Bridge Detail Sheet XS13-020-3. Inspection access ports shall be cast as voids in the panels at the panel manufacturing facility and the remaining cavity placed and filled with an approved type OH-V patching product in accordance with the manufacturer's recommendations. All inspection access ports shall be marked with a 25 mm diameter galvanized or plastic survey target anchored into the patching material and flush with the wall surface. Adhesively mounted survey targets will not be permitted. Survey targets shall not receive pigmented sealer.

25.2.10 Proprietary Structures Design

The design of sign structures under this specification shall be in accordance with the requirements of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

In addition to the requirements of Section 27, the shop drawings shall include, as a minimum, the following information:

- Wall layout plan and elevation complete with dimensions and elevations, and typical wall cross-sections;
- Precast concrete fascia panel reinforcing, connection and hardware detailing;
- Gabion Basket Facades
- Cross references to relevant bridge design Drawings;
- Design criteria and list of material properties;

- Extent of excavation;
- Backfill properties;
- All component and connection details;
- MSE wall drainage details; and
- Construction procedures and construction sequencing.

The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

25.3 Materials

25.3.1 Mill Test Reports

Mill test reports shall be provided in English for all steel fabricated components, steel soil reinforcement, connections, and associated hardware. Material test reports shall be provided for geosynthetic soil reinforcement and impermeable geomembrane. Mill and material test reports shall be submitted to the Department Representative for review and acceptance prior to being incorporated into the work.

The Contractor shall maintain a tracking system and complete set of records for all steel fabricated components. Mill test reports at a minimum shall include: heat number, date, location of production, compliance with production standards, chemical analysis, mechanical properties, including galvanizing processes. Mill test reports shall be authenticated by the manufacturer.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

25.3.2 Concrete

Concrete for leveling pads shall be Class C. Concrete for precast concrete fascia panels, anchor blocks, backing blocks, cast-in-place concrete wall coping caps, and all other concrete components shall be Class HPC. Concrete shall conform to the requirements of Section 4, Cast-In-Place Concrete. The maximum aggregate size for Class HPC concrete used in panel production shall suit the panel design and the requirements of CSA S6 and CSA A23.1.

25.3.3 Reinforcing Steel for Concrete

Reinforcing steel shall be in accordance with the requirements of Section 5, Reinforcing Steel.

25.3.4 Steel Soil Reinforcement, Connections and Hardware

Steel soil reinforcement consisting of welded wire reinforcement shall meet the requirements of ASTM A1064/A1064M. Steel soil reinforcement consisting of steel strip reinforcement shall meet the requirements of ASTM A572/A572M. Inspection wires shall meet the requirements of ASTM A1064/A1064M. Connections and hardware shall meet the specified design life of 100 years.

Steel with a boron content exceeding 0.0008% will not be permitted.

25.3.4.1 Galvanizing

Steel soil reinforcement, connections and associated hardware shall be galvanized in accordance with ASTM A123/A123M and ASTM F2329/F2329M. Safeguarding measures to prevent embrittlement and testing to detect embrittlement shall be completed in accordance with ASTM A143/A143M for all lots of steel soil reinforcement, connections and associated hardware.

Repair of damaged or insufficiently coated galvanized material shall be completed in accordance ASTM A780/A780M Method A3, Metallizing and will only be permitted when damaged areas are small and infrequent as determined by the Department Representative. Damaged or insufficiently coated areas less than 100 mm^2 in area may be repaired in accordance with ASTM A780/A780M Method A1, Repair Using Zinc-Based Alloy. The thickness of the coating for Method A3 and A1 shall be 180 μm, and the repair tested for adhesion.

Galvanized material shall be stacked or bundled and stored to prevent wet storage staining. Wet storage staining will be identified by the Department Representative in accordance with the American Hot Dip Galvanizers Association (AHDGA) Wet Storage Stain. Light and medium wet storage stains shall be removed by brushing with a stiff-bristled nylon brush to the satisfaction of the Department Representative. Heavy and extreme wet storage stains shall be repaired.

A repair procedure shall be submitted to the Department Representative for review and acceptance when damaged or insufficiently coated galvanized material is large and/or frequent, as determined by the Department Representative, and/or for heavy/extreme wet storage staining. The Department Representative's review comments shall be incorporated into the repair procedure to the satisfaction of the Department Representative prior to commencement of the work. Repairs may require complete removal of the galvanized coating and re-galvanizing. The finished appearance shall be similar to the adjacent galvanizing as determined by the Department Representative.

25.3.5 Geosynthetic Soil Reinforcement

Geosynthetic soil reinforcement shall meet Article 11.10.6.4.3b, Geosynthetic Reinforcements, of the AASHTO 2020 LRFD Bridge Design Specifications. The requirements "for applications involving severe consequences of poor performance or failure" shall apply. Product specific durability studies shall be carried out to determine the product-specific long term strength reduction factor (RF) and shall be submitted for the Department Representative's review and acceptance. These studies shall be used to estimate the short term and long term effects of the environment factors on the strength and deformational characteristics of the geosynthetic reinforcement throughout the specified design life.

Geosynthetic reinforcing materials shall satisfy the requirements of the following tests:

- ASTM D7737/D7737M;
- GRI-GG2 - GG Junction Strength;
- ASTM D5262;

- GG4-05, Standard Practice for Determination of the Long Term Creep Design Strengths of Geogrids;
- GG4(a), Standard Practice for Determination of the Long-Term Design Strength of Stiff Geogrids – 2012;
- GG4(b), Standard Practice for Determination of the Long-Term Design Strength of Flexible Geogrids – 2012; and
- ASTM D6706.

Geosynthetic reinforcing materials shall contain stabilizers or inhibitors to prevent degradation of properties due to ultraviolet light exposure.

The nominal long-term reinforcement design strength (Tal) values for specific products shall be determined by third party agencies such as the Highway Innovative Technology Evaluation Centre (HITEC) or AASHTO National Transportation Product Evaluation Program (NTPEP) and product lines shall be retested at a minimum of every 3 years.

25.3.6 Safety Railings

Steel components of safety railings shall be fabricated and galvanized in accordance with Section 12, Bridgerail. Safety railings shall conform to CSA G40.21 Grade 300W.

25.3.7 Backfill

Backfill for construction of MSE walls shall be crushed aggregate material conforming to the gradation requirements listed in Table 25-1, Backfill Gradation Requirements, and shall be free of organic matter and other deleterious materials.

Table 25-1 Backfill Gradation Requirements

Metric Sieve Size (CGSB 8-GP-2M)	**Designation/Class**		
	Crushed Aggregate Material Des 2 Class 20	**Crushed Aggregate Material Des 2 Class 25**	**Crushed Aggregate Material Des 2 Class 40**
Sieve Size µm	**Percent Passing**	**Percent Passing**	**Percent Passing**
40 000	100	100	100
25 000	100	100	70 - 94
20 000	100	82 - 97	n/a
16 000	84 - 94	70 - 94	55 - 85
10 000	63 - 86	52 - 79	44 - 74
5 000	40 - 67	35 - 64	32 - 62
1 250	22 - 43	18 - 43	17 - 43
630	14 - 34	12 - 34	12 - 34
315	9 - 26	8 - 26	8 - 26
160	5 - 18	5 - 18	5 -18
80	2 - 10	2 - 10	2 - 10

% fractures by weight (2 faces)	60+	60+	50+
Plasticity Index	NP - 6	NP - 6	NP - 6
L.A. Abrasion Loss Percent Maximum	50	50	50

Laboratory density testing shall be completed in accordance with ASTM D698 on the selected backfill source(s) and provided in the submission requirements outlined in Subsection 25.2.10, Proprietary Structures Design.

The physical properties of the MSE wall backfill material selected by the Contractor from Table 25-1, Backfill Gradation Requirements shall be used by the MSE wall supplier in the detailed design of the MSE wall.

In no case shall any backfill placed within 2 m of the precast concrete fascia panels or rock-filled gabions baskets have more than 5% passing the 0.080 mm (80 μm) sieve size.

Soil filters between soil zones shall be designed based on the properties of the adjacent materials.

The selected backfill material shall also meet all field and laboratory testing requirements specified in Table 25-2, Backfill Requirements for Galvanized Steel Soil Reinforcing or Table 25-3, Backfill Requirements for Geosynthetic Soil Reinforcing, based on soil reinforcement type used in the MSE wall system.

Table 25-2 Backfill Requirements for Galvanized Steel Soil Reinforcing

Backfill Requirement		**Test Method (ASTM)**	**Test Method (AASHTO)**
Resistivity	≥3000 ohm-cm	ASTM G57	AASHTO T 288
pH	5 - 10	ASTM G51	AASHTO T 289
Chlorides	≤100 ppm	ASTM D512	AASHTO T 291
Magnesium Sulphate Soundness	Loss less than 30% after four cycles	ASTM D5262	AASHTO T 104
Sulphates	≤200 ppm	ASTM D516	AASHTO T 290
Organic Content	≤1.0%	ASTM D2974	AASHTO T 267

Table 25-3 Backfill Requirements for Geosynthetic Soil Reinforcing

Backfill Requirements		**Test Method (ASTM)**	**Test Method (AASHTO)**
pH	3 - 12	ASTM G51	AASHTO T 289
Organic Content	≤1.0%	ASTM D2974	N/A
Design Temperature at Site	≤30°C	N/A	N/A

Collection of samples for testing shall be from proposed stockpiles at the top, middle and bottom portions, approximately 0.6 m in from the face of the stockpile. Resistivity testing shall be completed on 6 samples (2 top, 2 middle, 2 bottom). PH, chloride, sulphate, and organic content testing shall be completed on 9 samples (3 top, 3 middle, 3 bottom).

25.3.8 Geotextile Filter Fabric

Non-woven geotextile filter fabric shall meet the requirements specified in Table 25-4, Non-woven Geotextile Filter Fabric Requirements.

Table 25-4 Non-woven Geotextile Filter Fabric Requirements

Physical Property	Test Method (ASTM)	Minimum Required Value
Grab Strength	ASTM D4632/D4632M	650 N
Elongation – Failure	ASTM D4632/D4632M	50 %
CBR Puncture Strength	ASTM D6241	250 N
Trapezoidal Tear	ASTM D4533/D4533M	275 N

The minimum fabric lap length shall be 300 mm.

25.3.9 Impermeable Geomembrane

Impermeable geomembrane shall be PVC, HDPE or LLDPE with a minimum thickness of 0.75 mm, and meet the physical property requirements outlined in Table 25-5, Impermeable Geomembrane Requirements.

Table 25-5 Impermeable Geomembrane Requirements

Physical Property	Test Method (ASTM)	Minimum Required Value
Tear Strength	ASTM D1004	45 N
CBR Puncture Strength	ASTM D4833	140 N

25.3.10 Precast Concrete Fascia Panel Installation Shims

All proposed permanent shims used in precast concrete fascia panel installation shall meet the specified design life of the MSE wall.

25.3.11 Gabion Basket Facades

25.3.11.1 Rock Requirements for Gabion Units

Gabion baskets shall be filled with clean, hard, non-weathered rock of average least dimension equal to 125mm and no larger than 200mm for boxes less than 500mm high and 250mm for boxes greater than 500mm in height.

Table 25-6 Rock Requirements for Gabion Units

Depth of cage (mm)	Rock size according to largest dimension	
	Average smallest dimension (mm)	Maximum (mm)
300	125	200
>500	125	250

25.3.11.2 Wire Requirements for Gabion Units

All wire and wire mesh used in the construction of the baskets shall comply to ASTM 975-20. Wire diameters and coating areas shall be no less than the following values given in Table 2:

Table 25-7 Wire Requirements for Gabion Units

Wire Designation (1)	**Type**		
	Galvanized Basket	**Galvanized and PVC Coated Basket**	**Galvanized and PVC Coated Mattress**
Netting Wire dia. (mm)	2.90	2.65	2.20
Self-Edge Wire dia. (mm)	3.85	3.40	2.65
Binding Wire dia. (mm)(2)	2.20	2.20	2.20
Zinc Coating (gm/m^2)	245		
PVC Coated (mm)	--	0.42	

Notes:

(1) The allowable tolerance on all properties is ± 3%
(2) Galvanized clips with a wire diameter of 2.90 mm may be used with galvanized baskets.

25.4 Supply and Fabrication of Precast Concrete Fascia Panels

The fabrication of precast concrete fascia panels shall be fabricated and supplied in accordance with Section 7, Precast Concrete Units and this Subsection. In the case of conflicting requirements, the requirements of this Subsection shall apply.

The concrete materials used in the fabrication of precast concrete fascial panels shall meet the requirements of Subsection 25.3.2, Concrete.

All edges of precast concrete fascia panels shall be chamfered.

Geosynthetic reinforcing embedded into precast concrete fascia panels shall be installed using structural steel jigs to maintain alignment and projection lengths. Geosynthetic reinforcing embedded into precast concrete fascia panels shall exit perpendicular to the precast concrete fascia panel unless otherwise reviewed and accepted by the Department Representative. Geosynthetic reinforcing tabs exiting precast concrete fascia panels shall have a uniform projection length.

Concrete shall have a minimum compressive strength of 18 MPa prior to formwork removal.

Exposed precast concrete fascia panels shall be finished in accordance with Subsection 4.25, Concrete Surface Finish with the exception that all required surface cavities shall only be filled with a Department approved concrete patching material and trowelled smooth to a uniform texture similar to a form finish. The entire exposed precast concrete fascia panel finish texture shall be a form finish, not abrasive brush blasted, and not washed or rubbed with concrete patching or sacking materials. Class 3 concrete surface finishes, when specified, shall not be applied until the Department Representative has reviewed and accepted the precast concrete fascia panel installation and cast-in-place concrete coping cap work at the project site.

Precast concrete fascia panels with the following defects will be rejected:

- Units with variation in the trueness of the face of a precast concrete fascia panel when checked with a 1 m long straight edge placed in any direction on the concrete surface, the gap between the straight edge and the concrete surface exceeds 2 mm
- Units with honeycombing, cracks, spalls or broken corners;
- Units with more than 10 surface cavities per m^2 with cavity diameters from 2 mm up to 5 mm;
- Units with more than three surface cavities per m^2 with cavity diameter from 5 mm up to 10 mm; and
- Units with any surface cavities greater than 10 mm in diameter.

Inspection and assessment of surface cavities shall be completed by the Contractor immediately after stripping of forms. Surface cavities of 5 mm or less on precast concrete fascia panels meeting the above criteria will not require further repair.

Repair of surface cavities shall be completed in a sheltered environment with a minimum ambient temperature of 10°C. Saturation of the face of the precast concrete fascia panels in preparation for the repair of surface cavities shall begin immediately after stripping. During repair of surface cavities, and up to the start of elevated temperature curing or moist curing, panel faces shall be kept in a continuously saturated surface dry condition. As an alternative to moist curing with filter fabric, precast concrete fascia panels may be moist cured in an enclosure with controlled temperature and humidity such that all exposed concrete surfaces remain saturated for the duration of the curing period. If stacked during curing, sufficient space shall be maintained between panels to permit airflow and inspection of surfaces by the Department Representative.

25.5 Construction

25.5.1 General

The Contractor shall employ qualified personnel experienced in constructing MSE walls to supervise and perform the work. Construction of the MSE wall system shall conform to the shop drawings, supplier's submitted construction procedures and construction sequencing, and these specifications.

The Contractor shall also require the supplier of the MSE wall system to provide a full-time qualified representative on site during construction to advise the Contractor's personnel regarding construction procedures and to monitor that construction is being completed in accordance with the shop drawings and the supplier's submitted construction procedures and construction sequencing. The MSE wall supplier's full-time representative shall have a minimum of 5 years of MSE wall construction experience. Qualifications of the MSE wall supplier's full-time representative shall submitted to the Department Representative for review and acceptance 3 weeks prior to the construction milestone meeting. The MSE wall supplier's full-time representative shall also be acceptable to the MSE wall engineer of record in accordance with Section 27, Design, Supply and Installation of Proprietary Works by the Contractor.

A construction milestone meeting for MSE wall construction shall be held a minimum of 3 weeks prior to the commencement of the work. The agenda shall be developed by the Contractor and MSE wall supplier and reviewed and accepted by the Department Representative prior to scheduling the meeting. The Contractor's project manager, MSE wall construction superintendent, the MSE wall engineer(s) of record, MSE wall supplier construction representative, and any other personnel directly involved in supervision of the work shall attend the construction milestone meeting at date, time and location acceptable to the Department Representative.

The Contractor shall provide the Department Representative with a weekly summary report detailing daily construction activities and compliance. Work that is not in compliance with the accepted shop drawings, construction sequencing and procedures, shall be corrected immediately to the full satisfaction of the Department Representative.

The Contractor shall meet all requirements of Section 27 during construction and for post-construction documentation.

25.5.2 Conformance Criteria

Further to of Section 27, Design, Supply and Installation of Proprietary Works by the Contractor, the Contractor shall provide, as a minimum, a construction report for each of the following construction phases confirming compliance with all Contract requirements:

- Foundation base preparation;
- On-site delivery of all MSE wall components;
- Backfill requirements;
- Alignment of precast concrete fascia panels or gabions; and
- Wall alignment and tolerance measurements.

Construction reports will be considered Professional Work Products and shall be authenticated by a Professional Engineer responsible for field reviews in accordance with Section 27.

The Contractor shall maintain soil reinforcing placement records, soil compaction records, and precast concrete fascia panel alignment and tolerance measurement records throughout MSE wall construction and submit them to the Department Representative on a daily basis within 24 hours.

MSE wall components that are damaged during construction shall be repaired or replaced at the Contractor's expense as outlined in these specifications and completed to the full satisfaction of the Department Representative.

25.5.3 Excavation

Excavation for the MSE wall construction shall be carried out in conformance with Section 1, Excavation and this specification. In the case of conflicting requirements, the requirements of this Section shall govern.

The Contractor shall establish the locations and extents of all existing underground services in the work area prior to commencement of work. All underground utility locations shall be clearly marked and protected during the course of construction. Damages to existing utilities resulting from the Contractor's operations shall be repaired at the Contractor's expense and to the satisfaction of the Department Representative.

Excavation shall be completed to the design grades shown on the design drawings, shop drawings, and as determined by the Department Representative. The Contractor shall proof roll the foundation subgrade after excavation to identify any soft spots. Soft material, as determined by the Department Representative, shall be removed and replaced with compacted crushed aggregate material to the satisfaction of the Department Representative. Any temporary excavation support required shall be the sole responsibility of the Contractor and no separate or additional payment will be made.

The Contractor shall not commence further construction of the MSE wall until the excavation, ground improvements, and foundation base preparation have been completed and the sealed and signed formalized documentation has been submitted to the Department Representative for review and acceptance. The Department Representative's review and acceptance of the foundation base preparation shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

25.5.4 Concrete Leveling Pads

Construction of concrete leveling pads shall conform to the requirements of Section 4, Cast-In-Place Concrete. Concrete leveling pad elevations shall be set by instrument. The deviation from the detailed design profile shall not exceed 3 mm over a 3 m length. After erection of the first row of precast concrete fascia panels, any openings between leveling pad steps shall be formed and filled with Class C cast-in-place concrete in a method acceptable to the Department Representative.

Concrete leveling pads that are not constructed to the elevations shown on the Drawings and/or within the specified tolerances, as determined by the Department Representative, shall be removed and replaced. After the removal of the unacceptable concrete leveling pads, the foundation base shall once again be prepared, inspected, reviewed and accepted by the Department Representative in accordance with Subsection 25.5.2, Conformance Criteria.

25.5.5 Backfilling

Backfill material shall be placed and compacted in accordance with Section 2, Backfill, the MSE wall supplier's recommendations and these specifications. In the case of conflicting requirements, the most stringent requirements shall govern.

All backfill material shall be placed in lifts not exceeding 150 mm in thickness of loose material.

The Contractor shall not place backfill material on frozen substrate.

Backfill material shall be placed such that soil reinforcement is fully supported for the entire length of the soil reinforcement. At precast concrete fascia panel connections, small localized pockets may be present to facilitate connection hardware installation. The extent of the small, localized pockets shall be in accordance with the supplier's recommendations and acceptable to the Department Representative.

No equipment shall be allowed to run directly on soil reinforcement. Backfill material compaction shall be performed such that equipment moves parallel and away from the precast concrete fascia panels, toward the end of the soil reinforcement. Only hand operated power tampers and vibrators shall be used for compaction within 1000 mm of the precast concrete fascia panels. At the completion of each day's work the Contractor shall slope the last level of backfill material away from the precast concrete fascia panels to direct potential run-off water.

Backfill placement and compaction shall closely follow the erection of each course of precast concrete fascia panels. Backfill material shall be placed in such a manner as to avoid any damage or disturbances of the MSE wall components or misalignment of the precast concrete fascia panels. Any MSE wall components that are damaged during backfill material placement as determined by the Department Representative shall be removed and replaced at the Contractor's expense. Any misalignment or distortion of the precast concrete fascia panels or rock-filled gabion baskets due to placement of backfill material shall be corrected by the Contractor at their expense and to the satisfaction of the Department Representative prior to continuing with the Work.

The Contractor shall ensure that the soil reinforcement is installed in a taut manner and remains taut during backfilling.

For any wall layout where overlap of geosynthetic reinforcement occurs, a minimum of 75 mm of compacted backfill material shall be placed between geosynthetic reinforcement layers.

A control strip density shall be established on the first lift and every 900 vertical millimetres of backfill material placed thereafter (once every 6 lifts) for every 45 m of wall or part thereof and not less than once per day. The control strip density shall be measured in accordance with Alberta Transportation Test Method ATT-58A, Density Test Control Strip Method. All backfill material lifts shall be compacted to a minimum of 98% of the control strip density and shall be measured in accordance with Alberta Transportation Test Method ATT-11, Density Test In-Place Nuclear Method. Compaction testing results shall be provided to the Department Representative at the end of each day or as requested by the Department Representative.

Sieve analysis shall be completed on backfill material being placed at the beginning and end of each day for each zone of backfill containing soil reinforcing. Results shall be submitted to the Department Representative at the end of each day or as requested by the Department Representative. The Contractor shall also complete sampling and testing of the backfill material during construction in accordance with Table 25-8, Backfill Sampling and Testing Requirements during Construction, to demonstrate continued compliance.

Table 25-8 Backfill Sampling and Testing Requirements during Construction

Range of Resistivity (ohm-cm)	Sample Interval for Resistivity Testing (m^3)	Sample Interval for PH, Chlorides, Sulphates, Organic Testing (m^3)
>5000	3000	1500
<5000 and ≥3000	1500	750

If any test result does not meet specification requirements, the Contractor shall stop backfilling operations immediately and resample and retest the backfill material. Additional testing of material already placed may be required and will be determined by the Department Representative. Test results shall be submitted to the Department Representative within 3 days of completion. Backfilling operations shall not continue until all testing is completed and any non-compliant backfill material removed and replaced. All costs associated with sampling and testing, including removal and replacement of non-compliant backfill material, and the replacement of any damaged MSE wall components shall be at the Contractor's expense and to the satisfaction of the Department Representative.

25.5.6 Precast Concrete Fascia Panel Installation

The height of shims at any location shall not exceed the specified precast concrete fascia panel installation tolerances.

Any precast concrete fascia panel damaged during installation, including cracks, spalls or broken corners, as determined by the Department Representative, shall be rejected, and new precast concrete fascia panels provided by the Contractor and at the Contractor's expense.

All precast concrete fascia panel lifting hook pockets shall be patched with an approved type NH or HEH concrete patching material. The approved concrete patching material shall be placed in accordance with the manufacturer's recommendations.

Precast concrete fascia panels shall be installed to the following tolerances:

- The out-of-flatness of wall surfaces measured in any direction shall not exceed 25 mm under a 3 m straight edge;
- The offset of adjacent panel edges at joints shall not exceed 10 mm;
- The overall out-of-vertical alignment of the completed wall shall not exceed 4 mm/m of the total MSE wall height; and
- The joint gap width shall be between 10 mm and 30 mm.

For any precast concrete fascia panel that does not meet the specified installation tolerance, the backfill material shall be removed and the precast concrete fascia panel reset to the specified tolerance before continuing with further construction.

After all precast concrete fascia panels have been acceptably installed as determined by the Department Representative, the exposed concrete surfaces shall be thoroughly cleaned and prepared by high pressure washing and allowed to dry for 72 hours. Upon acceptance of the prepared concrete surfaces by the Department Representative, the specified concrete surface finish shall be applied.

25.5.7 Cast-in-Place Concrete Wall Coping Caps

Construction of cast-in-place concrete wall coping caps and surface finishes shall conform to the requirements of Section 4, Cast-In-Place Concrete and Section 5, Reinforcing Steel. Cast-in-place concrete wall coping cap elevations shall be set by instrument.

Galvanized anchor bolt assemblies for safety railings shall be cast into the concrete.

Cast-in-place concrete wall coping cap sections located at corners shall be isolated from contact with other concrete components with 12 mm thick closed cell foam.

25.5.8 Gabion Basket Facades

Gabions shall be placed on level, well compacted foundations, firmly connected to the front edge of the trench. All buried faces shall be wrapped in filter fabric meeting the minimum grades as specified in Subsection 25.3.8, Geotextile Filter Fabric, and laps shall be minimum 300mm. Cages are to be packed in uniform layers no more than 250mm between adjacent boxes, to achieve an even-faced finish and filled to just below the top wire brace. The braces are then to be twisted to provide tension.

Backfill shall be placed before subsequent layers are installed and compacted to design drawing specifications.

Gabion units, grouped together to form a gabion structure, shall be securely bound to each other along all contacting self-edges in the same manner as the faces are bound in the assembly of the cages.

25.5.9 Impermeable Geomembrane

Seams of impermeable geomembranes shall be placed parallel to the MSE wall and lapped in the direction of positive drainage to produce a shingling effect. The membrane shall be installed in accordance with the manufacturer's recommendations and in weather conditions that are acceptable to the Department Representative.

25.5.10 Safety Railings

All steel components of safety railings shall be installed in accordance with Section 12, Bridgerail.

25.5.11 Material Storage

The Contractor's lay-down area shall be graded level to ensure precast concrete fascia panels or rock-filled gabion baskets are safely and uniformly supported on timber bearing blocks with plastic separators. Precast concrete fascia panels shall be stacked on timber planks or pallets and separated by timber blocks with dimpled plastic separators designed by a Professional Engineer licensed to practice in the Northwest Territories and Nunavut.

Precast concrete fascia panels shall be stored such that the uniform colour of the panels is maintained and protected from staining or discolouration. Panels with stained, discoloured, or damaged front faces as determined by the Department Representative shall not be incorporated into the wall.

All materials shall be stored above ground, covered and protected from rain, snow, dirt, and ultraviolet light. Any damage identified by the Department Representative shall be repaired by the Contractor to the full satisfaction of the Department Representative.

25.5.12 Drainage Management during Construction

The Contractor shall construct, maintain and modify temporary drainage features to prevent adverse amounts of surface run-off water from entering the MSE wall construction area. Any erosion or other adverse effects, resulting from inadequate drainage management shall be immediately addressed by the Contractor and repaired to the full satisfaction of the Department Representative.

25.6 Measurement and Payment

Measurement for payment of mechanically stabilized earth walls will be by the square metre of wall acceptably installed, measured to the nearest 0.1 m^2.

Payment will be made at the unit price bid for "Mechanically Stabilized Earth Walls", and will be full compensation for the proprietary structure design; supply; fabrication; delivery; installation; testing and inspection construction; and all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings, shop drawings, and to the satisfaction of the Department Representative.

90% of the unit price bid will be paid once the MSE precast concrete panels or rock-filled gabion baskets have been acceptably installed and backfilled. The remaining 10% of the unit price bid will be made once the cast-in-place concrete wall coping caps have been placed and specified surface finishes applied, safety railings have been installed, drainage systems are functional, and the Contractor has fulfilled all proprietary structure requirements, as determined by the Department Representative.

STANDARD SPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 26 RCP AND PBC STRUCTURES

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26.1 General

This specification is for the supply and fabrication, delivery, and installation of Reinforced Concrete Pipe (RCP) and Precast Box Culvert (PBC) structures.

The Work shall be carried out as shown on the Drawings and in accordance with the following specifications. Where standards and standard specifications are referenced, the version current at the time of tendering shall govern, unless a specific date is identified. Metric versions are inferred, when available and relevant. The requirements of these specifications shall govern over all referenced standards in the case of conflicting requirements.

Any underground utilities located on the Drawings are approximate and are to be confirmed by the Contractor at the project site.

26.2 Supply and Fabrication

The Contractor shall submit a supply and fabrication inspection and test plan (ITP) for RCP and BPC structures to the Department Representative a minimum of 6 weeks prior to commencement of the work. The Contractor's supply and fabrication ITP shall include, but not be limited to, all specified witness points, hold points, inspection and testing requirements, and the associated acceptance criteria for each component being fabricated. The Contractor's supply and fabrication ITP shall also include and clearly identify the party and person/position responsible for providing written acceptance of witness points, hold points, quality control inspection and testing, and reporting requirements. Fabrication shall not commence until the Contractor's supply and fabrication ITP has been reviewed and accepted in writing by the Department Representative.

26.2.1 Reinforced Concrete Pipe

RCP shall be supplied and fabricated according to the design method used. The design method for RCP will be indicated in the Special Provisions of the Contract.

Indirect designed RCP including flared end pipe sections shall be supplied and fabricated in accordance with CSA A257 or ASTM C76M and these specifications.

Direct designed RCP structures shall be supplied and fabricated in accordance with ASTM C1417M and these specifications.

When specified on the Drawings, maintenance access holes (manholes) shall be supplied and fabricated in accordance with ASTM C478M.

In the case of conflicting requirements, the requirements of these specifications shall govern.

26.2.2 Precast Box Culvert

The supply and fabrication of all PBC structures shall be in accordance with ASTM C1433M and these specifications. In the case of conflicting requirements, the requirements of these specifications shall govern.

26.2.3 Qualifications

RCP and PBC sections shall be supplied and fabricated by a fabricator certified by the Canadian Precast Concrete Quality Assurance (CPCQA) Certification Program in the applicable Product Group classification. A copy of the fabrication facility's current CPCQA certificate of conformity along with the latest CPCQA inspection audit report shall be submitted to the Department Representative for review and acceptance prior to the prefabrication meeting.

The fabricator shall notify the Department Representative of any sub-contractors in their employ. The fabricator shall be responsible for the work of their sub-contractors. All terms of the Contract, such as right of access, shall apply to the fabricator and all sub-contractors.

The fabrication of RCP and PBC structures shall be completed in a sufficiently large environmentally controlled permanent building capable of manufacturing products in a well-organized and continuous operation. The building shall be capable of maintaining a controllable temperature and humidity to meet fabrication requirements and prevent material contamination and/or deterioration.

26.2.4 Prefabrication Submissions

The Contractor shall submit the following information to the Department Representative for review and acceptance a minimum of 4 weeks prior to the commencement of fabrication unless noted otherwise:

- List of fabricators and qualifications;
- Fabrication sequence and equipment;
- Shop drawings;
- Modifications to RCP and PBC Structures, if applicable;
- Mill test reports and product data sheets;
- Concrete mix design; and
- Fabrication schedule.

Prefabrication submissions will be considered hold points and shall be included in the Contractor's supply and fabrication ITP. The Contractor and the Department Representative shall provide written acceptance of the prefabrication submission hold points in the supply and fabrication ITP prior to the commencement of fabrication.

26.2.4.1 List of Fabricators and Qualifications

The Contractor shall submit a list of all fabricators and their sub-contractors detailing their scope of work, qualifications, and certifications. The Contractor shall also submit the quality control plans of all fabricators and their sub-contractors.

26.2.4.2 Fabrication Sequence and Equipment

The Contractor shall submit details of the fabrication sequence and equipment that will be used to complete the work.

26.2.4.3 Shop Drawings

Shop drawings shall be submitted to the Department Representative for review and acceptance a minimum of 4 weeks in advance of the commencement of fabrication. The Department Representative's review comments shall be incorporated into the shop drawings to the satisfaction of the Department Representative and the shop drawings resubmitted prior to the commencement of fabrication.

Shop drawings shall be electronic unlocked PDF format. Each shop drawing shall have a sufficient blank space for the Department Representative's review stamp.

The shop drawings will be reviewed by the Department Representative solely to ascertain general conformance with codes and specifications. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for completing the Work in accordance with the Contract requirements.

The Contractor shall incorporate as-built construction details, including the actual mill test report heat numbers into the shop drawings. One electronic copy (PDF format) of as-built shop drawings shall be submitted to the Department Representative within 3 weeks of construction completion.

Shop drawings are not required for RCP fabricated in accordance with ASTM C76M or CSA A257.

26.2.4.4 Modifications to RCP and PBC Structures

If modifications to RCP or PBC structures are proposed by the Contractor, design notes, independent check notes, and shop drawings shall be submitted to the Department Representative for review and acceptance a minimum of 6 weeks prior to commencement of the work. Design notes, independent check notes and shop drawings will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. The design notes, independent check notes, and shop drawings will be reviewed by the Department Representative for conformance with the Government of the Northwest Territories' design requirements and the Contract requirements. Review comments provided by the Department Representative shall be incorporated into the design notes, independent check notes and shop drawings and resubmitted to the Department Representative for review and acceptance prior to the commencement of the work. The design engineer of record and independent checker shall submit separate authenticated design notes and check notes. The design notes and independent check notes shall be presented in a legible and logical format, clearly identify material properties, and sufficiently detailed to allow a technical review of design concepts and assumptions used. All material properties shall be confirmed and documented by the design engineer of record and independent checker prior to the commencement of fabrication.

The independent checker may be employed by the same company as the design engineer of record. The independent check must be completed fully independent of the design engineer of record, including a complete re-analysis of all aspects of the design including calculations and engineering, preferably by a methodology or computer program other than that used by the design engineer of record. The design engineer of record and independent checker shall ensure that the shop drawings are complete and accurately convey the design criteria and assumptions used in their designs.

The Contractor shall incorporate and submit as-built design notes, check notes, and shop drawings for records at the completion of construction. One paper copy and one electronic copy (PDF format) of as constructed shop drawings, design and check notes, and supplier inspection construction records shall be submitted to the Department Representative within 3 weeks of construction completion.

26.2.4.5 Mill Test Reports and Product Data Sheets

Mill test reports and product data sheets shall be provided in English for all materials used in the fabrication of RCP and PBC structures a minimum of 1 week prior to the commencement of fabrication.

Where mill test reports originate from a mill outside Canada or the United States of America, the Contractor shall have mill test reports verified by a certified laboratory in Canada by testing the material to the specified material standards, including boron content. The testing laboratory shall be accredited by a Canadian or American accreditation body to ISO/IEC 17025 for the tests required. The accreditation body shall be a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). Preparation and collection of samples for testing shall be directed and witnessed by or completed by personnel employed by the testing laboratory. A verification letter shall be provided by the testing laboratory that includes accreditation documentation, applicable mill test reports, testing standards, date of verification testing, and declaration of material compliance with Contract requirements. The verification letter shall be signed by an authorized officer of the testing laboratory.

26.2.4.6 Concrete Mix Design

Concrete mix design submission requirements shall be provided in accordance with Subsection 4.4.3, Concrete Mix Design Submission Requirements.

26.2.4.7 Fabrication Schedule

The Contractor shall provide and maintain a current and complete fabrication schedule in a format acceptable to the Department Representative. The fabrication schedule shall include the schedules of all fabricators and their sub-contractors.

26.2.5 Prefabrication Meeting

A prefabrication meeting shall be held for the supply and fabrication of PBC and direct designed RCP structures.

The prefabrication meeting shall not occur until the prefabrication submissions have been completed, reviewed and written acceptance provided by both the Contractor and the Department Representative.

The prefabrication meeting shall be held at the fabricator's facility and at a date and time acceptable to the Department Representative. A minimum of 2 weeks notice shall be given to the Department Representative prior to the proposed date and time.

The Contractor, fabricator and their sub-contractors shall be in attendance at the prefabrication meeting including project manager(s), fabrication superintendent(s), independent testing agency representatives, and all employees involved in supervision of the work.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (up to 3 representatives from the Government of the Northwest Territories and consultant) to attend prefabrication meeting(s) outside the Northwest Territories.

26.2.6 Materials

26.2.6.1 Hydraulic Cement

Hydraulic cement used in the fabrication of RCP and PBC structures shall be Type HS or HSb and conform to the requirements of CSA A3001.

26.2.6.2 Reinforcing Steel

Reinforcing steel for RCP structures shall conform to the requirements of ASTM C76M or ASTM C1417M.

Reinforcing steel for PBC structures shall conform to the requirements of ASTM C1433M and Section 5, Reinforcing Steel.

26.2.6.3 Rubber Gaskets and Flexible Joint Sealants

Rubber gaskets for RCP structures shall conform to the requirements of CSA A257.3.

Flexible joint sealants for PBC structures shall conform to the requirements of ASTM C990M.

Rubber gaskets for PBC structures shall conform to the requirements of ASTM C1619.

26.2.7 Fabrication

26.2.7.1 Section Identification Markings

26.2.7.1.1 Reinforced Concrete Pipe

All classed and indirect designed RCP sections shall be marked with waterproof paint or have markings cast into the sections as follows:

- Pipe classification and manufacturing standard;
- Nominal inside diameter;
- Date of fabrication;
- Name or logo of fabricator;
- Plant identification; and
- Installation orientation markings, if required.

All direct designed RCP sections shall be marked with waterproof paint or have markings cast into the sections as follows:

- Pipe designation:
    - Di_____, _____T_____, H_____ - _____ where,
    - Di = designated pipe nominal inside diameter, mm;
    - T = installation type;
    - H = (minimum)-(maximum) fill height, m;
- Manufacturing standard;
- Date of fabrication;
- Name or logo of fabricator;
- Plant identification;

- Pipe identification number; and
- Installation orientation markings, if required.

When RCP sections are marked by casting identification into concrete, the minimum specified concrete cover shall be maintained.

26.2.7.1.2 Precast Box Culvert

All PBC sections shall be marked with waterproof paint or have markings cast into the sections as follows:

- Box designation:
- S_____, R_____, H_____- _____ where,
    - S = designated box section span, mm,
    - R = designated section rise, mm,
    - H = (minimum)-(maximum) fill height,
- Manufacturing standard;
- Date of fabrication;
- Name or logo of fabricator;
- Plant identification;
- Box identification number; and
- Installation orientation markings showing the top of culvert wall up on both inside and outside faces.

When PBC sections are marked by casting identification into concrete, the minimum specified concrete cover shall be maintained.

26.2.7.2 Standard Asset Identification Plaques

Standard asset identification plaques shall be supplied and installed in accordance with Section 13, Miscellaneous Iron, and Standard Drawing S-001, Standard Asset ID Plaque and Bench Mark Tablet.

26.2.7.3 Defects

Defects in RCP or PBC identified either at the fabricator's plant or at the construction site shall be repaired by the Contractor at their expense and to the satisfaction of the Department Representative.

Honeycomb, cavities, spalls, chips, cracking and other defects shall be immediately reported to the Department Representative. Repair procedures shall be developed by the fabricator and submitted to the Department Representative for review and acceptance. The Department Representative's review comments shall be incorporated into the repair procedure to the satisfaction of the Department Representative prior to commencement of the work. Repair procedures may vary for the RCP and PBC structures and the Contractor shall consider the physical dimensions and properties of the element being repaired. The Department Representative shall be notified a minimum of 24 hours prior to the commencement of any repair.

In cold weather conditions repair work shall be carried out in accordance with Subsection 4.20, Concreting in Cold Weather.

26.2.7.3.1 Honeycomb, Cavities, Chips, Spalls, and Casting Defects

As a minimum, the Contractor's repair procedure for repairing defects less than 30 mm in depth shall include:

- Roughening the repair area to remove all loose material and laitance;

- Filling the repair area with an approved concrete patching material listed on the Alberta Transportation's Products List Concrete Patching Material in the Overhead/Vertical (OH-V) category or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List;
- Placing the repair material in accordance with the manufacturer's published product data sheet;
- Wet curing the repair material for a minimum of 72 hours; and
- Finishing the repair area to achieve a surface uniform in colour and texture to the surrounding concrete.

As a minimum, the Contractor's repair procedure for repairing defects greater than 30 mm in depth shall include:

- Saw cutting the repair extents in neat perpendicular lines;
- Removing the concrete to a depth beyond the reinforcement by a minimum of 1.5 times the maximum concrete aggregate used in the concrete mix;
- Roughening the repair area to remove all loose material and laitance;
- Repairing and cleaning reinforcement to its original condition;
- Saturating the repair area with water for a period of 3 hours prior to concrete placement;
- Cleaning and drying the repair area with oil-free compressed air;
- Placing and curing the replacement concrete in accordance with the requirements of these specifications; and
- Finishing the repair area to achieve a surface uniform in colour and texture to the surrounding concrete.

26.2.7.3.2 Cracks

All cracks shall be measured, mapped, and documented in a fabrication quality control inspection report by the fabricator and submitted to the Department Representative for review and acceptance. Cracks shall be monitored, repaired or sections replaced as follows:

- Sections with cracks 0.3 mm in width or greater shall be replaced with new sections;
- Cracks greater than 0.2 mm and less 0.3 mm in width shall be assessed by the Contractor and a repair or replacement strategy developed accordingly. The repair or replacement strategy shall be submitted to the Department Representative for review and acceptance prior to the commencement of the repair or replacement work; or
- Cracks equal to or less than 0.2 mm in width shall be monitored throughout construction and if crack width growth occurs, the cracks shall be repaired or sections replaced in accordance with the requirements of these specifications.

26.2.7.4 Handling and Storage

All materials shall be stored in a neat and orderly manner to facilitate testing and inspection.

Rubber gaskets and sealants shall be stored in accordance with the manufacturer's recommendations.

All RCP and PBC sections shall be handled carefully and in such a manner as to prevent cracking, gouging, chipping, or any other damage to the concrete surfaces.

RCP and PBC sections shall be stored at ground height with supports acceptable to the Department Representative and shall not be stacked vertically.

RCP and PBC sections designated by the Department Representative as unacceptable, due to failure to meet the specified requirements, shall be immediately repaired in accordance with Subsection 26.2.7.3, Defects, or replaced by the Contractor at their expense.

26.2.8 Inspection and Testing

26.2.8.1 Access

The Contractor shall provide acceptable facilities for the inspection and testing of the work. The Department Representative shall have full access to all phases of the work at all times. When required by the Department Representative, the Contractor shall also provide labour for assistance in checking layout and performing inspection and testing duties. The Department Representative shall be provided the time needed to complete quality assurance inspection and testing requirements.

26.2.8.2 Responsibility

Quality control inspection and testing shall be completed by the Contractor. Quality control shall be the sole responsibility of the Contractor.

Quality assurance inspection and testing completed by the Department Representative shall not be considered as relieving the Contractor of their sole responsibility for completing the work in accordance with the Contract.

The Contractor shall be responsible for all travel, boarding and lodging costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant) to inspect and test RCP and PBC structures being fabricated outside the Northwest Territories and including up to three trips to the fabrication facility by the Department Representative during the course of fabrication.

Testing, inspection and related costs incurred by the Department Representative resulting from defective work, non conforming materials, or the Contractor's proposed modification to RCP or PBC structures shall be paid for by the Contractor.

If any equipment, process or procedure causes repeated occurrences of damage, as determined by the Department Representative, the equipment, process or procedure shall be repaired, replaced or modified to the satisfaction of the Department Representative.

26.2.8.3 Quality Control Inspection and Testing by the Contractor

As a minimum, quality control inspection, testing, and the personnel completing these activities shall conform to the requirements of CSA A23.4 and the Precast/Prestressed Concrete Institute (PCI) Quality Control Manual MNL-116. In the case of conflicting requirements, the most stringent shall govern, as determined by the Department Representative.

Sampling, casting, curing and testing concrete specimens shall be completed by the Contractor in accordance with the requirements of the following CSA standards:

- Sampling - CSA A23.2-1C;
- Concrete Test Cylinders - CSA A23.2-3C;
- Testing Concrete Cylinders - CSA A23.2-9C;
- Air Content - CSA A23.2-4C;
- Density of Concrete - CSA A23.2-6C; and
- Air Void Determination - CSA A23.2-17C.

The Contractor's quality control testing and inspection records shall be submitted to the Department Representative on a weekly basis for review and acceptance. All QC testing and inspection reports shall contain the written acceptance of the fabricator's QC manager.

26.2.8.4 Quality Assurance Inspection and Testing by the Department Representative

The Department Representative will inspect the work and review all QC inspection and testing records and/or reports produced by the Contractor to verify their conformance to the Contract requirements.

The Department Representative may complete additional quality assurance inspection and/or testing at their sole discretion. The Contractor shall provide full access to the work in accordance with Subsection 26.2.8.1, Access.

26.2.8.5 Witness Points and Hold Points

The Contractor and the Department Representative shall provide written acceptance of the work at each of the specified witness points and hold points within the ITP.

If fabrication continues past a hold point without the written acceptance of the work by both the Contractor and the Department Representative, the Contractor shall be solely responsible for all additional costs incurred by the Department Representative to verify the acceptability of the Work and provide written acceptance of the hold point. The Contractor shall also be solely responsible for all costs required to repair or replace the Work, as determined by and to the satisfaction of the Department Representative.

Inspection stations shall be set up by the Contractor within the fabrication facility to the satisfaction of the Department Representative for each of the specified witness points and hold points such that the associated inspection and/or testing requirements can be acceptably completed.

The following will be witness points and hold points:

- Form dimensions and set-up (witness point);
- Placement of reinforcement (witness point);
- Concrete mixture and placement (witness point);
- Clean-up and repair (hold point);
- Storage of RCP and PBC structures (witness point);
- Verification testing and inspection of RCP and PBC structures if fabricated outside of Canada and the United States (hold points); and
- Final inspection (hold point).

26.2.8.6 Final Inspection

The Contractor and the Department Representative shall provide written acceptance of all fabricated RCP and PBC structures upon the completion of fabrication. Review and acceptance of RCP and PBC structures by the Department Representative at the fabrication facility will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

26.2.8.7 Fabrication Outside of Canada and the United States of America

In addition to the requirements of Subsection 26.2.8, , RCP and PBC structures fabricated outside of Canada and the United States of America shall be shipped to a shop located in Canada that is certified by the CPCQA in the applicable product group classification of the component for verification inspection and testing. The RCP and PBC structure components shall be in a condition that facilitates verification testing and inspection requirements. Verification testing and inspection shall be completed in accordance Subsection 26.2.8, . A Prestressed/Precast Concrete Institute (PCI) certified Level 2 inspector shall also inspect RCP and PBC structures for the presence of damage that may have occurred during transportation.

In addition to the verification testing and inspection requirements, three concrete cores shall be taken from each precast concrete unit, at locations determined by the Department Representative, and tested by a laboratory certified to CSA A283 to determine that the concrete meets all Contract requirements.

Components shall not be shipped from the Canadian shop to the project site until all requirements have been met and the work has been reviewed and accepted by the Department Representative.

The Contractor shall be responsible for all verification inspection and testing costs, including all costs incurred by the Department Representative (from the Government of the Northwest Territories or consultant). The Contractor shall also be responsible for all hourly charge out rates, travel, meals and accommodation of the Department Representative inspector(s) to complete inspection and testing duties at the fabrication facility for 100% of the fabrication time. The Contractor shall also be responsible for the cost of one trip every two weeks for two Department Representatives to and from the fabrication facility.

The Contractor shall have no claim against the Government of the Northwest Territories resulting from delays caused by these requirements.

26.3 Construction

Construction of RCP and PBC structures shall be in accordance with CSA S6-19 Clause 7.8.16, Construction, and these specifications. RCP structures shall also be constructed in accordance with ASTM C1479M.

The structure shall be kept dewatered to the full extent of the excavation until all backfilling is completed.

Cranes shall be used for the handling and erection of PBC sections and RCP sections that are 2 m or greater in span and/or rise dimension.

All underground utility locations shall be clearly marked and protected during the course of construction. Damages to existing utilities resulting from the Contractor’s operations shall be repaired at the Contractor’s expense and to the satisfaction of the Department Representative.

26.3.1 Water Management

In addition to the ECO Plan submission requirements and the requirements of the Specifications for Highway Construction, Edition 7, Division 2 General Requirements, Section 2, Environmental Requirements, the Contractor shall also prepare and submit a separate water management plan to the Department Representative for review and acceptance a minimum of 2 weeks prior to the preconstruction meeting. The water management plan shall outline the means and methods that will be used to control and manage water and/or ice at all times during the Work in accordance with all applicable environmental requirements and regulations. The water management plan will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

The water management plan will be reviewed by the Department Representative solely to ascertain general conformance with environmental regulations, specifications and any applicable Special Provisions of the Contract. The Department Representative's review and acceptance shall not be considered as relieving the Contractor of their sole responsibility for the design, construction, monitoring, performance, and maintenance of the water management plan.

26.3.2 Excavation

Excavation shall be completed to the lines and grades shown on the Drawings or as determined by the Department Representative, and in accordance with Section 1, Excavation.

Excavations shall be dewatered to the bottom of the excavation until all backfilling is acceptably completed.

26.3.3 Transportation, Handling and Storing Materials

RCP and PBC structures shall be transported, handled and stored to prevent damage.

RCP and PBC structures shall be protected from dirt, road salts, slush or other contaminants during transportation, handling and storage. RCP and PBC structures that become contaminated with any dirt, mud, road salts, slush or other contaminants during transportation, handling and storage, shall be cleaned and surfaces prepared to the satisfaction of the Department Representative prior to installation.

RCP and PBC structures shall be transported, hauled and stored on timber blocking. Timber blocking shall be located at positions that prevents the damage of materials. The ground of the storage area shall be solid and unyielding and drainage diverted away from the storage area.

26.3.3.1 Clearance to Ship

The Contractor shall provide the Department Representative a transportation schedule for RCP and PBC structures a minimum of 1 week prior to shipment from the fabrication facility. Written acceptance in accordance with Subsection 26.2.8.6, Final Inspection shall be provided by both the Contractor and the Department Representative prior to the commencement of shipping.

Review and acceptance at the fabrication facility by the Department Representative will not relieve the Contractor of their sole responsibility to meet the requirements of the Contract.

26.3.4 Installation

26.3.4.1 General

Installation of RCP and PBC structures shall not proceed until the excavation, foundation, and bedding material placement has been reviewed and accepted by the Department Representative.

The Contractor shall install RCP and PBC sections to the lines and grades as shown on the Drawings, in accordance with the manufacturer's instructions and as determined by the Department Representative.

RCP and PBC structures shall be installed from the lowest bedding elevation to the highest bedding elevation.

The tolerance from the grades shown on the Drawings or established by the Department Representative shall not exceed ± 15 mm. The Contractor shall implement appropriate measures to control the grades to meet the tolerance requirements.

Under no circumstance shall the Contractor use an excavator or any other mechanical device or piece of equipment to push, pull, pound or rock RCP or PBC sections to achieve alignment. Sections shall not be dropped, dragged or rolled along the ground at any time.

The ends of each precast section shall be clean and dry of all dirt, oil, grease, and any foreign materials prior to joining sections together. Sections shall be firmly drawn together in a manner that results in a continuous, watertight conduit with a smooth and uniform interior surface. The joined sections shall accommodate for expansion, contraction, settlement, or lateral displacement requirements.

Allowable joint gap spacing between joined sections shall not exceed 13 mm for RCP structures and 20 mm for PBC structures.

If installed sections do not meet the specified alignment requirements, the sections shall be completely disassembled, bedding material adjusted, rubber gasket or sealants replaced and sections re-joined to the satisfaction of the Department Representative.

Defects identified at site shall be addressed in accordance with Subsection 26.2.7.3, Defects.

26.3.4.2 Erection Procedure

The Contractor shall submit an erection procedure for RCP structures with a diameter of 2 m or larger and for all PBC structures to the Department Representative for review and acceptance a minimum of 3 weeks in advance of the scheduled start of installation.

At a minimum the erection procedure shall include drawings and supporting documents necessary to describe the following:

- Access to work;
- Type and capacity of equipment;
- Sequence of operation, including traffic accommodation, haul or transport truck, and crane positions;
- Detailed crane position on the ground with details of load distribution on wheels and outriggers;
- Details of section lifting, showing forces at lifting pins/lugs;
- Details of temporary works for positioning and alignment of precast concrete sections; and;
- Joint seal installation details and sequencing.

The erection procedure will be considered a Professional Work Product and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG. Safety and compliance with the Northwest Territories Safety Act and Occupational Health and Safety Regulations thereunder shall be integral parts of the Work. The Contractor shall immediately provide the Department Representative with any documentation required by Occupational Health and Safety Regulations upon request.

The Department Representative's review and acceptance shall not be considered as relieving the Contractor of the responsibility for the safety of their methods or equipment, nor from carrying out the work in full accordance with the erection procedure, drawings and specifications. The Contractor shall follow the engineered erection procedure at all times.

26.3.4.3 Reinforced Concrete Pipe

Installation of RCP structures shall include a rubber gasket at each joint between sections. The Contractor shall follow the rubber gasket manufacturer's storage and installation requirements.

The Contractor shall use lifting clutches with 3-legged chain sling (wire or link) for RCP sections with a diameter of 1050 mm or greater.

26.3.4.4 Precast Box Culvert

Installation of PBC structures shall include a flexible joint sealant or rubber gasket at each joint between sections. The Contractor shall follow the rubber gasket manufacturer's storage and installation requirements.

The Contractor shall use embedded lifting anchors, lugs, or pins for PBC section installation. All lifting cavities shall be filled with an Overhead/Vertical (OH-V) concrete patching material listed on the Alberta Transportation's Products List or a comparable material from the British Columbia Ministry of Transportation and Infrastructure Recognized Products List once installation has been completed, reviewed and accepted by the Department Representative.

26.3.5 Backfilling

When installation of the structure has been accepted by the Department Representative, backfilling with the material(s) specified on the Drawings may commence. Backfilling shall be in accordance with the Drawings and Section 2, Backfill. In addition, the following requirements shall be met:

- When the ambient air temperature is below 0°C, no backfilling will be permitted unless otherwise accepted by the Department Representative. When acceptance is granted, all backfill material shall be in a thawed state when placed and compacted. No backfill material will be permitted to be placed on frozen substrate;
- Backfilling under the haunches shall be compacted to achieve the density specified;
- Backfilling shall be free of voids and provide uniform support to the structure. The backfill material shall be placed such that the level of fill on one side does not exceed the level of fill on the other side of the structure by more than 300 mm;
- The backfill material shall be placed and compacted by equipment moving parallel to the structure with simultaneous handwork along the structure. Large earth moving equipment and large compaction equipment shall not be permitted within 1 m of the structure. Any damage to the structure from compaction equipment used shall be repaired by the Contractor at their expense and to the full satisfaction of the Department Representative;

- The first 300 mm of backfill material over the structure shall be placed, levelled and compacted without vibration. Subsequent fill material over the structure shall be placed and compacted by equipment moving perpendicular to the longitudinal axis of the structure. The Contractor shall obtain the Department Representative's review and acceptance prior to using any equipment above the structure.
- For compacted non-granular backfill materials, the quality, methods of placement and compaction, shall be submitted to the Department Representative for review and acceptance prior to the commencement of the work. Highly plastic clay or material with high silt content will not be permitted.
- Clay seal material shall be highly plastic clay with a minimum plasticity index of 40. Clay seal materials shall be classified in accordance with ASTM D2487.

26.3.6 Post-Installation Inspection

The Contractor and the Department Representative shall jointly carry out a post-installation inspection after all backfilling is complete. Post-installation inspections will be considered hold points.

Joint gap measurements will be taken and recorded by the Department Representative at all section joints.

All cracks will be identified, measured in width and length by the Department Representative.

All defects shall be noted, recorded, and repaired or replaced by the Contractor in accordance with the requirements of these specifications and to the satisfaction of the Department Representative prior to the stream being re-routed through the new structure or being opened to pedestrian traffic, as applicable.

26.3.6.1 Reinforced Concrete Pipe

A post-installation inspection will only be required for RCP structures with inside diameter of 1500 mm or larger.

Joint gap measurements inside the RCP structure will be taken and recorded by the Department Representative at the locations of minimum and maximum gap at each section joint.

26.3.6.2 Precast Box Culvert

A post installation inspection will be required for all PBC structures.

Joint gap measurements inside the PBC structure will be taken and recorded by the Department Representative at the locations of minimum and maximum gap along of the top, bottom, and both side surfaces at each section joint.

The inside alignment along the top, bottom, and both side surfaces at each section joint will be measured and recorded by the Department Representative.

26.3.7 Substrate Holders

Substrate holders shall be supplied, fabricated, installed and constructed as shown on the Drawings and as outlined in the Special Provisions of the Contract.

26.3.8 Heavy Rock Riprap

Heavy rock riprap shall be supplied and placed as shown on the Drawings and in accordance with Section 10, Heavy Rock Riprap.

26.4 Measurement and Payment

Payment for the following items will be made at the applicable unit price or lump sum prices bid:

- Detour Road - Construct and Maintain;
- Demolition, Disposal and Salvage of Existing Structure;
- Excavation;
- RCP– Supply;
- PBC – Supply;
- Crushed Aggregate Backfill – Des 2 Class 25 or Des 2 Class 40;
- Non-Granular Backfill;
- RCP – Install;
- PBC – Install;
- Substrate Holders;
- Guardrail;
- Roadway Work; and
- Heavy Rock Riprap.

Such payments will be full compensation for all labour, materials, equipment, tools, and incidentals necessary to complete the Work as shown on the Drawings and to the satisfaction of the Department Representative.

Unit price payments will be based on actual quantities acceptably completed and remaining in the Work, as determined by the Department Representative.

Payment for “RCP – Supply” and “PBC – Supply” will be made to a maximum of 80% of the lump sum or unit price bid once the materials have been acceptably supplied and delivered to the project site. The remaining 20% of the lump sum or unit price bid will be made once the structure has been acceptably backfilled and installation tolerances have been measured, reviewed and accepted by the Department Representative.

All costs associated with the supply and installation of geotextile filter fabric, when specified, will be considered incidental to the Work, and no separate or additional payment will be made.

All cost associated with the management of water and/or ice will be considered incidental to the Work, and no separate or additional payment will be made.

SECTION 27 DESIGN, SUPPLY AND INSTALLATION OF PROPRIETARY WORKS BY THE CONTRACTOR

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27.1 General

This specification is for the design, supply, and installation of proprietary portions of the Work provided by the Contractor, their sub-contractors and their proprietary suppliers. Proprietary portions of the Work are those portions of the work which require the design or supply of a proprietary design under the terms of the Contract.

27.2 Design

27.2.1 Responsibilities

The Contractor shall be responsible for providing the design, supply, fabrication, and installation of the proprietary portions of the Work. The Contractor shall provide assurances for all supplied proprietary design works, complete with any documentation required to fully validate the design by the Professional Engineer responsible for the work.

The Contractor shall provide the following documents unless otherwise specified in the Special Provisions of the Contract:

- Design Reports
- Independent Checks
- Shop Drawings
- Design Drawings
- Material Specification Sheets
- Letters of Assurance
- Field Inspection Reports
- Record Drawings

Without limiting the responsibilities of the Contractor or supplier of the proprietary portion of the work, the Contractor shall retain and be responsible for:

- An engineer of record for each design element; and
- A field reviewer by or under the direct supervision of the engineer of record or another professional engineer acceptable to the engineer of record. (Field reviewer is the Professional Engineer responsible for the field reviews.).

During the design phase of the proprietary works, the Contractor shall identify the following:

- The engineer of record prior to starting the design of the proprietary portion of the work; and
- The field reviewer.

The Contractor's engineer of record shall have sufficient previous experience in the design and construction of similar structures.

Completed Letters of Assurance in accordance with the forms provided in Appendix A shall be submitted as follows:

- Included with the Proprietary Structure Design Report
- Assurance of Professional Design & Commitment for Field Review

27.2.2 Proprietary Structure Design Reports

The Contractor shall submit to the Department Representative a Proprietary Structure Design Report for each proprietary portion of the Work which has been prepared and shall consist of all information necessary for the design, fabrication, transportation, quality control and installation of the proprietary structure, including, but not limited to the following:

- A covering Letter sealed by the Contractor's engineer of record.
- Complete set of design calculations and notes including:
    - A listing of all assumptions made in the design;
    - Verification of design methodology and applicable design codes and standards;
    - A summary of all design input information;
    - A summary of loading conditions and load cases considered; and
    - Service life calculations.

For any part of the design prepared by the Contractor, the Department Representative shall not the bear responsibility to provide assurance for that portion of the design. However, the Department Representative will collect all applicable information from the Contractor's engineer of record to ascertain and confirm that the design criteria have been met.

All design notes, independent check notes, shop drawings and other engineering products will be considered Professional Work Products and shall be authenticated by a Professional Engineer licensed to practice within the Northwest Territories and Nunavut and validated with the firm's Permit to Practice stamp, as issued by NAPEG.

Upon completion of the final design and prior to construction, the Contractor's engineer of record shall submit to the Department Representative an "Assurance of Professional Design and Commitment for Field Reviews" form provided in Appendix A.

27.3 Supply, Fabrication and Construction

All material properties, shop drawings and construction documentation shall be submitted, reviewed and accepted by the Department Representative prior to the commencement of fabrication and construction. The Contractor shall submit test certificates from approved independent testing authorities to confirm that respective materials meet the design and fabrication specifications.

Fabrication and construction drawings shall include, but not be limited to:

- Plan views of all structural systems showing the information required for the general layout of the design;
- Elevations showing original and final ground profiles, designations and locations of the relevant elements and all other elevations and dimensions required to construct the work;
- Details and typical sections of all proprietary and associated components;
- complete fabrication/ shop drawings;
- Notes listing design codes, design criteria, unfactored applied loads and material and construction specifications;
- Details and requirements for the handling of fabricated elements and stockpiling at the site prior to installation in the Works.

The Contractor shall supply complete fabrication and construction drawings along with specifications describing, in detail, the sequence of installation, equipment to be used and any other information required to complete the work in accordance with the contract requirements.

Material and Construction specifications shall include, but not be limited to:

- Field construction manuals describing in detail, the sequence of installation process including equipment to be used and details of any temporary works as required;
- Specifications for materials and other work supplied by the Contractor.

The Contractor shall implement a quality control program and supply quality control documentation in accordance with all sections related to any works in these specifications.

Quality control procedures shall include, but not be limited to:

- A listing and description of the quality control procedures and installation tolerances required by the Contractor's engineer of record to verify that the completed structure will conform with its design requirements and will be fabricated and constructed in compliance with the Contract.
- Identification of the Professional Engineer and field reviewer and providing the "Assurance of Professional Design and Commitment for Field Review" form provided in Appendix A. The form shall be signed and sealed by the Contractor's engineer of record for the design of any proprietary part of the structure.

27.3.1 Documentation

The Contractor shall submit a completed copy of the Proprietary Structure Design Report in unlocked electronic pdf format to the Department Representative a minimum of six (6) weeks prior to the start of fabrication or construction of the proprietary portion of the Work. The Proprietary Structure Design Report and all drawings shall be sealed by the engineer of record. The Department Representative will evaluate, and review all submitted documentation and provide any revisions to the Contractor. The Contractor shall resubmit the Proprietary Structure Design Report with any revisions until such time that the Department Representative deems the design to be in compliance with the contract requirements.

All drawings shall include one full size (PA1), as determined by CAN 2-9.60M, reproducible drawing set (560 × 860 mm), submitted in unlocked electronic pdf format for review. Lettering for notes and dimensions shall be at least 2.5 mm and 4mm for headings. Drawings shall be legible when reduced to half-size.

Once the Proprietary Structure Design Report has been reviewed and accepted by the Department Representative, the Contractor shall submit a complete copy in unlocked electronic pdf format of the final Proprietary Structure Design Report to the Department Representative. The Contractor shall provide the complete final set of drawings in unlocked electronic pdf format.

Any work done, or materials ordered prior to the completion of the review process shall be at the Contractor's risk. No part of the works shall be allowed to be constructed or installed prior to the review of the Proprietary Structure Design Report.

All costs and schedule impacts associated with the acceptance of the Proprietary Structure Design Reports will be considered incidental to the Work and no additional or separate payment nor completion date adjustments will be made.

27.3.2 Field Reviews

The Contractor shall be responsible to employ personnel experienced in the fabrication and construction of similar structures and retaining a Professional Engineer to fulfill the responsibilities of the field reviewer. The field reviewer shall ensure that the works constructed comply in all material respects with the design and the construction standards, and whether or not the design itself is in conformance with the project standards. Field reviews shall be performed by or under the direct supervision of a Professional Engineer licensed to practise within the Northwest Territories and Nunavut. The field reviewer shall be the engineer of record or any other professional engineer retained by the engineer of record.

27.3.3 Quality Control

The Contractor shall implement a quality control program and supply quality control documentation which shall include but not be limited to:

- Stages at which construction and fabrication monitoring is to be carried out;
- Identification of those responsible for each aspect of the quality control (field reviewer, a person under the direct supervision of the field reviewer, or a third party)
- Method, frequency and location of measurement and testing;
- If tolerances are exceeded and if procedures include a stoppage of work, details of corrective action to be taken as a prerequisite to resuming work;
- On-site reference documentation including construction and installation procedures, fabrication and construction drawings, Letters of Assurance, any documentation required by the Occupational Health and Safety Regulations, and quality control reports for off-site fabricated elements;
- Identification and contact information for any supplier's designated representative;
- Identification and contact information for the field review engineer who will be responsible for the field reviews during fabrication and construction.

Upon completion of construction of the work, the Field Reviewer shall execute an "Assurance of Field Reviews and Compliance" form provided in Appendix A.

27.4 Record drawings

The Contractor shall provide record drawings to the Department Representative. The record drawings shall be the final representation and details of the design including any significant changes during construction. The record drawings shall be an accurate representation of what was constructed.

During fabrication and construction, the Contractor shall be responsible for coordinating and tracking any changes to the accepted fabrication and construction drawings that may be required. The Contractor shall coordinate reporting and approving of all changes for any part of the supplied design with the engineer of record, the field reviewer and the Department Representative. Tracking shall consist of maintaining a record of all such changes to the accepted fabrication and construction drawings on a set of field markup drawings which will be used to produce the record drawings for each structure

The Contractor shall submit upon completion of the work all record drawings to the Department Representative of the construction of any part of the work that is designed or supplied by the Contractor, a third-party provider or a proprietary supplier.

The Contractor shall also submit a completed "Assurance of Professional Design – Post Construction" form provided in Appendix A. for each proprietary design component to the Department Representative

Record drawings shall be annotated and signed off by the Contractor's engineer of record responsible for the design with the following: *These drawings accurately record all significant design changes known to me, having exercised due diligence in monitoring the construction of the work, and the design, as represented herein, substantially conforms with the design intent and sound engineering practice.*

The Contractor shall submit record drawings and "Assurance of Professional Design – Post Construction" forms within two (2) weeks of completion of the proprietary portion of the Work

27.5 Payment

Payment will be incidental to the proprietary component, and no additional or separate payment will be made for design, supply and installation of proprietary works by the Contractor.

Appendix A: Letter of Assurance Forms for Engineer of Record and Field Reviewer

Word Documents available on request by the Department Representative.

ASSURANCE OF PROFESSIONAL DESIGN & COMMITMENT FOR FIELD REVIEW

PROJECT NO. ASSET ID NO.

PROJECT/STRUCTURE NAME

LOCATION / DESCRIPTION

To: Government of the Northwest Territories – Department of Infrastructure

Address Line 1

Address Line 2

Attention: Department Contact Person

Date:

I hereby give assurance that:

1. I am a Professional Engineer[1], registered or licensed to practice in the Northwest Territories and Nunavut;
2. I have utilized the standards of care, skill, and diligence that, in accordance with the standards of my profession, are required of Professional Engineers performing designs in the Northwest Territories and Nunavut;
3. The parts of the design[2] prepared by me or under my supervision as listed in the attached *Schedule A - Summary of Design and Field Review Assignments* substantially conform to all applicable design codes and standards; and; and
4. I undertake to be responsible for Field Reviews[3] of the above referenced parts of the design in accordance with the assignments noted in the attached *Schedule A - Summary of Design and Field Review Assignments*.
   ☐ **Yes** / ☐ **No**

SIGNATURE OF PROFESSIONAL ENGINEER		*(please affix professional seal here)*
NAME OF PROFESSIONAL ENGINEER *(please print)*	DATE SIGNED Y M D	
ADDRESS *(please print)*		
PHONE NO.		

(If the Professional Engineer is a member of a firm, also complete the following sentence.)

I am a member of the firm of *(legal name)* _____
and I sign this document on behalf of the firm.

[1] "Professional Engineer" means a person who is registered or licensed as a Professional Engineer with NAPEG; and includes a limited licensee.

[2] the "design" means the compendium of drawings, plans, specifications and other like material produced by the designers to calculate, determine and define the items of work to be constructed.

[1] "field reviews" means such reviews of the construction at the project site (and/or the fabrication locations, where applicable) considered necessary by and at the discretion of the Professional Engineer, as agreed to in writing by the Department.

Attachment:

- *Schedule A – Summary of Design and Field Review Assignments*

SCHEDULE A – SUMMARY OF DESIGN AND FIELD REVIEW ASSIGNMENTS

Note: This document is an attachment to the *Assurance of Professional Design & Commitment for Field Reviews* and *Assurance of Field Reviews and Compliance* forms.

Check the Yes or No boxes for each discipline to indicate responsibility for Field Reviews. If Yes, indicate which of the items apply by checking the box adjacent to the item, or provide an alternate means acceptable to the Department to clearly define the scope of the assignment and responsibilities.

Please note: *To revise the descriptions or to add additional fields to accommodate specific responsibilities, the 'protection' of this form may be removed ("Review", "Protect Document", and click "Stop Protection" button). Then add more rows below and copy/paste with fields; then 'protect' the document again to recommence fill in.*

1) CIVIL

Geographic Limits: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐ a)	Highway and side road horizontal and vertical alignment geometry	☐ t)	Geometric definition of structures and retaining wall primary alignments
☐ b)	Road cross section templates	☐ u)	Structural capacity of civil components
☐ c)	Interchanges	☐ v)	Site utilities including water mains, sanitary sewer, gas, electrical, ITS and telecommunications routing
☐ d)	Intersections	☐ w)	Site electrical and lighting systems
☐ e)	Roadside design and clear zone	☐ x)	Property acquisition concept
☐ f)	Bicycle and pedestrian accommodation	☐ y)	Traffic engineering
☐ g)	Clearing and grubbing	☐ z)	Detour geometrics
☐ h)	Roadway and drainage excavation	☐ aa)	Traffic management plan
☐ i)	Earth excavation and embankments geometry	☐ bb)	Guide signs
☐ j)	Rock excavation and embankments geometry	☐ cc)	Guide sign structures geometry
☐ k)	Special slope treatment locations	☐ dd)	Signing and pavement marking
☐ l)	Earthworks quantities balance and mass haul	☐ ee)	Noise wall structure
☐ m)	Paving, granular surfacing, base and sub-bases geometry	☐ ff)	Review of applicable shop drawings
☐ n)	Quantity estimating	☐ gg)	
☐ o)	Construction staging concept	☐ hh)	
☐ p)	Storm drainage	☐ ii)	
☐ q)	River Engineering	☐ jj)	
☐ r)	Hydraulic Design of Major Crossings	☐ kk)	
☐ s)	Bridge Foundation Scour Design	☐ ll)	

2) STRUCTURAL

Geographic Limits or Components: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐	a)	Structural design of bridges	☐	h)	Verification of the satisfactory completion of an in-house check of the structural design
☐	b)	Structural design of retaining walls	☐	j)	
☐	c)	Bridge seismic design	☐	k)	
☐	d)	Structural aspects of deep foundations	☐	j)	
☐	e)	Guide sign foundations	☐	k)	
☐	f)	Review of applicable shop drawings	☐	l)	
☐	g)	Structural aspects of unbonded post-tensioned concrete design and construction	☐	m)	

3) ELECTRICAL

Geographic Limits: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐	a)	Electrical systems and devices	☐	f)	
☐	b)	Electrical systems and devices maintenance manuals	☐	g)	
☐	c)	Structural capacity of electrical components, including anchorage and seismic restraint	☐	h)	
☐	d)	Clearances of all electrical utility equipment	☐	i)	
☐	e)	Review of applicable shop drawings	☐	j)	

4) ENVIRONMENTAL

Geographic Limits: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐	a)	Environmental impact assessment	☐	h)	Environmental regulatory process management
☐	b)	Public Information process and management	☐	i)	Environmental audits and site remediation
☐	c)	Monitoring, assessment and abatement of environmental noise	☐	j)	
☐	d)	Monitoring, assessment and abatement of air quality	☐	k)	
☐	e)	Monitoring, assessment and abatement of water quality	☐	l)	
☐	f)	Monitoring, assessment and abatement of storm water management	☐	m)	
☐	g)	Environmental impact mitigation planning and implementation	☐	n)	

5) GEOTECHNICAL — Temporary

Geographic Limits: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐	a)	Excavation	☐	e)	
☐	b)	Shoring	☐	f)	
☐	c)	Underpinning	☐	g)	
☐	d)	Temporary construction dewatering	☐	h)	

GEOTECHNICAL — Permanent

Geographic Limits: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐	i)	Gravel and paving structure strength and lifecycle	☐	v)	Rock excavation and embankments
☐	j)	Pavement mix design	☐	w)	Special slope treatment
☐	k)	Borrow and aggregate materials sourcing	☐	x)	Foundations
☐	l)	Bearing capacity of the soil	☐	y)	Soil earth structures
☐	m)	anchorage and seismic restraint	☐	z)	Retaining wall global stability

☐ n) Geotechnical aspects of deep foundations	☐ aa) Seismic design of retaining walls
☐ o) Compaction of engineered fill	☐ bb)
☐ p) Structural considerations of soil, including slope stability and seismic loading	☐ cc)
☐ q) Backfill	☐ dd)
☐ r) Permanent dewatering	☐ ee)
☐ s) Permanent underpinning	☐ ff)
☐ t) Granular surfacing, base and sub-bases	☐ gg)
☐ u) Earth excavation and embankments	☐ hh)

6) SAFETY AUDITOR: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐ a)	☐ c)
☐ b)	☐ d)

7) OTHER ENGINEERING SPECIALIZATION: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐ a)	☐ c)
☐ b)	☐ d)

8) OTHER ENGINEERING SPECIALIZATION: _____

I am responsible for Field Reviews ☐ Yes ☐ No

☐ a)	☐ c)
☐ b)	☐ d)

SIGNATURE OF PROFESSIONAL ENGINEER		*(please affix professional seal here)*
NAME OF PROFESSIONAL ENGINEER *(please print)*	DATE SIGNED Y M D	
ADDRESS *(please print)*		
PHONE NO.		

(If the Professional Engineer is a member of a firm, also complete the following sentence.)

I am a member of the firm of *(legal name)* _____

and I sign this document on behalf of the firm.

The Department concurs with this assignment of responsibilities and will ensure that the Field Reviews indicated above as not being the responsibility of the Registered Professional are performed.

DEPARTMENT SIGNATURE	DEPARTMENT NAME (please print)	DATE

(Note: The Department's signatory will normally be the "Department Contact" assigned to oversee the EOR's contract.)

ASSURANCE OF PROFESSIONAL DESIGN
POST CONSTRUCTION

PROJECT NO. ASSET ID NO.

PROJECT/STRUCTURE NAME

LOCATION / DESCRIPTION

To: Government of the Northwest Territories –
Department of Infrastructure

Date:

Address Line 1

Address Line 2

Attention: Department Contact Person

I hereby give assurance that:

1. I am a Professional Engineer[1], registered or licensed to practice in the Northwest Territories and Nunavut;
2. I have utilized the standards of care, skill, and diligence that, in accordance with the standards of my profession, are required of Professional Engineers performing designs in the Northwest Territories and Nunavut;
3. I have relied upon the assurances of the Field Reviewers attached hereto; and
4. I have reviewed the record drawings for the Project/Structure and the parts of the design prepared by me or under my supervision as listed in the *Schedule A – Summary of Design & Field Review Assignments* and executed by me on INSERT DATE HERE substantially comply with all applicable design codes, standards, and guidelines.

SIGNATURE OF PROFESSIONAL ENGINEER		*(please affix professional seal here)*
NAME OF PROFESSIONAL ENGINEER *(please print)*	DATE SIGNED Y M D	
ADDRESS *(please print)*		
PHONE NO.		

(If the Professional Engineer is a member of a firm, also complete the following sentence.)

I am a member of the firm of *(legal name)*
and I sign this document on behalf of the firm.

[1] "Professional Engineer" means a person who is registered or licensed as a Professional Engineer with NAPEG; and includes a limited licensee.

Attachment:

- *Schedule A – Summary of Design and Field Review Assignments*
- *Assurance of Field Reviews and Compliance*
  - *List all Field Review Assurance forms being relied upon, including that of the Engineer-of-Record (if the Engineer-of-Record has performed any Field Review*

ASSURANCE OF FIELD REVIEWS & COMPLIANCE

PROJECT NO. ASSET ID NO.

PROJECT/STRUCTURE NAME

LOCATION / DESCRIPTION

To: Government of the Northwest Territories – Department of Infrastructure

Date:

Address Line 1

Address Line 2

Attention: Department Contact Person

I hereby give assurance that:

1. I am a Professional Engineer[1], registered or licensed to practice in the Northwest Territories and Nunavut;
2. I have fulfilled my obligation for field reviews[2] for this Project/Structure;
3. I have utilized the care, skill and diligence that, in accordance with the standards of my profession, are required of Professional Engineers performing field reviews in the Northwest Territories; and
4. I hereby provide the assurance that those parts of the work for which I have the field review responsibility substantially comply with:
   a. The design[3], and
   b. The applicable construction codes, standards, guidelines, and the Project/Structure specifications.

SIGNATURE OF PROFESSIONAL ENGINEER		*(please affix professional seal here)*
NAME OF PROFESSIONAL ENGINEER *(please print)*	DATE SIGNED Y M D	
ADDRESS *(please print)*		
PHONE NO.		

(If the Professional Engineer is a member of a firm, also complete the following sentence.)

I am a member of the firm of *(legal name)*

and I sign this document on behalf of the firm.

[1] "Professional Engineer" means a person who is registered or licensed as a Professional Engineer with NAPEG; and includes a limited licensee.

[2] "field reviews" means such reviews of the construction at the project site (and/or the fabrication locations, where applicable) considered necessary by and at the discretion of the applicable Professional Engineer, and agreed to in writing by the Department.

[3] the "design" means the compendium of drawings, plans, specifications and other like material produced by the designers to calculate, determine and define the items of work to be constructed.

NOTE: This form must be submitted to the Department in a timely manner after completion of the Project but before final acceptance by the Department is made. A separate signed copy of this form must be submitted by each Professional Engineer who has undertaken field reviews for this Project/Structure.