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Design & Build Contract

Canola Oil Transload Facility

PROJECT REF: CAVAN-MIS-2022-342/D&B/2022/022

DP World Fraser Surrey Inc.

Contract Documents

Volume 2: Employer's Requirements

Part 2 - Performance, Design and Technical Specification for the Civil & Process Mechanical Works

September 2023

Design & Build Contract

Canola Oil Transload Facility

VOLUME 2 – EMPLOYER'S REQUIREMENTS

Part 2: Performance, Design and Technical Specification for the Civil & Process Mechanical Works

Prepared for

DP WORLD FRASER SURREY Inc

Prepared by

Group Procurement

DP World FZE

September 2023

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Table of Contents

bdc

TABLE OF TABLES:

P2.1 General

P2.1.1 Introduction

This document forms part of the Employer's Requirements for this Contract and is issued as part of a set of documents:

- Volume 1: Commercial
- Volume 2: Employer's Requirements ○ Part 1: General Requirements ○ Part 2: Performance, Design and Technical Specification for the Civil & Process Mechanical Works ○ Part 3: Performance, Design and Technical Specification for the Building Works
- Volume 3: Drawings
- Volume 4: Schedule of Prices

This volume (Volume 2, Part 2) provides the minimum requirements defined by the Employer that apply to all onshore and marine based facilities (Performance, Design and Technical Specification for the Civil & Process Mechanical Works).

The new facility shall include the items below.

P2.1.2 Railcar Unloading Facilities:

- Rail unloading yard for thirty-two (32) canola oil railcars, on two (2) new tracks, one replacing existing Intermodal Track 6, and one parallel to this replaced spur. The unloading area must include drip pans for containment, collection and eventual treatment of containment water which is routed to the Oil Water Separator (OWS). The drip pans shall be installed over the full length of rail car unloading tracks and have a width matching the maximum diameter of the railcar body.
- The railcar unloading system shall consist of the installation of thirty-two (32) bottom unloading stations over two (2) tracks with sixteen (16) railcar unloading stations per track, unloading simultaneously via 100 mm (4 inch) mechanical arms, complete with automated pumping system for unloading.
- Railcars are DOT-111/117 type with car lengths capacities and lengths ranging from 16.9 to 18.5 meters. ○ The majority of rail cars received are expected to range in length from 18.0 to 18.5 meters. The railcar unloading infrastructure shall be designed so that the majority of combinations of 32 rail cars ranging in length between 18.0 and 18.5 meters can be safely unloaded with connections to bottom unloading arms and adjustable access to the top of each rail car without shunting, splitting, spotting or adjusting the 16 car rail lengths.

○ The railcar unloading arms and top access shall be designed to maximize the number of cars which are compatible with the bottom unloading arms and adjustable access to the top of each rail car understanding that some spotting and breaking of rail cars will be required to optimize operations and connectivity of cars when shorter railcar configurations are received.

Table 1: DOT-111/117 Railcar Lengths & Capacities

Car Types	Carrier	Railcar Capacity (US gallons)	Railcar Length (ft inch)	Railcar Length (m)	16 Railcar String Length (m)
1	PROX	23470	55' 5"	16.9	270
2	TILX	23550	55' 4.25"	16.9	270
3	PROX	27200	55' 10.5"	17.0	272
4	PROX	28300	57' 5.5"	17.5	280
5	TILX	27740	58' 2.75"	17.8	285
6	PROX	28680	58' 6.5"	17.8	285
7	SHQX	29000	59' 1.125"	18.0	288
8	TILX	25498	59' 3.25"	18.1	290
9	PROX	25790	60' 2.5"	18.4	294
10	GATX	29188	60' 7.5"	18.5	296
11	TILX	29188	60' 7.5"	18.5	296

- The design must allow all thirty-two (32) railcars to be unloaded within one eight (8) hour shift utilizing four operators. The indicative design is based on the following assumed cycle:

  ○ 20 minutes allowed for operator safety talk and reaching the railcar unloading yard; ○ 32 min allowed for top connection - opening of top hatch and vent valves; ○ 64 min allowed for bottom connection - connecting unloading arms and opening unloading valves;

  - 50% of design flowrate may be assumed during this step; ○ 248 minutes allowed for emptying of railcars at design flowrate; ○ 32 min allowed for top disconnection - closing of all vent valves and top hatches; ○ 64 min allowed for bottom disconnection – closing of unloading valves disconnection of unloading arms and capping;

  ○ 20 minutes buffer time; ○ 480 minutes total cycle time;
- Terminal operators must be provided safe access to the top of the railcars to open a vent prior to unloading and also to shut the vent after unloading is complete. This requires a center-access catwalk/gangway between the two (2) unloading tracks to provide top access.
- Unloading shall be via the bottom of the railcars via mechanical arms, unloading piping, and collection manifold. Each bottom connection to the railcar shall be fitted with a low flow indicator.
- The canola oil from the railcars shall be piped to a set of three (3) cross-connected railcar unloading pumps. The pumps shall be located on a pump pad near the railcar unloading stations and the new storage tanks.
- The railcar unloading pump design shall be based on three (3) by 50% pumps such that two operating pumps can achieve the required design flow rate. The railcar unloading pumps shall

each have a minimum pumping capacity of 344.5 m3/h and be driven by a minimum 45 kw (60 HP) motor at 1,800 RPM. Any relaxation of this minimum requirement shall be at the sole discretion of the Engineer.

- The railcar unloading pump motors shall be controlled by Variable Frequency Drives (VFDs).
- A Coriolis mass-flow meter (mass flow accuracy of +/- 0.05%) for custody transfer shall be installed in the railcar unloading pump discharge pipeline.
- Discharge from the new unloading pumps shall be tied into a piping system to distribute CSD grade canola oil to the new storage tanks. It shall also be able to be routed to the marine loading pumps and transferred directly to ship (i.e., bypassing storage).
- The system shall utilize flow control.
- It is recommended to keep the unloading pumps as close to the railcars as possible to minimize the non-recoverable pressure loss in the suction piping.
- Self-priming pumps shall be required for this application.
- Pulsation dampeners may be required on the railcar unloading line on the discharge side of the railcar unloading pumps. D-B contractor shall perform a transient analysis study during detailed engineering which shall confirm if the pulsation dampeners are required and also verify the required line class for the railcar unloading line and fittings, etc. This shall also include verification of the required minimum closing times for various valves, etc. The transient analysis study report shall be submitted to the Employer and the Engineer and is subject to Engineer approval.
- ~~The current design does not include water in the rail yard. DP World have not considered any requirements for wash down water in the rail yard at this stage.~~
- 100mm diameter water line to be installed to rail yard and terminated in chamber with valve such that connection can be made at a later date if required.
- Rail containment to be above ground, similar to drip trays.

P2.1.3 Canola Oil Storage Facilities:

- For Phase 1 a total working capacity (working capacity of a tank is defined as the available volume for use between low liquid level (LLL) and high liquid level (HLL)) of approximately 45,000 metric ton (MT or t) of CSD grade canola oil shall be provided. To maximize operational flexibility, three (3) identical storage tanks each with 15,000 MT (16,122 m^3)

working capacity shall be installed for storage of CSD grade canola oil. Tanks are to be installed within a containment area with a low point drainage sump and associated sump drainage pumps.

- To allow the future construction of Phase 2 (future expansion) provision shall be made for the construction of two (2) additional 15,000 MT working capacity CSD grade canola oil storage tanks and three (3) additional 2,000 MT working capacity RBD grade canola oil storage tanks.
- Tie-in points shall be provided for the extension of the piping to the future Phase 2 tanks.
- All new tanks shall include the following provisions: ○ Fixed roof design constructed in accordance with API 650 (Welded Steel Tanks for Oil Storage). ○ Equipped with automated/motorized isolation valves (i.e., shutoff valves) at both inlet and outlet for containment if connecting pipe ruptures, as well as providing overfill protection.
  - Level gauging per API 2350, 5th Edition.
  - Each tank shall include a high liquid level alarm and high-high liquid level trip to protect the tank from overfill.
  - Interior surface shall be seeded with canola oil.
  - The exterior shell shall be fully coated, excluding the underside of the floor.
  - Two (2) agitators for each 15,000 MT CSD storage tank which can operate continuously or intermittently to avoid product settling and gumming during storage. ○ Roof access by stair, and platform providing access to roof fittings, together with guard rail and fall protection if required.
  - Complete with clean-out/maintenance access manhole and associated door. DB Contractor to design for safe access. ○ A -walled containment area complete with a continuous spill containment membrane shall be installed to ensure that if one of the storage tanks ruptures, all spilled liquid will be contained. A minimum of two (2) sets of stairs providing access to and egress from the secondary containment area shall be provided at appropriate locations.
    - Design volume of containment area is 110% of the largest tank plus volume displaced by all other tanks to the height of the containment wall plus volume displaced by piping in the containment area as per API 2610 and NFPA 30.
  - Each of the tanks shall be set in place on an elevated foundation. Deep foundation is the preferred tank foundation option however, the design solution is the Contractor's responsibility.
  - Cathodic protection of the tank bottom shall be incorporated into the design. ○ New area lighting and storage controls shall be included.
  - Tanks and piping connected are to be designed to accommodate long term settlement.

P2.1.4 Canola Oil Marine Loading Facilities

P2.1.4.1 Canola Oil Marine Loading Pumping Facilities

- The marine loading pumps shall be based on three (3) by 50% pumps such that two operating pumps can achieve the required design flow rate. The marine loading

pumps shall be located on a pump pad near the storage/containment area. The operational pumps shall draw canola oil from the storage tanks and pump it through the marine loading pipeline to the marine loading arm.

- The nominal loadout rate of each of the three (3) pumps shall be 700 MT/h, the two (2) operational pumps shall therefore load at 1400 MT/h or 1520 m^3/h.
- A Coriolis mass-flow meter (mass flow accuracy of +/- 0.05%) for custody transfer of product loaded on to vessels shall be installed.
- The marine loading pump motors shall be powered and controlled by VFDs.
- The flow to the vessel can be managed by operator selection of the valve opening of the actuated valve in the marine loading pipeline.
- Additional flow control is available via the pump motors VFD speed control.
- Pulsation dampeners may be required on the marine loading line on the discharge side of the marine loading pumps. D-B contractor shall perform a transient analysis study during detailed engineering which shall confirm if the pulsation dampeners are required and also verify the required line class for the marine loading line and fittings, etc. This shall also include verification of the required minimum closing times for various valves, etc. The transient analysis study report shall be submitted to the Employer and the Engineer.

P2.1.4.2 Canola Oil Marine Loading Pipeline Facilities

- Canola oil shall be pumped from the storage tanks to the marine loading arm for export via liquid bulk carriers. The piping shall be installed below grade until it surfaces near the marine trestle. The above grade piping shall be optimized to minimize footprint and be protected from regular terminal traffic.
- Piping over the water to the berth shall be double walled with leak detection monitoring of the interstitial space and meet all applicable code or permitting requirements.
- The minimum marine loading pipeline diameter is 400 mm (16 inch).
- To maintain product quality, a minimum 150 mm (6-inch) return/recirculation line, which follows the routing of the marine loading pipeline, shall be included from the marine trestle back to the storage tanks and pump area.

P2.1.4.3 Canola Oil Marine Loading Arm Facilities

One marine loading arm shall be supplied suitable for the loading of all grades of Canola Oil to the range of design vessels set out in the Employer's Requirements.

The marine loading arm shall be electro hydraulically operated and supplied with a radio remote control suitable for operation from the jetty or vessel. A manually operated pump shall be supplied for use in the event of power or equipment failure. Hydraulic fluid shall be marine safe.

All electrical equipment shall be CSA certified for installation and use in Canada.

The marine loading arm shall be designed such that it is full balanced when empty of product and shall be equipped with a mechanical emergency release coupling and a non-return valve. Powered emergency release coupling shall be provided as an option.

The DB Contractor to determine suitable size of MLA to accommodate the full range of anticipated vessel sizes and manifold locations as well as tidal and river flow fluctuations. Drain valves shall be provided at the lowest point of the system, at the main swivel assembly and at any other point necessary for the safe and efficient cleaning of the system.

The marine loading arm shall include all access platforms and ladders necessary for operation, inspection and routine maintenance / cleaning. An electrical insulating flange shall be provided.

High point Nitrogen connection shall be provided to (blowing) loading arm **Marine**

Loading Arm Specification:

Design System Throughput:	1400 MT/hr
Arm Diameter	10”
Design Operating Temperature Range -13°C to +38°C (align with other references)	
Design Wind Speed	80 km/h operating 95 km/h parked position
Hazardous Area Classification	Class 1, Div 2, Zone 2 (the D-B Contractor is ultimately responsible for their own design, if they want to change the classification, and can demonstrate that it complies with all codes and regulations, this can be reviewed and agreed)
Finish:	Marine Grade corrosion protection

The Contractor shall propose equipment directly from original equipment manufacturers (OEMs) responsible for the design, manufacturing, and supply of it. Proposed OEMs for critical equipment shall be approved by the employer / engineer and shall be an OEM that has manufactured and supplied, commencing from the beginning of the year 2014 and onwards, at least six (6) MLAs destined to North America, related to comparable edible oil applications, and was the designer and manufacturer of these MLA.

The Contractor shall submit to the employer the following:

- A declaration certifying that OEM is the designer, manufacturer, and supplier of MLAs.
- Documentation certifying and evidencing that the OEM has manufactured and supplied at least six (6) MLAs destined to North America, related to comparable edible oil applications, from 2014 onwards.

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- Additional proof of such MLAs projects delivery, such as reports and relevant documentation.

The design build contractor to prepare and confirm information below, assuring the correct functionality of the MLA for the operational purpose:

Table 2: Design Specification for Marine Loading Arm

Design Specification for Marine Loading Arm	
Distance jetty face to center line of riser	DB Contractor to confirm
Distance jetty face to berthing line (min/max)	DB Contractor to confirm
Distance between center line of riser (min/max)	DB Contractor to confirm
Dock to flange center line	DB Contractor to confirm
Dock to flange face (below dock)	DB Contractor to confirm
Dock to high water level	DB Contractor to confirm
Difference between high and low water level	DB Contractor to confirm
Distance of manifold flange to vessel side (min/max)	DB Contractor to confirm
Low water level to vessel manifold (smallest full vessel)	DB Contractor to confirm
High water level to vessel manifold	DB Contractor to confirm
Sway	DB Contractor to confirm
Fore / After surge	DB Contractor to confirm
Flange center on vessel manifold (min/max)	DB Contractor to confirm
Smallest and largest vessel	DB Contractor to confirm

P2.1.5 Site Containment and Wastewater Treatment

P2.1.5.1 Containment Area Sump Systems

- The sealed containment areas shall not permit water to flow naturally to the surrounding environment either by surface runoff or by percolation.
- A two (2) x 100% sump pump system shall be provided for the containment areas. The sump pump system shall collect all potentially contaminated runoff, precipitation and any spilled canola oil, and transfer it to a suitably sized oil water separator for treatment.
- The oil water separator (OWS) shall be sized to receive all containment water or canola oil collected at the following containment areas: ○ Railcar unloading stations - The pans underneath the loading area, and their adjacent surfaces, are anticipated to collect small volumes of canola oil.
    - Railcar unloading pumps - This area is anticipated to be contaminated with canola oil due to any failures of pump seals that may occur over time.
    - CSD storage tanks - This area is anticipated to be relatively clean. All water and oil collected shall be routed to a single sump.
    - Marine loading pumps - This area is anticipated to be contaminated with canola oil due to any failures of pump seals that may occur over time.

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P2.1.5.2 Spill Containment Ship Loading Area

- The ship loading area shall be designed to prevent spills during operations

P2.1.5.3 Wastewater Treatment

- All water collected by the sump systems described shall be pumped to a central oil water separator (OWS separator) by submersible pumps. All submersible pumps shall be mounted on rails such that they can be safely removed for maintenance without requiring personnel to enter the sump.
- A sensor shall be installed on the oil water separator to provide indication (sound alarm at control building) to the operator when it requires to be pumped out.
- The treated water meeting the regulatory discharge criteria shall be gravity discharged to the nearest suitable existing storm water manhole location.
- Downstream of the Oil Water Separator a manual cut off valve requires to be installed that can be used in case of emergencies.

P2.1.6 Utilities and ancillary items including:

Nitrogen distribution piping system including all connections, valving and appurtenances, but excluding the nitrogen supply skid which is to be provided by Employer.

- Nitrogen will be used for various purposes at the new facility:
  ○ Purging of the marine loading arm after use ○ Purging of the pipeline after use, to ensure product does not degrade in the piping ○ Blanketing of the marine vessel by controlled injection into the marine loading pipeline ○ Actuation of pneumatic valves ○ Future blanketing of the Phase 2 RBD canola oil storage tanks
- The employer will be responsible for a lease agreement for the nitrogen supply skid with the Nitrogen supplier. The nitrogen supply skid is anticipated to include a 43,000 l liquid nitrogen tank (estimated), vaporizer, valves, instrumentation, and controls including telemetry equipment to provide tank level and other diagnostics back to the supplier. All relevant details shall be confirmed by the Contractor with the Employer including the provision of sufficient space, access, piping connections, etc.

P2.1.7 Fire Protection

- Design shall comply with NFPA 307, the National Fire Code, as well as the Vancouver Fraser Port Authority (VFPA) and the Surrey Fire Department requirements.
- Fire water is provided to the site by the City of Surrey.

P2.1.8 Ancillary Facilities

- Parking area for ten (10) vehicles at the outside the MCC Building.
- Motor Control Centre (MCC) building shall be provided near the storage location including the following:
    1. Building vendor shall certify that the building meets the National Building Code of Canada (NBCC) 2020.
    2. The final height for the building shall be determined during detailed design based on the minimum bend radii of cables and cable tray, as well as accessibility for maintenance and installation.
    3. Floor level shall be above the design flood level.
    4. One set of double doors located at one end of the building for equipment and service access. Doorway to come with a 0.6 m (2') removable transom.
    5. One 0.9 m x 2.15 m (3' x 7') insulated personnel door in addition to the double doors.
    6. Programmable Logic Controller (PLC) / Electrical room
    7. Control Room

P2.1.9 Marine Berth

The existing lay by berth (Berth 10) shall be modified to allow for the loading of canola oil. The scope for the marine berth structure generally consists of:

- Demolition of the existing Berth 10 Dolphin number 2.
- A new marine loading platform adequate to support the operation and maintenance of the marine loading arm and associated piping and utilities, complete with bollards and fendering to support the berthing and mooring of the range of design vessels.
- Provide a platform for a marine gangway for safe vessel access. The vessel gangway is an optional scope.
- A new trestle structure to provide for vehicle and pedestrian access to the loading platform to support the operation and maintenance of the canola oil marine loading system.
- A new catwalk to provide pedestrian access from existing Berth 9 to the new marine loading platform at Berth 10.
- The berth structures shall be fitted with handrails, bull rails, ladders, and life-saving equipment.
- Shore protection as required by the structure design.
- Enclosed operators shelter.
- The replacements and recommendations in Appendix 1 - DP World Fraser Surrey Inc. - Dolphin & Trestle Structural Condition Assessment for Berth 10, shall be completed. For clarity, this shall also include the application of a corrosion protection system to the pile cap and pile connections as described in 3.1.4 and 3.1.5 of the Condition Assessment Report as well as full replacement of the Guardrails which have been assessed to have a residual life of 2 years or less.

P2.2 Design and Operations Data

P2.2.1 Design Vessels

The following design dimensions are to be used for the berthing and mooring structures:

Particulars	Design Largest Vessel Handymax	Design Smallest Vessel Small Handy
Dead Weight Tonnage (DWT)	50,000	20,000
Length Overall, LOA (m)	210	160
Length between perpendiculars, LBP (m)	200	152
Beam (m)	32.2	23
Max Draft, loaded (m)	12.6	9.5
Displacement, loaded (MT)	66,000	29,000

The Contractor shall consider the vessel manifold location based on typical manifold locations for the design vessel range noted above.

P2.2.2 Product Properties

Types of canola oil that will be handled at the new facility will include:

Name	Designation	Anticipated Percentage of Terminal Throughput
Crude Super Degummed Canola Oil	COPA Type I	100%

Composition and physical properties of products are as per below:

Standard Specifications	Type I Crude Super Degummed
Free fatty acid (as oleic acid), maximum % by mass	1
Moisture & volatile matter & impurities, maximum % by mass	0.3
Flashpoint (typical), minimum °C	150
Chlorophyll content, maximum parts per million[1]	30
Neutral oil (typical), minimum % by mass	98.5
Loss (typical), maximum % by mass	1.5
Phosphorus content, maximum parts per million	50
Erucic acid, maximum % by mass	2
Sulfur (typical), parts per million	25

(1) Obtained from COPA

Canola Oil

			Reference ID
Equation(s) for Predicting Evaporation			
Little evaporation			ESD 01
Density (g/mL)			
	Temperature (°C)		
Degummed	0	0.9304	ESD 01
	15	0.9205	
	25	0.9136	
Refined	0	0.9306	
	15	0.9205	
	25	0.9135	
Dynamic Viscosity (mPa·s or cP)			
	Temperature (°C)		
Degummed	0	182	ESD 01
	15	83	
	25	54	
Refined	0	189	
	15	86	
	25	56	

P2.2.3 Heat Trace and Insulation

Heat tracing and insulation are not required as the piping system will not be exposed to ambient temperature below the canola oil gel point of -15°C.

P.2.24 Piping Material Compatibility and Design

All piping, valves, pumps, and devices will be built to Carbon Steel, with a maximum hydrostatic test pressure to be determined during detailed engineering. All material selections will be finalized by Contractor but shall not compromise the food grade quality or nature of the product being handled. All seals and O-rings should be comprised of Graphoil, Viton, BUNA or EPDM, and gaskets should be spiral wound stainless steel and Graphoil as per the piping specifications.

The DB contractor shall design the piping to comply with the requirements of ASME B31.3-2020. The DB contractor shall complete full piping stress analysis and recommend pipe support locations and verify that equipment nozzle loads are within vendor allowables.

P2.3 Site Characteristics and Environmental Data

P2.3.1 Environmental Ambient Conditions

The site is fully exposed to local weather conditions. All outdoor equipment and structure will be subjected to direct sun, rain, snow, ice, wind, and lightning.

The climatic conditions for the site are given in the following tables.

Table 3: Site General Location

Reference Code:	NBCC 2020
Location:	Surrey, BC
Latitude:	49°11’21.74” N
Longitude:	122°54’22.39” W

Table 4: Climatic Design Parameters

Design Parameters	Value or Range
Hourly Wind Pressures, 1/10	0.36 kPa
Hourly Wind Pressures, 1/50	0.47 kPa
Snow Load (Ss)	2.4 kPa
Rain Load (Sr)	0.3 kPa

Ambient temperatures to be used for project design:

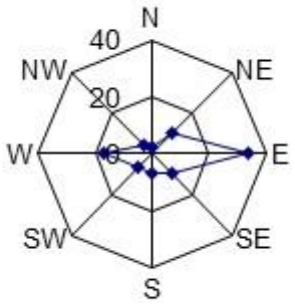
- Low -13 °C
- Mean +10 °C
- High +38 °C

All systems apart from wastewater treatment shall be designed using a design duty point temperature of 0 °C; the wastewater treatment system shall be designed using a design duty point temperature of 10 °C.

P2.3.2 Wind Conditions

In the exposed areas of Vancouver Port, prevailing winds are predominantly from east and from west throughout the year. This general wind pattern is locally influenced and modified by the topography of the surrounding land. Wind records were obtained from Atmospheric Environment Services for Vancouver Airport. The wind records indicate monthly frequency of occurrence of wind speed and direction relative to an eight-point compass. The percentage of occurrence by direction is presented in the figure below.

Wind Rose – Vancouver Airport



The following exceedance frequencies of wind speeds have been derived from the annual wind statistic for Vancouver Airport:

Storm Description	Mean Hourly Wind Speed	National Building Codes
Return period of 10 years	U = 18.9 m/s	U = 23.3 m/s
Return period of 50 years	U = 21.4 m/s	U = 26.4 m/s

P2.3.3 Seismic

The design earthquake shall be based on the NBCC 2020 design earthquake, 2% probability of exceedance in 50 years (1 in 2475 return period)

The Contractor shall complete a Site-Specific Response Spectra Analysis. The site-specific design response spectra envelope shall not be less than 80% of the NBCC 2020 design response spectrum. The assessment shall consider varying soil conditions / ground improvements throughout the Work area.

The design performance criteria for all structures during the 1 in 2475-year event is life safety/no collapse.

The following Seismic Importance levels (as defined by the relevant design codes) shall be used:

- Storage Tanks: Normal
- Buildings: Normal
- Marine Structures: Low

This site may be susceptible to liquefaction at low levels of seismic excitation. Ground improvement measures may be required to mitigate damage associated with design level events.

Kinematic loading that results from the liquefaction and lateral spreading of soils during seismic activity shall be considered in the design as required. Detailed design requirements shall address potential for combinations of inertial loads and kinematic loads from soil lateral spreading.

Dynamic methods of analysis shall be used to determine forces and displacements. The effects of soil/structure interaction shall be considered and analyzed as well as the effects of liquefaction with flow slides.

P2.3.4 Soil Conditions and Geotechnical Design

The Contractor shall make its own determination of the soil conditions and conduct any additional geotechnical investigations and testing that may be required.

Geotechnical design shall include assessment of liquefaction potential and soil improvement as required to meet slope stability requirements, settlement criteria, and seismic performance levels.

An accredited geotechnical engineering specialist approved by the Engineer Shall be retained by the Contractor to perform geotechnical design.

The Contractor shall undertake any additional investigation, which may be necessary to establish the design.

A non-linear time-history dynamic method of analysis of soil structure interaction using finite difference or finite element methods shall be used to model seismic response of the marine and tank structures and foundation soils. The results of this analysis may not be used in place of methods described in the relevant codes but shall be used to supplement and confirm the final design is in accordance with the code.

The Contractor shall assess the soil structural interaction including inertia forces, and the effects of soil liquefaction, ground displacements, lateral spreading, kinematic loading, soil softening, etc.

Geotechnical design will follow LRFD limit states design methods and recommendations given in the codes listed above.

P2.4 Design Life

The Design Service Life is defined as the period of time the structure remains serviceable subject to fair wear and tear. Regular inspections and reasonable level of periodic and as-needed maintenance will be required to ensure the Works remain serviceable during the design life.

The minimum required design life for the facility is 50 years, unless noted otherwise. The

following Works will have a service life of 50 years:

- Concrete work;
- Steel work (including tanks, sheet piles and piles) whether painted, coated, galvanized or provided with cathodic protection;
- Mechanical piping and utilities;
- Buildings,
- Structural foundations;
- Storage tanks, and

- Marine structures.

The following Works will have a service life of 20 years :

- Pavement
- Fences, gates and handrails
- Mechanical pumps, valves, and instruments
- Marine fenders, bollards, ladders bull rails and other marine furniture, and
- Electrical works

Road Markings will have a service life of 5 years.

Unless otherwise specified, all infrastructure and equipment shall be designed to operate continuously 24 hours per day, 365 days per year for the anticipated design conditions specified.

P2.4.1 Heat Trace and Insulation

Heat tracing and insulation are not required as the piping system will not be exposed to ambient temperature below the canola oil gel point of -15°C.

P2.4.2 Piping Material Compatibility and Design

All piping, valves, pumps, and devices will be built to Carbon Steel, with a maximum hydrostatic test pressure to be determined during detailed engineering. All material selections will be finalized by Contractor but shall not compromise the food grade quality or nature of the product being handled.

All seals and O-rings should be comprised of Graphoil, Viton, BUNA or EPDM, and gaskets should be spiral wound stainless steel and Graphoil as per the piping specifications in Part 3.1.

The DB contractor shall design the piping to comply with the requirements of ASME B31.3-2020. The DB contractor shall complete full piping stress analysis and recommend pipe support locations and verify that equipment nozzle loads are within vendor parameters.

P2.5 Guarantees and Warranties

Contractor shall provide process performance guarantee data, as specified on final supplied equipment data sheets.

The Contractor shall obtain guarantees (which term shall include warranties, express undertakings and the like) for elements of the Works as specified below and / or in the Contract and shall ensure that the Employer is assigned the benefit of the guarantees. This includes any guarantees specified in the Contract that are to be obtained by Subcontractors, suppliers or otherwise.

All guarantees shall cover the Plant and Materials used in the Works as well as the installation of the same and shall provide the required guarantee for the defined duration for the completed installation, excluding normal wear and tear. The Employer shall not be liable for any costs for labour or parts related to inspection, repair or replacement of any defective components under guarantee.

Guarantees are required for the elements of the Works for a minimum of one (1) calendar year or any extension beyond this that the Contractor can obtain or is provided as a standard by manufacturers in the industry for the respective equipment.

In the event that the Contractor is unable to provide a guarantee for the specified duration for any element, then he shall notify the Engineer in writing prior to placing the order and shall furnish the Engineer with detailed particulars of the element's suitability and credentials. A reduced guarantee period may be considered, at the sole discretion of the Employer.

Unless otherwise specified in the Contract, guarantee periods shall begin on the issue of the TakingOver Certificate for the whole of the Works. These guarantees shall be kept by the Contractor until the issue of the Performance Certificate, when it shall supply them without delay to the Engineer for issue to the Employer.

The Final Payment Certificate shall not be issued until all guarantees have been provided by the Contractor.

The Contractor warrants that all Materials and Plant ordered, manufactured, delivered and incorporated into the Works shall be new (unless stated to the contrary in the Employer's Requirements) and in any event all Materials and Plant shall be of sound and satisfactory quality and appropriate for the intended purpose as set out in the Employer's Requirements. The Works shall be fit for their intended purpose and when completed shall be free from inherent or latent defects whether in design, engineering, manufacture, workmanship (fabrication and installation), Materials and Plant.

The guarantee shall include details of any inspections and maintenance regimes required to be undertaken after the issue of the Taking-Over Certificate in order to maintain the validity of the guarantee.

The guarantee period within which the Contractor shall be required to correct any issues arising shall be during the Defects Notification Period and shall cover both parts and labour, excluding normal wear and tear items.

In the event that a guarantee period stipulated by the manufacturer or supplier of the components furnished to the Contractor and incorporated into the Works

exceeds the Defects Notification Period, then the Contractor shall assign such guarantee rights to the Employer.

During the Defects Notification Period, the Contractor shall immediately, and at no cost to the Employer, remedy defects and / or correct deficiencies on Site, including exchanging any part or parts which do not comply with the Employer's Requirements or which otherwise show any defects excluding normal wear and tear items.

If the Contractor is requested to remedy such defects, and in the event that the Contractor does not commence work to correct the guarantee claims within thirty (30) days, the Employer has the right, after written notice to the Contractor, to arrange the repair / correction at the Contractor's expense. In such event, the Contractor shall furnish the Employer with all technical instructions necessary to remedy such defects within fourteen (14) days of the written notice. The Contractor shall also provide any additional explanation and / or clarification necessary to enable the Employer to follow such technical instructions to remedy the defect. In the event the Contractor does not provide such technical instructions, the technical instructions are incomplete or otherwise inadequate to resolve the claimed issue, the Employer has the right, after fourteen (14) days of written notice to the Contractor, to define the repair / correction based on specialist advice from a source of the Employer's choosing and arrange repair / correction at the Contractor's expense. The Contractor's guarantee shall remain in full force and effect, including any repairs made by the Employer.

With regard to parts wholly or partially replaced or repaired, the above-mentioned conditions shall apply in respect of all relevant parts for a revised equal period, effective from the completion of the repair.

During the warranty period, the Contractor shall be responsible for:

a) Routine inspections & reporting to the Employer
b) Completion of all obligations of manufacturer's guarantees, including guarantees services required by the manufacturer's.
c) The service period shall commence immediately after the issuance of the Taking Over Certificate or the commencement of the Defects Notification Period (which ever starts at the latest).

P2.6 System Overview

- The Phase 1 design capacity is rated at 1,000,000 MT per year. The future Phase 2 expansion design capacity is anticipated to be 2,000,000 MT per year.
- System to be engineered to include a high level of automation. The system shall include variable frequency drives (VFDs) for both the railcar unloading and marine loading pumps.
- For CSD grade canola oil, all tanks and piping will be carbon steel construction. No stainless steel (except valve trim), copper, brass, glass, or mercury-containing components to be specified.
- System to be configured to cater for direct loading of CSD grade canola oil from railcars to ship.
- Sparing philosophy for pumps ○ Rail unloading – Three (3) rail unloading pumps to be installed (two (2) operating, one standby), each with design capacity of approximately 50% of the required

maximum rated flow. The set of three (3) pumps will be cross connected by headers to allow any pump to handle flow from all sources. In the event of one pump failing during operation, the third pump will be brought into service, which will enable the railcar unloading to continue at the maximum rated flow. ○ Marine loading - Three (3) marine loading pumps to be specified (two operating, one standby), each with design capacity of approximately 50% of the required maximum rated flow. The set of three (3) pumps will be cross connected by headers to allow any pump to handle flow from all sources. In the event of one pump failing during operation, the standby pump will be brought into service and the two (2) remaining operational pumps will handle the entire marine loading product volume at the maximum rated marine loading rate.

- The marine loading pipeline is estimated to be circa 600 m long.
- All piping, pump and process equipment, and storage tanks to be designed for ambient temperatures ranging from -13°C (lowest ambient temperature) to +38°C (highest ambient temperature), which is within the normal operating range for typical carbon-steel.
- A Minimum Design Metal Temperature (MDMT) of -29°C shall be used for design.
- Project piping specifications are as documented in Section 16
- All marine piping in canola oil service (i.e. piping above water) will be designed as double walled piping to protect the environment from leakage. Interstitial leak monitoring is also required.
- The canola piping shall be equipped with expansion joints at locations where differential settlement may lead to pipe stress that would require maintenance or realignment within first 10 years of operation. In any case, at minimum, suitable expansion joints shall be provided at storage tank inlet and outlet connections.

P2.6.1 Equipment and Installation

The Contractor is to install the mechanical equipment and the associated piping and the supporting structures in accordance with the approved design drawings and vendor-supplied drawings.

The Employer shall have the right, at its sole and absolute discretion, to verify the recommendations and other documents provided by critical equipment OEM, and to request from any proposed supplier additional details, approvals, recommendations, and/or certificates. In addition, The Employer may, at its sole and absolute discretion, upon prior coordination with the Contractor, inspect the facilities of such supplier at any time or any facilities where components of critical equipment (e.g., MLAs) are being manufactured.

The Employer has listed in Appendix 2 – DP World list of preferred suppliers and will only consider the Contractor's application for an alternative supplier if:

- The Contractor can demonstrate that the proposed alternative equipment/ material is superior or equivalent to that supplied by the approved subcontractor/ supplier; and
- Cost and/or time benefits to the Employer are identified.

Other suppliers can only be used after written approval from the Employer at the Employer's sole discretion.

The table below lists the major equipment to be installed for Phase 1 of this project.

Equipment No. (new)	Type	Description	PFD No.
P-1040/50/60	Self-Priming Centrifugal Pump with soft starter	Canola Oil Railcar Unloading Pumps	7704-PID-002
T-2010	Fixed Roof Atmospheric Pressure Storage Tank	Canola Oil CSD Grade Storage Tank	7704-PID-004
AG-2010/15	Tank Agitators	Tank Agitators	7704-PID-004
T-2020	Fixed Roof Atmospheric Pressure Storage Tank	Canola Oil CSD Grade Storage Tank	7704-PID-005
AG-2020/25	Tank Agitators	Tank Agitators	7704-PID-005
T-2030	Fixed Roof Atmospheric Pressure Storage Tank	Canola Oil CSD Grade Storage Tank	7704-PID-006
AG-2030/35	Tank Agitators	Tank Agitators	7704-PID-006
MLA-4210	Marine Loading Arm	Marine Loading Arm (Powered Remote Control, ERC as option)	7704-PID-010
P-4010/20/30	Centrifugal Pump	Canola Oil Marine Loading Pumps	7704-PID-007
PD-1070	Pulsation Dampener	Railcar Unloading Pipeline Pulsation Dampener	7704-PID-003
PD-4000	Pulsation Dampener	Marine Loading Pipeline Pulsation Dampener	7704-PID-008
PD-4300	Pulsation Dampener	Marine Loading Pipeline Pulsation Dampener	7704-PID-009
ST-4200	Canola Oil Slop Sump Tank	Canola Oil Slop Sump Tank	7704-PID-010
P-1010/20	Sump Pumps	Unloading Stations Containment Area Sump Pumps	7704-PID-001
P-4110/20	Sump Pump	Railcar Unloading Pumps, Marine Loading Pumps,	7704-PID-008
P-2110/20	Sump Pumps	CSD Grade Tank Farm Containment Sump Pump	7704-PID-006
-	Tote tank	Remote location tote tank (per remote loc)	7704-PID-009
OWS-5020	Oil Water Separator	Oil Water Separator	7704-PID-012
P-5030/40/50	Centrifugal Pumps	Treated Water Discharge Pumps	7704-PID-012
P-4230/40	Centrifugal Pumps	Slop Tank Pumps	7704-PID-010
-	Railcar Unloading Arms / Hoses	Railcar unloading arms and/or hoses	7704-PID-001
STR-1030	Duplex Strainer	Railcar Unloading Pumps Suction Strainer	7704-PID-002
STR-4040	Duplex Strainer	Marine Loading Sumps Suction Strainer	7704-PID-007
-	Nitrogen Supply Skid (By Employer)	Nitrogen Package for Nitrogen Supply	7704-PID-011

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Table 5: Equipment

P2.6.2 Commissioning and Start-Up

The Contractor is responsible for all commissioning and startup of the facility through to issuance and acceptance of the Taking Over Certificate.

A prerequisite for issuing the Taking Over Certificate for the works, is successful completion of the commissioning of the whole project by demonstrating practically, unloading of Canola oil from railcars located at each track, loading of the storage tanks, loading of vessels from storage, and direct hit (loading of vessels directly from railcars), demonstrating that the main and all auxiliary functions as designed are also working to the envisaged requirements. Employer shall provide support to arrange for trains and vessels on a trial basis for purposes of assisting with the commissioning of the Canola Terminal by the Contractor.

Before commissioning of the whole system, the Contractor shall carry out all necessary tests and procedures, and obtain all permits/ certificates that may be required. A plan for commissioning of the entire system shall be submitted to the Engineer and the Employer for review and approval.

The Contractor shall be responsible to provide all maintenance, operational and vendor training that may be required to ensure that the employer can effectively operate and maintain the facility prior to the completion of the commissioning and taking over of the Works.

Commissioning submissions, notices and requirements shall include:

- A Detailed Commissioning plan covering the entire system which shall be submitted by the Contractor for approval to the Engineer 10 months prior to the planned start of commissioning
- A comprehensive commissioning schedule shall be provided a minimum of 6 months prior tot the start of commissioning. The commissioning schedule shall be update at least monthly, or as requested by the Engineer, and shall specify when the first canola oil shall be delivered to site by rail and the quantities proposed as well as a date for the first vessel arrival.
- A minimum of 30 days prior to the delivery of canola oil to the facility a third-party inspection agency, approved by the Employer, shall complete a survey of the Works to confirm that the facility is suitable for canola oil commissioning.
- Commissioning plans shall include:
    - All factory acceptance testing, prerequisite quality tests, approvals, certifications, and confirmations ○ A detailed operator training program and schedule ○ Test runs, start-up procedures, balancing, pre-commissioning, etc.
    - Individual system tests and commissioning plans
    - Full works commissioning step by step, system by system prior to introduction on canola oil
    - Canola Oil Commissioning including:
        - Product recycle system
        - Product custody transfer metering
    - Performance Testing – ▪ Railcar unloading

- Vessel loading from tanks
- Vessel loading directly from railcars

- The Contractor shall be responsible for and shall reimburse the Employer for any Canola Oil which is damaged, lost, or rendered unfit for human consumption as a result of any activities in connection with commissioning of the terminal.

P2.7 Standards Codes and Regulations

All works are to be designed and constructed to comply with applicable provincial and federal acts, laws, codes, standards, and regulatory requirements as well as with industry standards.

As part of the design basis development, the Contractor shall provide a listing of all codes, standards and guidelines for the design of the Works for approval by the Engineer.

All codes and standards are meant to reference the latest editions. Where there is a discrepancy, the more stringent requirement will apply.

All deviations require written approval by the Employer.

P2.8 Demolition

P2.8.1 Work Scope

The Contractor shall remove those parts of the existing facility necessary for construction of the Works as generally depicted on the Drawings.

Demolition shall include, but not be limited to, the following:

- Removal or relocation of utilities or services that conflict with the Works
- Removal of existing Berth 10 Mooring Dolphin #2 including the entire length of the pile. Fenders and bollards to be handed over to Employer.
- Removal of intermodal track 6 as required to facilitate the new rail Works
- Removal and relocation of existing storm water systems in the canola oil storage area
- Removal or relocation of existing security and perimeter fencing, while maintaining and obtaining all required approvals for changes to the Transport Canada and Canadian Border Services Agency secure site perimeter.
- Removal of paving of various types to facilitate the Works.
- Removal of all other elements required for the completion of the Works.

Demolition works shall be undertaken subject to the submission of a full design package outlining all relevant details for the demolition Works and approval from the Engineer.

P2.8.2 Function

The demolition works shall be planned and organized to ensure that they do not cause disruption or impacts to the terminal operations. The demolition Works shall in all cases be confined to the project Site. Any impacts from the demolition works that impact the terminal operations including, drainage issues, water supply constraints, loss of power or communications shall immediately be rectified by the Contractor at his sole cost.

P2.8.3 Materials and Structural Form

All materials from the demolition material shall be removed from the site and disposed at Contractor cost of at an approved location unless it is suitable and required for reuse in the works in which case it shall be placed in a well-organized stockpile. Re use of disposal material in temporary or permanent works is subject to Engineer approval and material fulfilling all of the requirements stated in the Employer's Requirement,

The Contractor shall obtain all necessary licenses and consents for the disposal of materials from the demolition. Any contaminated material shall be disposed of safely and in compliance with health and safety and environmental legislation. Contamination or pollution of existing watercourses shall not be permitted.

P2.8.4 Requirements and Design Criteria

Demolition Works shall be shown on the Contractors Drawing indicating the scope, extent and spatial limitations of all demolition.

P2.8.5 Design Method

Any demolition Works which may impact the terminal operations and the safety there of including rail Works, utilities and services shall be reviewed by a professional as part of a demolition design package.

P2.8.6 Workmanship

All demolition works shall be completed in a safe workmanlike manner and shall once started be continued till completion of an area or section. All demolition areas must be maintained in a safe condition throughout the Works or shall be properly barricaded off as needed to ensure worker safety and limit hazards to personnel.

P2.8.7 Quality Control

During the carrying out of the demolition works the Contractor shall keep the Engineer informed of any changes to the scope or extents of the planned demolition Works. The Engineer may require the Contractor to pause demolition Works and update the demolition plan prior to proceeding if the demolition Work being completed materially differ from the approved plans or substantial additional operational or safety risk is identified during the carrying out of the Works.

If material changes or deviations occurred during the carrying out of the demolition Works the Contractor shall submit within five (5) days of completion of the relevant elements an update to the approved demolition work plan and Drawings.

P2.9 Earthworks

P2.9.1 Work Scope

The work scope of the earthworks and ground improvements includes:

- Earthworks include:
    - Clearing and grubbing – including the minimum area required for the safe installation of the marine access trestle including the abutment and approach slab and as generally required to prepare the area around the canola storage tanks
    - Excavation – including all excavations related to the installation of the rail unloading infrastructure, process mechanical piping, trenchless crossings, utilities, storage tanks, building foundations, sumps, containment areas, containment liners etc.
    - Fill – including the importation or reuse, transport, placement and compaction of any granular material or geotextiles to obtain the required levels and structural capacities or bearing strengths for the various structures and pavements.
    - Disposal of Unsuitable or Excess Material – Any material which is not suitable for use, or is in excess of the quantity required, to construct the Permanent Works shall be disposed of by the Contractor at his sole cost.
- Ground improvement include steel or concrete foundation piling, deep soil mixing, rapid impact compaction, preloading, surcharge, wick drains or any other ground improvement methods which may be selected by the Contractor.
- Other associated Works include:
    - Any photographic, video, settlement, or vibration monitoring which may be reasonably be required by the Engineer to ensure the integrity or monitoring of other infrastructure for potential damage or impacts during construction ○ Repair and remediation of any impacts to other infrastructure as a result of the Works ○ Verification, quality or performance testing of the earthworks or ground improvements
    - Management of all surface or ground water that may enter the site either passively or actively, such as, through well point dewatering, including treatment meeting all Authority requirements prior to discharge to storm, sanitary or the environment.
    - Dust mitigation, etc.

P2.9.2 Function

All earthworks and ground improvements shall be completed, as necessary to meet the design levels and provide adequate stability and bearing capacity for the Permanent Works.

P2.9.3 Materials and Structural Form

The Contractor shall satisfy himself as to the nature of the Site by examination of all the site investigation information and study data and samples obtained in the course of investigations on behalf of the Employer and others. The Contractor shall rely on his own verification of the data supplied for which the Employer accepts no liability and provides no warranty. The Contractor shall make his own interpretation of any information provided, which is given for information only and without prejudice. The Contractor shall be deemed to have satisfied himself as to the adequacy of his plant for dealing with with the materials (manmade and/or naturally occurring) encountered.

P2.9.4 Requirements and Design Criteria

The earthworks and ground improvements shall be designed to withstand the seismic and operational loads and achieve the settlement criteria in these and other parts of these Employer's Requirements.

The settlement criteria shall include:

- Canola Storage Tanks – Shall be designed to meet the settlement requirements of API650. The piping connections, the storage tanks, the tank containment liner in the storage tank area shall be designed to accommodate the components long-term and differential settlements without significant maintenance or replacement while remaining fit for purpose.
- The Rail Car Unloading Structures - shall be designed to accommodate the full magnitude of their respective expected long-term total or differential settlements without significant maintenance or replacement while remaining fit for purpose.
- The Marine Loading Facilities – shall have a maximum long-term settlement that meets the requirements of CSA-S6.

P2.9.5 Design Method

Before commencing the construction of any of the earth works, the Contractor shall prepare calculations, drawings, work method statements and risk assessments and a design report to demonstrate to the Employer that his design will satisfy the specified criteria.

Additional ground investigations are required for design purposes, such additional ground investigations shall be the responsibility of the Contractor and ground investigation coverage shall be in line with the Contractor's design, chosen safety philosophy and applicable codes and standards.

Settlement of existing areas will be estimated using appropriate methods. The Contractor's design shall demonstrate, in the calculations that the limiting overall settlement criteria will be achieved. In his calculations of settlement, the following shall be considered: immediate settlement, consolidation settlement, secondary (creep) settlement, and seismic induced settlement (if any).

Bearing Capacity for foundations and structures will be assessed using appropriate methods as outlined in the Canadian Foundation Engineering Manual.

Seismic design shall provide for site specific analyses of the amplification of ground motions due to site conditions. Seismic liquefaction resistance across the Site shall be checked.

Structures should be sited or protected from hazards to meet life safety requirements of the 2020 National Building Code.

P2.9.6 Workmanship

P2.9.6.1 Excavations by Hand Near Existing Services

The Contractor shall set out, identify, mark, and protect existing services and conduits installed at the Terminal Site. Utilities that are still in use shall be protected, ensuring that:

a. Manholes, vaults, junction boxes, service pits etc., are not damaged;
b. Drains and services are not impacted by the Works and kept clear of debris.

In the vicinity of all existing utilities, services shall be first located by electronic scanning, and uncovered by vacuum excavation or hand digging. Every care shall be taken to avoid damage to such services. Temporary supports shall be provided where necessary and may require an engineered design be provided by the Contractor to ensure safety of workers.

P2.9.6.2 Clearing And Grubbing

Clearing and grubbing operations are defined as follows:

- Removing trees, shrubs, grass, weeds, overhanging branches and other miscellaneous vegetation;
- Removing stumps and roots (including any subsequent regrowth) to a depth not less than 300mm below subgrade level;
- Removing other vegetable matter from the ground surface (including any subsequent regrowth);
- Removing abandoned services;
- Removing artificial obstructions from the ground surface;
- Saw cutting and removal of existing asphalt pavement surfacing to allow tie in with the new or existing pavements;
- Disposing of cleared materials including all organic material off site.

The Contractor shall be responsible for the selection of a disposal site and any costs of disposal.

P2.9.6.3 Excavation

After the Site has been cleared and grubbed it shall be excavated to the top of subgrade levels or other specified levels, including for services and pits etc., as shown on the Drawings.

Excavation of material shall be taken to include the following operations:

a. Loosening in-situ material;
b. Excavating, loading and hauling loosened material;
c. Unloading hauled material;
d. Disposing of unloaded material at disposal areas;
e. Compacting material at the bottoms of excavations;

Reuse of Existing Material

Where material which is suitable for use as fill has been excavated it may be stockpiled, ready for reuse as fill material as appropriate or may be directly reused in the works. If stockpiled material is in excess of the quantity required to complete the Works or is creating an environmental hazard, that is not immediately rectified, it shall be promptly removed from the site.

Any excavated material proposed for reuse will be reviewed taking into account, but not be limited to assessment of the material against the following parameter:

a. A minimum soaked CBR of 30% and shall be well graded
b. It shall be classified in accordance with ASTM D 2487 with the following grading requirements:
    i. Coefficient of Uniformity, Cu > 4
    ii. Coefficient of Curvature, 1 < Cc < 3
c. All fill material shall be free from clay, grass, roots and other organic matter.
d. The maximum particle size in the fill shall be 100 mm.
e. No greater than 5% fines passing a No. 200 (75 µm sieve)
f. Contamination test results

In the event that this excavated material fails to meet the criteria above, the Contractor, may within 14 days blend the excavated material to achieve the specified parameters.

If the material excavated from these areas does not meet the requirements specified for fill, including after one attempt at blending, it shall be disposed of offsite within 14 days.

General Excavations

- Sides of excavations shall be adequately sloped or supported meeting all Authority requirements to ensure the safety of those working within the excavations.
- Excavations shall be kept free from standing water. The Contractor shall provide such pumping capacity and other measures as may be necessary for this purpose. Disposal of water shall meet all Authority requirements and shall be treated for turbidity or contamination by the Contractor, if needed, to meet all regulatory and environmental obligations.

- No excavated material suitable for reuse in the Works shall be taken from the Site except on the direction or with the permission of the Engineer.
- No surplus material shall be disposed of on Site without approval of the Engineer.
- Unsuitable ground, voids or damaged surfaces below the subgrade level shall be excavated and then filled to formation level with granular fill material or Lean concrete in accordance with CSA A23.1/A23.2.
- The Contractor shall notify the Engineer without delay of any permeable strata, fissures or unusual ground encountered during excavation.
- Work shall be carried out by the Contractor in such a way as to avoid disturbance to the surrounding ground. Particular care shall be taken to maintain stability when excavating in close proximity to existing structures and services.
- The work shall be carried out in a careful manner to ensure that the exposed surfaces and subgrades are protected and shall be responsible for removing disturbed soils which are unsuitable for the founding of the Works.
- In excavations that are to remain open, exposed faces shall be accurately trimmed to the slopes and profiles required for stability. Open excavations shall be maintained in stable condition and shall be protected against any deterioration due to the effects of inclement weather. The Contractor shall maintain open excavations in an acceptable condition and shall rectify the effects of deterioration due to weather.
- The Contractor shall obtain approval prior to placing material, fill or concrete.

Trench Excavation

Trench excavations shall comply with the following:

Trenches shall be excavated to the lines and levels required, allowance having been made for working space, stability of sides and for bedding and surrounds where these are specified.

- Trenches shall be sufficiently wide to allow proper and efficient jointing to be carried out in clean, dry, and safe conditions.
- Excavation of pipe trenches shall not be undertaken more than two days in advance of the associated pipe laying activities.
- The widths of trenches crossing roads, or at other locations as directed, shall be as narrow as practically possible.

- Pipe trenches shall as far as practicable be kept free of surface or groundwater.
- Trenches shall not be excavated more than 50 m in advance of pipe/duct laying. The bottoms of all trenches shall be trimmed to grade and level with the subgrade reviewed and accepted by the Engineer before any bedding is placed or pipes laid.

The Contractor shall install approved warning tapes during backfilling work over buried pipes, cables, and ducts. Warning tape shall be colour-coded according to the service and suitably inscribed for identification and shall be submitted to the Engineer for approval.

Excavations for Structures

The bottom of all excavations above the water table for the foundations of structures shall be carefully levelled and compacted and, if necessary, stepped or benched horizontally. Any pockets of soft or unsuitable material or loose rock in the bottom of excavations shall be removed and refilled with concrete or other suitable material, as accepted by the Engineer.

When undertaking excavations below the water table, the Contractor shall take all necessary measures to manage and ensure the discharge of ground water meets all relevant Authority requirements.

If, due to excessive exposure after excavation, or for any other reason, the surfaces of excavations deteriorate, the unsuitable material shall be removed or re-compacted as directed by the Engineer at the Contractor's expense.

No excavation shall be filled or covered with concrete until the subgrade has been inspected and approval given by the Engineer to proceed. Immediately after approval, foundations shall be blinded with concrete or clear crush gravels wrapped in geotextile as submitted by the Contractor and approved by the Engineer.

When instructed by the Engineer, the Contractor shall produce the calculations for the structural stability of any temporary works, but approval shall not relieve the Contractor of their responsibility for adequately supporting any excavation.

P2.9.6.4 Filling

Filling refers to the placement of fill in any area of the Works, including areas excavated for foundations, structures, services, etc., and areas requiring fill to raise levels to final design grades or pavement subgrades in accordance with the Contractors Documents.

Material For Filling

Fill shall comprise, where possible, suitable excavated materials and shall be free from any organic matter or man-made material.

Prior to commencement of filling, the Contractor shall submit to the Engineer for approval their proposals for carrying out the work. The proposals shall include the compaction equipment and methods for adjusting the quality and the moisture content of the material that is intended to be used.

The Contractor's proposals for the sourcing of fill materials shall be submitted at a sufficiently early stage to allow all necessary testing to be completed and approvals given such that construction is not delayed.

No filling shall be carried out until all materials proposed for incorporation to the Works are submitted and approved.

All fill shall have no greater than 5% fines passing a No. 200 (75 µm sieve) unless otherwise approved in writing by the Engineer

Embankment/subgrade fill, sub-base gravels, base gravels shall be defined based on geotechnical design by DB Contractor

Placing of Fill Material

Granular material shall be placed and compacted in layers not exceeding 300 mm thick to achieve a density of 95% of the Standard Proctor Maximum Dry Density (SPMDD). Special methods of compaction shall be used over areas which are inaccessible to rollers or other heavy plant. The Contractor shall avoid damage to pipes, cables, structures and the like, when compacting fill around and over them.

The filling shall, where practicable, be built up and compacted evenly, and shall be maintained at all times with a sufficient camber and cross fall and a surface sufficiently even to enable surface water to drain readily from it.

P2.9.6.5 Geotextile

Contractor shall provide design calculations for any proposed geotextile considering at a minimum but not limited to required tensile strength, elongation, permeability, puncture strength and filter properties.

Geotextile fabric shall be laid on prepared surfaces in accordance with the manufacturer's recommendations.

P2.9.6.6 Ground Improvements

Geotechnical Studies

The Contractor shall prepare as a minimum the following for geotechnical reporting:

A soil interpretative report providing the Contractor’s interpretation of soil conditions in terms of characteristic parameters for the design. This soil interpretation report shall contain an evaluation of the data obtained by the soil investigation programs for the development and shall be submitted to the Employer for his review. The soil interpretation report shall form part of the Contractor’s Documents.

A Geotechnical design report covering all design aspects of interest. The design report shall cover, but not be limited to the following:

a. A table of content sheet.
b. Detailed written methodology setting out the design philosophy, construction program and design assumptions.
c. A summary of the geotechnical parameters adopted for the design together with supporting interpreted factual data and geological sections.
d. Any assumptions made in developing the geotechnical design parameters shall be reported and justified. Copies of references used to justify the design parameters and assumptions shall be supplied with the calculations.
e. The design calculations (logically structured and appropriately annotated) including analysis and results for stability analysis and settlement calculations.
f. An assessment of interaction between the different project components (like piled structures, structures with shallow foundations of the adjacent structures, pavement, etc.)
g. The properties of the fill material and any ground improvement required by the design and how the attainment of these properties will be assessed in the field for material both above and below the water level. Target values for instrumented Becker Penetration Testing (BPT) of reclamation fills at 1 m depth intervals.
h. A detailed construction plan (showing the proposed construction programme and works are feasible with the equipment proposed).
i. Monitoring and testing programs that will be implemented to confirm geotechnical design assumptions.
j. Stability of the Site under static and seismic loading.
k. Estimate of Post-Taking-Over total and differential settlements including methodology for estimations.
l. Post-seismic settlements and horizontal movements.
m. Copies of the relevant Standards and Codes of Practice used in the design shall be referenced as appropriate.
n. What mitigation action the Contractor will undertake should the monitoring indicate that the fill material or ground improvement will not be achieved in accordance with either the Contractor's design requirements or the performance criteria given in the Employer's Requirements.
o. Potential impacts to existing infrastructure and related monitoring and mitigation measures.

Ground Improvement Trials

The Contractor shall undertake such trials as are necessary to show that the proposed equipment, methods, and other details are suitable to meet the acceptance criteria that the Contractor's Designer considers necessary to meet Employer's Requirements and design Criteria.

Ground improvement trials shall be undertaken at locations to be agreed with the Engineer. Trials shall be undertaken prior to general implementation of ground improvement.

As a minimum a ground improvement trial will be required for each proposed ground improvement methodology and where there are variations in for example subsoil and fill material.

The ground improvement plant and methodology shall be adjusted where necessary by the Contractor to achieve the acceptance criteria.

Suitable testing in ground improvement trial areas shall be carried out before and after ground improvement to confirm that the contractor has achieved the design criteria. Testing post ground improvement will depend on the ground improvement methodology and shall be proposed by the Contractor to the approval of the Engineer, unless already identified as a requirement within these Employer's Requirements.

The Contractor shall prepare a program showing the dates and durations of his proposed activities for ground improvement trials and shall give the Engineer at least 48 hours' notice of their intention to commence. No permanent ground improvement works shall be commenced until the trials have been completed to the entire satisfaction of the Engineer.

The area(s) set aside for the ground improvement trials shall be located within zone(s) within which the Contractor plans to undertake the respective ground improvement technique(s) such that upon successful ground improvement trial completion, the trial area(s) may be incorporated as part of the Permanent Works. Due consideration shall be given by the Contractor in selecting the area(s) of the Site set aside for the ground improvement trials to underlying ground conditions across the Site. The selection of the area(s) set aside for the ground improvement trials shall be approved by the Engineer. The ground improvement trials shall be constructed in the same manner as that proposed for the
Permanent Works, using identical materials, procedures and equipment. The areas allocated for the ground improvement trials shall reflect the nature of the Permanent Works in scale and geometry.

The size in plan of the ground improvement trial area(s) shall be determined by the Contractor and shall be such that the construction is representative of the proposed Permanent Works installation such as to permit the evaluation of the effects of ground improvement on the reclamation fill, subsoil and on structures where applicable.

Area(s) allocated for the ground improvement trials shall be subject to such pre- and post-treatment materials testing and monitoring as necessary to demonstrate that the ground improvement method is capable of consistently and permanently improving the engineering characteristics of the reclamation fill so as to satisfy the Engineer.

Ground Improvement Methods

DB Contractor to determine level of ground improvement required based on geotechnical analysis to meet the design criteria listed in section 5.4 and other related sections. To be approved by the Engineer.

P2.9.6.7 Lay-Out and Tolerances

If by any reason whatsoever excavations are carried out beyond the required line and level, the Contractor shall make good to the required line and level with the appropriate grade of filling to be contained in the true excavation, or with concrete or other approved material.

Earthworks shall be constructed so as not to depart from the widths, lengths, heights, and shapes specified in the Contractors Documents by more than the tolerances stated below.

The widths, lengths, and heights for the surfaces of a layer other than the final layer shall be calculated from the design given in the Contractors Documents and the depth of the particular intermediate layer in the structure.

The horizontal locations of any point on a layer surface shall not differ from the corresponding point given in the documents, by more than ±50 mm except for the following situations:

a. For edges not adjacent to any other structure, the tolerance shall be -50 mm +250 mm (where the + tolerance is in the direction which increases the width of the earthworks);

b. Where alignment of the pavement with an existing road structure is necessary, the new work shall be joined to the existing work in a smooth manner as shown on the Drawings or, if this is not shown, in an approved manner.

The heights of earthworks measured anywhere on a layer surface shall not vary from those given in the documents by more than the following:

a. Tops of embankments ±75mm.
b. Subgrade +0 mm/ -75 mm.
c. Tops of benches and berms ±75 mm.
d. Invert of drainage ditch ±50 mm.

The gap beneath a 3 m long straight edge placed anywhere on the surface of a subgrade shall not exceed 50 mm after due allowance has been made for design shape, where relevant.

P2.9.6.8 Temporary Drainage & Dewatering

The Contractor shall construct temporary drainage using both pipes and open channels as required to maintain proper drainage throughout all stages of the Works.

The Contractor shall also be responsible for the maintenance of the drainage system to ensure the system can be operated effectively throughout the Works.

The Contractor shall ensure that the temporary drainage system will operate effectively with the stormwater draining away from all operational areas of the terminal and from all areas which have been

taken over. The Contractor shall take special mitigation measures to prevent uncontrolled runoff entering the local marine habitat.

During the construction of the Works the Contractor shall ensure the levels of the groundwater are lowered sufficiently below the proposed formation to provide a firm foundation.

If passive drainage measures (eg. sump pumps and gravel) are not able to support the Works below the water table in a workmanlike fashion the Contractor shall implement an active dewatering (eg. well point dewatering) system to control the ingress of water and/or protect the subgrade. Active dewatering of the excavation or site may not be undertaken without the details and the methods to be employed, submitted by the Contractor and approved by the Engineer.

The water pumped from the excavations or well points shall be pumped to disposal points or sumps as approved by the Engineer and shall be treated through sedimentation and/or treatment tanks before disposal as required to meet all relevant Authority requirements.

All necessary precautions shall be taken to prevent any adjacent ground from being adversely affected by loss of fines through any dewatering process. Any effects of settlement as a result of dewatering shall be repaired by the Contractor.

No new or existing pipes in any existing or new permanent work shall be used for the purpose of carrying water away from the excavation without approval, in writing, from the Engineer.

The Contractor shall provide the Engineer with details of silt traps or other measures to be undertaken to minimize the discharge of solids arising from dewatering operations.

P2.9.6.9 Proof Rolling

Proof rolling with a 16-tonne smooth vibrating roller shall be performed in the following situations:

a. On completion of the placement of fill material
b. On completion of other general excavation areas prior to placement of fill material.
c. On completion of excavation to building, structure or subgrade levels.
d. At pavement subgrade level.

Special attention shall be paid to the compaction of subgrade below and adjacent to permanent structures including but not limited to the pits, curbs, and channels, drains and footings. This may require the use of an alternative compactor or roller.

A final “dead roll” (no vibration) of the entire area at pavement subgrade level shall be carried out by the Contractor in the presence of the Engineer to identify any “soft spots”.

P2.9.6.10 Excavation of Unsuitable Material

Any areas which fail during the final “dead roll” shall be excavated as directed by the Engineer.

The excavation shall be backfilled to the original level with approved subgrade material.

All fill shall be placed uniformly in layers. The thickness of the compacted layer shall not exceed
300mm.

P2.9.6.11 Backfill to Structures and Services

The Contractor shall not backfill around structures until the structural elements have attained adequate strength and been approved for backfilling by the Contractor’s Designer.

Large compaction equipment and other heavily loaded construction equipment should not be permitted within a minimum 1m horizontal distance from the face of structures that are subjected to damage if exposed to concentrated static or dynamic stresses. Within this zone, limited lift thicknesses and smaller compaction equipment shall be used to achieve compaction.

Where backfill is to be placed on more than one side of a structure, the placing of the fill shall be sequenced so that the stability of the structure is not threatened.

The Contractor shall record and issue to the Engineer the level and position of the corners of the structure before and after the filling operation.

Backfilling above subgrade using sub-base and base gravel materials shall be performed in layers of maximum compacted thickness of 150 mm, to the standard of compaction described for the location in the appropriate section of the Specification.

Approved backfill material, in accordance with the Drawings, shall be utilized above and around the services.

Filling to service/utility trenches requires particular attention by way of measures to limit the adverse effects of settlement and differential settlement. As a minimum, well graded 19mm gravel shall be placed around services and ducts.

Particular care shall be taken to avoid damage, when compacting fill around, over, or in the vicinity of, new and existing pipework, ducts, cables, structures and the like.

The use of cement-stabilized materials or high-slump low-strength concrete shall be considered for filling to areas in which normal compaction methods are difficult to execute, e.g., adjacent to foundations or structures, provided that adverse effects of differential settlement and reflective cracking in pavements can be avoided.

P2.9.7 Quality Control

Prior to the importation or placement of any material, the Contractor shall submit samples of the materials proposed to be used to the Engineer along with the material source supplier and all relevant quality or test data information for approval. The Contractor's submission of import materials shall be submitted at a sufficiently early stage to allow all necessary testing to be completed and approvals given such that construction is not delayed.

The Contractor shall submit to the Engineer details of the proposed quality control measures to be put in place to ensure the quality and consistency of the fill material being supplied for the Works.

The Contractor shall test each fill material supply source. Only after the supply source test results have been provided to the Engineer and the supply source approved by the Engineer, the Contractor shall incorporate fill in the Works.

Contractor is to provide a method statement addressing, as a minimum, the following:

- Methods of excavation, filling, placing in layers and compaction Methods of containment of fill material below the water table to prevent excessive loss of fines to the waterways
- Program of sampling and testing to confirm fill material suitability
- Frequency and methods of in situ testing and any correlations to be used to confirm achievement of relative densities and allowable bearing pressure and settlement criteria
- Methods of controlling pollution of waterways

Unless stated otherwise, testing of earthwork materials and workmanship shall be carried out in accordance with the following:

Table 6: Earthwork Materials Tests and Standards

Test	Standard
Liquid Limit	ASTM D4318
Plastic Limit & Plasticity Index	ASTM D4318
Particle Size Distribution	ASTM C136, ASTM D7928
Sulphate testing	ASTM C1580
Chloride testing	AASHTO T291
Laboratory Compaction	ASTM D1557, ASTM D698
Laboratory California Bearing Ratio CBR	ASTM D1883
Shear box	aAASHTO T236
in situ density	ASTM D1556, ASTM D6938

P2.9.8 Monitoring

P2.9.8.1 Vibration

The Contractor shall protect any adjacent infrastructure from damage.

The Contractor is notified that power lines, substations, transformers, and other infrastructure is present in the vicinity of the Site. These facilities are to be protected from damage during any construction activities.

The Contractor is notified that there may be infrastructure in the vicinity of the Site which may be very sensitive to ground vibration, including all buildings and infrastructure, new and existing wharf and marine structures. The Contractor is responsible to ensure that construction does not damage such infrastructure.

The Contractor shall carry out vibration monitoring during any piling, rapid impact compaction or other high vibration Works, unless otherwise instructed by the Engineer. The Contractor shall record ground vibrations and at a minimum of three locations for each monitoring program, as nominated by the Engineer. Monitoring shall be carried out in accordance with methods proposed by the Contractor and approved by the Engineer.

P2.9.8.2 Condition Surveys

The Contractor shall provide photo and video surveys of all infrastructure that may potentially be impacted by the Works prior to commencement and prior to any specific works if requested by the Engineer.

The Engineer shall be notified a minimum of 24 hours prior to any photo or video surveys and be provided the opportunity to attend.

The surveys shall be submitted to the Engineer in an acceptable electronic format as a record of the condition of the site at that time. Results of all condition surveys shall be submitted within three (3) days of the survey being completed.

P2.9.8.3 Monitoring of Surfaces and Structures

The Contractor shall install and maintain survey monitoring points to detect any movement or settlement resulting from the Works.

The exact location of these survey monitoring points shall be agreed with the Engineer on Site but are expected to include at a minimum:

- Points located on the existing marine trestle extending Northeast from berth 9 which shall be monitored before and through completion of marine piling works.
- Asphalt and rail points along the centerline of the trenchless portion of the Canola conveyance corridor.
- The intermodal rail tracks 4 and 5 which shall be monitored during canola storage tank works.

- Asphalt, concrete, and manhole or valve lid points along the Fraser Surrey Port Lands Transportation Improvement Project (FSPL-TI) works which are completed or underway during canola storage tank works.

The reference stations shall be surveyed on a weekly basis using a total station or other approved method. Deviations of up to +/- 5 mm shall be considered to be within the tolerance of the survey. The Engineer shall be advised immediately of any deviations greater than this limit.

The Contractor shall submit a report to the Engineer each month which shall include, but not be limited to, the following:

a. A plan showing instrumentation/ monitoring point locations;

b. Provision of all raw data;

c. Plots for each instrument/monitoring point showing actual behavior of the existing structures. These shall take due account of the rate of progress of adjacent works on Site.

P2.9.8.4 Reinstatement And Handover

The Contractor shall hand over any area back to the Employer in the same (or better) condition than when it was received. This shall be verified by using the initial condition survey as a baseline for comparison with the final condition survey prior to the issue of the Taking-Over Certificate.

Any damage to an existing structure or area caused by the Contractor's operations shall be made good at the Contractor's cost and time and to the Engineer's satisfaction.

P2.10 Drainage

P2.10.1 Work Scope

The Contractor's scope of work for the new surface water drainage system shall include the following:

a. Realignment of the existing culvert through the Canola Oil Storage Area which shall be designed to continue functioning through all performance of the Works. This culvert must be designed to be serviceable while being fully sealed as it transits under the canola tank containment area.

b. A new drainage system along the canola service road, parking area, railcar unloading tracks and the area generally bounded by the intermodal track 5 and the security fence.

c. All contact water collected by the new drainage system shall pass through an oil / water separator prior to discharge to the storm system.

d. All gravity drainage shall be designed to accommodate the predicted short term and longterm settlement without repair or replacement.

e. All containment water shall be collected into a sump pump system suitable to facilitate collection and pumping of all containment water to the oil water separator. The sump pumps shall be sized for a 1 in 10 year rainfall event of duration 1 hour plus a suitable design margin.

f. All containment areas shall have watertight concrete walls extending to a minimum elevation of 4.2m geodetic such that they will not be susceptible to overtopping by water during a design flood.

g. The MCC building's roof water shall be connected to the water drainage system through a buried pipe connection.

h. The Oil Water Separator (OWS) be sized for the total flow of all sump pumps and shall have a treated water discharge quality with less than 15 ppm of oil in the treated water.

i. Oil Grit Water Separator to be sized by DB Contractor.

j. Testing and commissioning of all pipework

k. All temporary drainage works required to maintain existing Terminal Site drainage, protect the environmental and meet all Authority requirements.

l. Sumps will be designed for safe access and maintainability.

m. All areas shall fully drain, puddling will not be accepted.

P2.10.2 Function

P2.10.2.1 Contact Water

The water drainage system shall ensure that the terminal pavement is positively drained. Falls shall be designed to shed surface water from paved and surfaced areas via a system of curbs, swales, catch basins, manholes, pipes and water treatment infrastructure.

The contact water drainage system shall be designed with a sluice gate or valve prior to discharge to the existing drainage system so that the system can be isolated in the event of a large spill. All contact water shall pass through an oil water separator prior to discharge into the environment.

P2.10.2.2 Containment Water

Containment water includes water with a higher risk of canola oil contamination which must be collected separately from the contact water and pumped for treatment within an oil water separator. The Containment water includes all water collected from the rail car unloading facility spill pans, the canola oil storage tank facility, the railcar unloading and marine loading pumps, and any other process drains or outfalls.

P2.10.3 Materials and Structural Form

The drainage Works shall be designed, and constructed in accordance with the Master Municipal Construction Document (MMCD) Design Guideline Manual.

All chamber covers shall be provided with suitable lifting points to allow for access and maintenance.

Unless otherwise described in the Contract, the use, installation, application or fixing of materials and components shall be in accordance with all applicable recommendations of the manufacturers. Where appropriate, the Contractor shall make use of any technical advisory services offered by the manufacturers.

All goods and materials used in the Works shall comply with Canadian or internationally recognized standards unless otherwise agreed with the Engineer.

All goods and materials to be provided by the Contractor and incorporated in the Works shall be new, unused, and of the most recent or current design and specification, and incorporate all recent improvements in design and materials, unless otherwise noted.

At least 28 days prior to use, the Contractor shall submit to the Engineer a list of their proposed suppliers and sources of materials required for the execution of the Works. Samples shall also be submitted at the request of the Engineer.

The materials subsequently supplied shall conform to the quality of samples which have been inspected by the Engineer.

Names of additional suppliers and sources may be submitted by the Contractor during the execution of the Contract, but no source of supply shall be changed without the Engineer's approval.

When delivered to Site, pipes and specials shall be carefully unloaded without breakages to allow inspection of their condition.

P2.10.4 Requirements and Design Criteria

The storm water site drainage system design and construction shall be in accordance with the Design Criteria contained in this document and the following codes and standards, listed in descending order of precedence:

a. Design Criteria contained in this document
b. Master Municipal Construction Document (MMCD) Design Guideline Manual and the City of Surrey Supplementary to the Master Municipal Construction Document.
c. BC Supplement to TAC
d. Metro Vancouver Stormwater Design Guidelines

It will be the responsibility of the of the Contractor to determine the final storm water drainage system layout, pipe routes and sizes, grading and outfall locations to satisfy the Design Criteria.

The Contractor shall be responsible for confirming the actual location of all existing utilities located in the project site. The Contractor shall not rely on location plans, record drawings, as-built drawings, or other similar documents for confirming utility locations.

Manholes, electrical vaults, pull boxes, catch basins, and trench drains shall be located in areas to avoid equipment operating areas.

P2.10.5 Design Method

The surface water drainage system shall be designed using industry recognized computer modelling software (e.g., PCSWMM, Info SWMM).

The Contractor shall submit for review by the Engineer full design and technical details of the proposed layout, including pipe route, size, material, connections, site grading and associated details. The Contractor shall obtain all necessary licenses, consents and authorizations for the discharges from the drainage systems during the construction and operational phase.

Alternatives to the surface runoff and drainage system such as infiltration systems shall be supported with a full design submission.

P2.10.6 Workmanship

Workmanship shall be in accordance with the Master Municipal Construction Document (MMCD) Design Guideline Manual. (Section 33 40 01, Section 33 42 13 and Section 33 44 01).

Manholes and chambers shall be substantially watertight, with no identifiable flow of water penetrating the permanent Works.

All new pipework and chamber inverts shall be cleaned prior to handover of the works.

The Contractor shall phase the civil utilities works as to not disrupt existing terminal operations. Any works within the terminal to be carefully coordinated with the Employer.

The Contractor shall install temporary erosion and sediment control measures to prevent any impact from the construction works on the existing site drainage system.

P2.10.7 Testing and Trials

Testing of the surface water drainage system shall be in accordance with the Master Municipal Construction Document (MMCD) Design Guideline Manual (Section 33 40 01, 3.12).

The Contractor shall provide test results for the following:

- CCTV survey of all storm pipes and culverts

The Contractor shall notify the Engineer at least two (2) working days before the Contractor intends to test a section of pipe. The Employer or Engineer shall be present to witness all testing.

P2.11 Potable and Fire Water

P2.11.1 Work Scope

The existing fire protection water supply system shall be extended to serve the new facility, including new pipework, hydrants, and isolation valves.

The Contractor scope of work for the new water supply system shall include the following:

a. Water supply to provide fire hydrant coverage for the Canola service, road and railcar unloading areas and service building.

b. Fire hydrants provided at a normal 90 meter spacing, consistent with the National Fire Protection Association (NFPA 307 - 2021) guidance.

c. All connections and tie-ins to the existing system, including associated pits and valves.
d. Repair of existing paving for connections and tie-ins to the existing system
e. Testing and commissioning of all pipework.

No additional fire protection is proposed within the Yard 10 area of the Terminal Site.

P2.11.2 Function

The fire protection water supply system shall be extended ensure the required fire flows and pressures are provided to serve the new expanded terminal.

The fire protection water supply system shall take account of the phasing of the Works. The Contractor shall ensure that the existing fire protection water system for the terminal remains operational, with only short-duration shutdowns permitted for tie-ins to the existing network.

The Contractor shall phase the civil utilities works as to not disrupt existing terminal operations.

The Contractor shall install temporary erosion and sediment control measures to prevent any impact from the construction works on the existing site drainage system.

P2.11.3 Materials and Structural Form

The fire protection water supply system, which includes installing all piping, meters, valves, hydrants, backflow preventers and other appurtenances, as required for a fully functioning fire protection water supply system, shall be designed, and constructed in accordance with the Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual.

The proposed pipe material shall be determined by the Contractor.

The Contractor shall provide suitable soil testing to verify that the made ground does not contain any contaminants that are detrimental to the integrity of the pipe material proposed by the Contractor. If required, the Contractor shall provide suitable protection for the pipe.

The Contractor shall provide a pipe restraint system at all horizontal and vertical bends, tees, angle branches, crosses, dead ends, reducers, 5½° and 11¼° angle couplings, or other places where there is unbalanced hydraulic load.

P2.11.4 Definition Dimensions and Layout

It shall be the responsibility of the of the Contractor to determine the final pipe route, pipe size, and hydrant locations to satisfy the Design Criteria.

The Contractor shall be responsible for confirming the actual location of all existing utilities located in the project site. The Contractor shall not rely on location plans, as-built drawings, or other similar documents for confirming utility locations.

P2.11.5 Requirements and Design Criteria

The fire protection water supply system design and construction shall be in accordance with the Design Criteria contained in this document and the following codes and standards, listed below:

a. Design Criteria contained in this document.
b. Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual.
c. NFPA 307 -2021 Standard for Construction and Fire protection of Marine Terminals, Piers and Wharves.
d. 2020 National Fire Code
e. Insurance underwriter requirements
f. Appendix 3 - Fire and Loss Prevention Best Practice Recommendations.

Should the Contractor understand there to be a conflict between the standards/codes listed above such that it is unclear as to the design process to follow, the Contractor shall immediately inform the Engineer and request clarification.

The Contractor is required to meet the following Design Criteria for the fire protection water supply system:

a. Required minimum fire flow at each hydrant of 95 L/s (1,500 gpm).

b. Required minimum pressure head at this flow of 15 m (20 psi). Hydrants shall be nominally located according to the following criteria: Hydrants shall be located, not greater than 90m apart or 90 meters from buildings, and not located within a roadway

c. Water supply requirements is for a 2-hour time period.
d. As per existing terminal design, hydrants shall be protected by a bollard system.
e. Pipe shall be installed as ring main, allowing the flow to all hydrants to be provided from two directions.
f. Isolation valves shall be provided at all cross connections.
g. Pipe shall be seismically resilient.
h. Hydrant colour and paint specifications to match existing terminal design.
i. Fire suppression connections from domestic water networks shall have backwater valves installed, if required.

All fire protection water supply pipes shall be designed to mitigate leakage or loss of service resulting from permanent ground deformations in a seismic event. Most earthquake damage to buried pipelines occurs from pipeline deformation caused when pipelines are forced to move with surrounding soils.

The Contractor shall meet the following seismic loading Design Criteria:

a. Pipe remains watertight and fully operational following a 475-year return period earthquake.
b. Pipe suffers repairable damage, with no uncontrolled release of water, following a 2500-year return period earthquake.

The Contractor shall calculate the expected differential horizontal and vertical movement and provide a seismic design that will accommodate the movement. All pipes, fittings and appurtenance joints will be restrained so that they will not pull out when subjected to extension forces.

The proposed pipe size shall be determined by the Contractor. The Contractor shall be responsible for producing hydraulic calculations to demonstrate that their proposed fire protection water supply system satisfies the Design Criteria, based upon the residual pressure available in the existing system.

P2.11.6 Design Method

The fire protection water supply system shall be designed using industry recognized computer modelling software (e.g., OpenFlows, WaterCAD, InfoWater, InfoWorks).

The Contractor shall submit for review by the Engineer full technical details of the proposed layout, including pipe route, size, material, connections, and all associated details.

The Contractor shall obtain all necessary licenses, permits and authorizations for the discharges from the water supply systems during the construction and operational phase.

P2.11.7 Workmanship

Workmanship shall be in accordance with the Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual and the City of Surrey Supplementary to the Master Municipal Construction Document.

P2.11.8 Testing and Trials

The test pressures for the fire protection water supply system shall be as follows:

a. All fire water lines: 1380 kPa (200 psi).

Testing of the fire protection water supply system shall be in accordance with the Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual (Section 33 11 01, 3.19). The Contractor shall provide test results for the following:

a. Pressure testing of all pipework and fittings installed The

Engineer shall be present to witness all testing.

Following confirmation from the Engineer, that the pipework and fittings passed the required pressure tests, the pipe should be disinfected and flushed. Disinfection and flushing procedures shall be in accordance with the Master Municipal Construction Document (MMCD) Design Guideline Manual (Section 33 11 01, 3.21).

P2.12 Sanitary

P2.12.1 Work Scope

The Contractor's scope of work for the new sanitary system shall include the following:

a. The sanitary sewer is no longer part of the scope of works. .

P2.12.2 Function

Sanitary sewer shall be designed to meet occupancy requirements of the proposed building.

P2.12.3 Materials and Structural Form

The sanitary sewer system shall be designed and constructed in accordance with the Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual and City of Surrey Design Criteria Manual, and City of Surrey Supplementary Master Municipal Construction Documents.

Number of manholes and location shall be as per MMCD design guidelines. Manholes shall be in accordance with the MMCD design guidelines and should be able to sustain the design vehicle loads. Minimum grade of sewers shall be as required to obtain the minimum velocity of 0.60m/s.

Sewers shall be sufficiently deep to prevent freezing, clear other underground utilities, and to prevent damage from surface loading.

Unless otherwise described in the Contract, the use, installation, application or fixing of materials and components shall be in accordance with all applicable recommendations of the manufacturers. Where appropriate, the Contractor shall make use of any technical advisory services offered by the manufacturers.

All goods and materials used in the Works shall comply with Canadian or internationally recognized standards unless otherwise agreed with the Engineer.

All goods and materials to be provided by the Contractor and incorporated in the Works shall be new, unused, and of the most recent or current design and specification, and incorporate all recent improvements in design and materials, unless otherwise noted.

At least 28 days prior to use, the Contractor shall submit to the Engineer a list of their proposed suppliers and sources of materials required for the execution of the Works. Samples shall also be submitted at the request of the Engineer.

The materials subsequently supplied shall conform to the quality of samples which have been inspected by the Engineer.

Names of additional suppliers and sources may be submitted by the Contractor during the execution of the Contract, but no source of supply shall be changed without the Engineer's approval.

When delivered to Site, pipes and specials shall be carefully unloaded without breakages to allow inspection of their condition.

P2.12.4 Requirements and Design Criteria

The sanitary sewer system design and construction shall be in accordance with the Design Criteria contained in this document and the following codes and standards, listed in descending order of precedence:

a. Design Criteria contained in this document
b. Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual
c. City of Surrey Design Criteria Manual
d. City of Surrey Supplementary to the Master Municipal Construction Document.

It will be the responsibility of the of the Contractor to determine the final sanitary sewer system layout, pipe routes and sizes, grading and outfall locations to satisfy the Design Criteria.

The Contractor shall be responsible for confirming the actual location of all existing utilities located in the project site. The Contractor shall not rely on location plans, record drawings, as-built drawings, or other similar documents for confirming utility locations.

Manholes shall be located in areas to avoid equipment operating areas.

P2.12.5 Design Method

The sanitary sewer system shall be designed per method described in MMCD Design Guidelines and City of Surrey Design Criterial Manual.

The Contractor shall submit for review by the Engineer full design and technical details of the proposed layout, including pipe route, size, material, connections, site grading and associated details. The Contractor shall obtain all necessary licenses, permits and authorizations for the discharges from the drainage systems during the construction and operational phase.

Alternatives to the surface runoff and drainage system such as infiltration systems shall be supported with a full design submission.

P2.12.6 Workmanship

Workmanship shall be in accordance with the Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual. (Section 33 30 01, and Section 33 44 01).

Manholes and chambers shall be substantially watertight, with no identifiable flow of water penetrating the permanent Works.

All new pipework and chamber inverts shall be cleaned prior to handover of the works.

The Contractor shall phase the civil utilities works as to not disrupt existing terminal operations. Any works within the terminal to be carefully coordinated with the Employer.

The Contractor shall install temporary erosion and sediment control measures to prevent any impact from the construction works on the existing site drainage system.

P2.12.7 Quality Control

Testing of the sanitary sewer system shall be in accordance with the Master Municipal Construction Document (MMCD) 2019 Design Guideline Manual (Section 33 30 01, 3.12, and 3.14).

The Contractor shall provide test results for the following:

- CCTV survey of all sanitary sewers

The Contractor shall notify the Engineer at least two (2) working days before the Contractor intends to test a section of pipe. The Employer or Engineer shall be present to witness all testing.

P2.13 Pavement

P2.13.1 Work Scope

The Contractor shall design the pavements for the relevant uses and loads as defined in the Employer's Requirements.

The scope of the pavement area includes, but is not limited to, the following:

- Smooth interfaces with the existing pavement at the boundaries of the pavement areas.
- Paved service and emergency access road as indicated on the Drawings
- Paved access to all pedestrian stairs, containment areas and Plant such that all regular operational or maintenance related pedestrian movements are on a paved surface.
- Paved parking lot suitable for 10 vehicles
- Paved surfacing between the Canola unloading rail tracks to facilitate safe access and minimize slip and trip hazards
- Replacement or repair of any existing paved areas damaged or removed during the completion of the Works to match or improve the original existing condition.
- For clarity the Contractor shall allow for a minimum 8,642m2 area of new asphalt pavement as generally shown on the Drawings between the Canola rail offloading tracks and site perimeter and as approved by the Engineer. This does not include the required pavement between the canola offloading tracks, repairs to any damaged asphalt North of Track 5 or within Yard 10 related to repairs or trenching associated with the Works. Any area that does not receive asphalt pavement between the canola offloading tracks and site perimeter must be surfaced with a minimum of 150mm of road gravels and sloped to provide adequate drainage without puddling.

P2.13.2 Function

Pavements throughout the terminal are subject to different uses and loadings. The Contractor shall design the port pavements for the relevant uses and loads as defined in this document. All pavements shall be designed to achieve a minimum 20-year design life without significant maintenance or replacement.

The Contractor shall propose the materials and structural form for each individual area of pavement whilst meeting the criteria given in these Employer's Requirements.

The pavements shall be structurally competent to support the applied loads and provide a smoothrunning surface for all vehicles to operate without unacceptable differential settlement between structural surfaces. Ground treatment, if required, shall be designed to satisfy all total and differential settlement requirements specified within these Employer's Requirements.

The paving shall also be designed for vehicle wheel loadings and the number of vehicle and equipment movements provided in the Employer's Requirements. Pavement and all below grade infrastructure within yard 10 must be restored to the existing designated capacity of 28.7KPa (600 pounds per square foot [PSF]) and reach stacker axle loads of 1,023KN.

Access points to underground services shall be located outside of the parking slots to allow easy access, without vehicles needing to be relocated.

P2.13.3 Materials and Structural Form

All pavement base and sub-base materials shall be unbound (not bound with cement), with materials sourced from high quality primary aggregates. The use of recycled material is strictly prohibited.

P2.12.3.1 SUB-BASE AND BASE

Base and sub-base material, including unbound and modified gravel, crushed rock and crushed concrete, shall comply with the recommendations of 'The Structural Design of Heavy-Duty Pavements for Ports and Other Industries', the Geometric Design Guide for Canadian Roads (including the B.C. Supplement) and 'Standard Specifications for Highway Construction' by the BC Ministry of Transportation and Infrastructure.

Base and sub-base material shall consist of approved granular material compacted to 100% of the laboratory maximum dry density; the laboratory CBR value shall be a minimum of 80% at 100% of the laboratory maximum dry density after soaking for 96 hours.

Base and sub-base material shall be crushed rock that is clean and free from organic matter, clay balls and other deleterious material. The material shall comply with the requirements of the ASTM D2940 and the additional requirements of these Employer's Requirements.

The total sulphate content (as SO3) shall not exceed 2% by weight. The total chloride content (as NaCl) shall not exceed 3.3% by weight.

Aggregate shall have a Los Angeles abrasion value no greater than 50 (LA50) and a Magnesium soundness value less than 35 (MS35).

P2.13.3.2 HOT MIX ASPHALT

AGGREGATES FOR ASPHALT MATERIALS

Aggregates shall be clean, hard and durable.

ASPHALT MATERIAL CLEANLINESS

The fraction of material passing a 75-micron sieve, for coarse and fine materials, shall not exceed 8% of the total mass of aggregate when tested in accordance with the washing and sieving method.

HARDNESS

Coarse aggregates shall have the following properties:

A ten per cent fines value not less than 140 kN for natural crushed and uncrushed aggregates when tested in a dry condition;

An aggregate impact value not greater than 30% for natural crushed and uncrushed aggregates when tested in a dry condition.

DURABILITY

The coarse aggregate shall be tested in accordance with ASTM C88 and shall have a weighted loss not greater than 18% when magnesium sulphate is used.

If the water absorption value of the coarse aggregate is greater than 2% the soundness test shall be carried out on the material.

DESIGN, COMPACTION ASSESSMENT AND COMPLIANCE OF ASPHALT MATERIALS

Asphalt mix design verifications shall be carried out at least annually and made available to the Engineer for his approval at least 14 days before work starts.

Asphalt concrete up to a maximum aggregate size of 25 mm shall be designed in accordance with the Marshall Method ASTM D1559 (75 blows).

Asphalt concrete with an aggregate size of greater than 25 mm shall be designed in accordance with the Marshall Method ASTM D5581 (112 blows).

The Contractor shall nominate a target aggregate grading and target binder content for his proposed mixture which shall fall within the limits defined and complies with the appropriate Clauses of the Employer's Requirements.

For compliance purposes the binder content and aggregate grading limits shall be those obtained by applying the tolerances stated in the Employer's Requirements to the target binder content and target aggregate grading. The aggregate grading curve shall be smooth and continuous and shall not vary from the low limit on one size sieve to the high limit on the adjacent sieve size or vice versa.

The aggregate shall be combined so that on analysis of the design mixture, the grading of the coarse and fine aggregates when tested on a dry basis, shall fall within the limits of the following Table 7:

Sieve Size	Percentage by Mass Passing
	Hot Mix Asphalt Dense Mixture

	25 mm Nominal Size Aggregate	37.5 mm Nominal Size Aggregate
50 mm (2 inch)	--	100
37.5 mm (1.5 inch)	100	90 - 100
25 mm (1 inch)	90 - 100	--
19 mm (3/4 inch)	--	56 - 80
12.5 mm (0.5 inch)	56 - 80	--
4.75 mm (No. 4)	29 - 59	23 - 53
2.36 mm (No. 8)	19 - 45	15 - 41
0.300 mm (No. 50)	5 - 17	4 - 16
0.075 mm (No. 200) *	2 - 8	2 - 7

Table 7: Grading

* The material passing the No. 200 (0.075 mm) sieve may consist of the fine particles of the aggregates or mineral filler of both but should be free of organic matter and clay particles.

The blend of aggregates and filler, when tested in accordance with test method D4318, shall have a plasticity index not greater than 4, except that this plasticity requirement shall not apply when the filler is hydrated lime of hydraulic cement.

MIXTURE DESIGN

The 'Laboratory Design Mixture' for the asphalt mixtures shall comply with the requirements listed in the following table and precise values for each requirement shall be determined for each mixture in accordance with the procedures stipulated in ASTM D1559 or ASTM D5581 as appropriate. Table 8: Mixture Design

Requirement	Hot Mix Asphalt Dense Mixture	
Material	25 mm Nominal Size Aggregate	37.5 mm Nominal Size Aggregate
Optimum binder content	4.0-6.0%	Between 4.0 and 6.0%
Stability	≥15kN	≥15kN
Flow	2.0-4.0mm	2.0-4.0mm
Voids total mixture	3.0-5.0%	4.0-6.0%

Percentage voids in mineral aggregate.	12% minimum	12% minimum
Voids filled with binder	65-75%	65-75%

The Contractor shall report the mean optimum binder content and individual test values at mean optimum binder content and shall submit promptly to the Engineer a copy of the plotted curves resulting from the tests.

P2.13.4 Requirements and Design Criteria

P2.13.4.1 Codes and Standards

The paving shall be designed in accordance with the recommendations in A Guide to the Design of Flexible and Rigid Pavements in Canada by TAC, and AASHTO Guide for Design of Pavement Structures. All pavement materials shall also be in accordance with the Standard Specification for Highway Construction by the BC Ministry of Transportation and Infrastructure or relevant Canadian Standard.

The design of any asphalt paving work shall take account of ambient temperatures and shall utilize appropriate bitumen and binder content to provide a mix with high strength aggregate interlock.

Asphalt concrete up to a maximum aggregate size of 25mm shall be designed in accordance with the Marshall Method ASTM D1559 (75 blows). Asphalt concrete with an aggregate size greater than 25mm shall be designed in accordance with the Marshall Method ASTM D5581 (112 blows).

P2.13.4.2 Formation and Underlying Ground

The Contractor shall be responsible for ensuring the underlying ground has a minimum CBR of 20%.

P2.13.4.3 Vehicle Loads

Structural pavement design shall take account of dynamic factors resulting from vehicle braking, cornering, and accelerations.

All pavements shall be designed to resist rutting in areas of channelized traffic flows and surface fretting or delamination due to vehicle turning maneuvers.

P2.13.4.4 Pavement Types

All pavement formation designs shall be subject to the approval of the Engineer. Pavement details provided in the Employers Requirements are minimum thicknesses of pavement layers, and the Contractor shall design the pavement structure with pavement thicknesses greater or equal to it, subject to the Engineer's approval. Pavement in yard 10 must as a minimum meet the existing pavement design thickness. Adoption of the same pavement profile does not absolve the Contractor of any design responsibility, with the profile to be fully evaluated and robustly demonstrated to meet the Employer's Requirements.

The Contractor shall note that construction tolerances and ongoing settlements shall be allowed for in the determination of the pavement design thicknesses.

P2.13.4.5 Roads and Parking Areas

The canola oil storage area service and emergency roads and parking areas pavement shall be surfaced in asphalt.

The Contractor shall design the pavement structure with pavement thicknesses greater or equal to the following, subject to the Engineer's approval:

- 50 mm asphalt wearing course, overlying
- 50 mm asphalt lower course; overlying
- 500 mm compacted well graded crushed rock base/ sub-base, overlying
- Subgrade with a minimum CBR of 20%.

P2.13.4.6 Settlement

Without limiting the Contractor's responsibility overall for settlement of any kind/ anywhere, special measures shall be employed by the Contractor to eliminate the adverse effects of differential settlement of the surfacing.

P2.13.4.7 Design Methodology

The designer should (as a minimum) during the design process consider the following categories of failure:

- Environmental failure.
- Structural failure.
- Surface failure.
- Operational failure.

The paving shall be designed in accordance with the recommendations in The TAC Pavement Design and Management Guide. Appropriate dynamic load factors for wheel loads should be applied, in accordance with recommendations in the design guide.

The design shall be checked using an analytical method incorporating the mechanical properties of various pavement layers.

The Contractor shall submit pavement design to Employer for review at least 60 days prior to its use in the Works.

P2.13.4.8 Job Mixture Approval Trials

At least three days before material from each source of asphalt is laid in the works, the Contractor shall carry out a trial to demonstrate compaction, the capability of the compaction plant and the rolling procedures and pattern, which shall be approved by the Engineer. Subject to the agreement of the

Engineer the trial may be carried out off site. The trial area shall not be less than 30 m nor more than 60 m long and of a width and thickness required in the Contract. If the trial is carried out on Site and complies in all respects with this Employer's Requirements, then it may form part of the Works. The materials, mixing and laying plant proposed for the Works shall be used for the trial.

At least three samples of the provisional 'Job Standard Mixture' for the trial shall be taken after discharge from the mixer and before loading into the paver. The samples shall be used for preparation and analysis of aggregate/filler grading and binder content. The samples shall also be used for the manufacture of Marshall specimens to determine unit values for stability, flow, voids total mix, and voids filled with bitumen in accordance with ASTM D1559 (75 blows) or ASTM D5581 (112 blows) as appropriate.

Specimens for the determination of the 'Job Mixture Bulk Density' shall also be prepared from these samples in accordance with ASTM D1559 (75 blows) or ASTM D5581 (112 blows) as appropriate.

During the laying of the trial area, two samples of loose mixture shall be taken at three evenly spaced locations along the trial length, six samples in total. The maximum density of one sample of mixture from each location shall be determined. The average value of maximum density ρMax expressed in Mg/m3 shall then be used for subsequent calculations of the air void content of the compacted mixture. The remaining samples shall be analyzed to determine their composition.

At three locations, two nominal 150 mm diameter cores shall be taken using a suitable coring machine, six cores in total. Where appropriate two of the locations shall be from the wheel track zones of the completed traffic lane, the third location shall be agreed by the Engineer.

The cores from each location shall be tested to determine dried bulk density in accordance with ASTM D2726.

At or adjacent to the location of the cores, the density of the material shall be measured using a nuclear density gauge and the results correlated with the in-situ air dried bulk density.

The in-situ air void content shall be calculated using the initial dried bulk density, ρ. The air void contents shall be calculated to an accuracy of ±0.1% as follows:

Air voids content = $(1 - \rho/\rho\text{Max}) \times 100\%$

Where ρ is the bulk density and ρMax is the maximum density expressed in Mg/m3 determined as detailed above.

The percentage binder volume Bvol shall be calculated from each location in accordance with the following expression: $\text{Bvol} = \text{Bmass} \times (\rho/\rho b)$ where,

Bmass is the target binder content by mass added to the mixer expressed as a percentage of the total mixture. ρ is the average initial dried bulk density of the material at each location determined

from the pair of cores subjected to the bulk density procedure ρb is the density of the binder at 25°C

The trial area shall be acceptable if the mixture complies with the requirements detailed in these requirements. If the trial area fails to comply with the requirements and was intended to form part of the Works, it shall be removed. In the event that the trial area fails to comply, the Contractor may nominate an alternative target aggregate grading and target binder content and the trial shall be repeated until compliance has been demonstrated. The target aggregate grading and target binder content of the complying mixture shall be used in the Works.

P2.13.4.9 Standardization of Nuclear Density Gauges

The operational, warming-up period, if any, and standardization of the nuclear density gauge shall be carried out in compliance with the manufacturer's recommendations. The gauge shall be calibrated in accordance with the manufacturer's recommendations before use. The gauge shall be used in the direct transmission mode of operation.

P2.13.4.10 Compliance Requirements

The mean field bulk density of the core samples shall not be less than 98% of the Job Mixture Bulk Density.

The average in situ air void content of the core samples shall not fall outside the limits: 3.0% to 7.0% for surface course and 3.0% to 8.0% for binder course and base.

The average value of in situ air void content of a pair of core samples from each location shall not fall outside the limits: 3.0% to 8.0% for surface course and 3.0% to 9.0% for binder course and base.

The compositional analysis of aggregate grading and binder content shall demonstrate compliance with the requirements in the Operator's Requirements.

The horizontal alignments, surface levels and surface regularity of the finished surface shall comply with the tolerances of the Operator's Requirements. **P2.13.4.11 Variations In Plant Mixtures**

Mixtures produced by the mixing plant during normal routine production shall be designated the 'Plant Mixtures', and the limits of permissible variations between the 'Plant Mixtures' and the 'Job Standard Mixture' approved in accordance with the Operator's Requirements shall at all times meet the following requirements:

Table 9: Gradings for Hot Mix Asphalt

Requirement Dry aggregate/filler grading	Hot Mix Asphalt Dense Mixture 25 mm Nominal Size Aggregate
Passing 12.5mm or larger	±8%
Passing No. 4 (4.75mm) sieve, or larger	±7%
Passing No. 8 to No. 100 (2.36mm to 0.150mm)	±4%
Passing No. 200 (0.075 mm) sieve	±2%
Binder Content *	±0.3%
Voids total mixture	±1%
Voids filled with binder	±5%
Stability	Not less than specified above
Flow	Not more than 4.00 mm

Note: * not less than 4.0% Tolerances should be tested a minimum of once for every 400 tonnes produced from each plant.

P2.13.4.12 Sampling and Testing

The results of all sampling and testing shall be provided to the Employer within 14 days of completion of each individual test.

The compaction of materials laid in the Works shall be assessed by the determination of:

- In situ density measured using a nuclear density gauge on a running basis and;
- In situ bulk density and air void content of pairs of cores taken every 1000 square meters of laid material or days production if less.

The compaction of asphalt materials shall be continuously assessed using the nuclear density gauge with readings taken at 20 m intervals of laid material. At each location a series of readings shall be taken across the paver width. Additional readings shall be taken 300mm from the edge of a longitudinal joint. The Contractor shall take corrective action as is necessary whilst the material is still above the minimum rolling temperature if low densities are indicated at the time of laying.

Initially the calibrations of the nuclear density gauges established as specified shall be used. When results are available from loose samples and pairs of cores taken every 1000 square meters of laid material, each gauge shall be re-calibrated if the densities measured by that gauge and the densities of the cores show a different bias. Each gauge used shall be individually calibrated, the results of the calibration exercise being submitted to the Engineer in advance of the Works.

For material from each mixing plant, a pair of nominal 150 mm diameter cores shall be taken every 1000 square meters of laid material, one core from each wheel track zone, where appropriate. Cores shall be extracted using a suitable coring machine. Each core shall be subjected to the bulk density test procedure and the air void content shall be determined in accordance with the procedure defined in the Employer's Requirements using the maximum density ρMax expressed in Mg/m3.

Samples of loose material shall be taken from the paver augers, two 7.5 kg increments from either side of the paver from the middle third of the load. The samples shall be taken as near to each location from which cores are to be taken as is practicable and:

- The maximum density of a sample of the mixture shall be measured. The value of maximum density so determined, expressed in Mg/m3, shall be used for the subsequent calculation of the air void contents of the compacted mixture at that location.
- The compositional analysis of a sample shall be carried out to determine the aggregate grading and binder content.

Each core extracted shall be examined for evidence of excessive voids below the depth to which the nuclear density gauge penetrated. If excessive voids are observed, further cores should be taken to determine the extent.

Each layer of material shall be sampled and tested separately. Where separate coring of each layer would unreasonably delay placing a second layer, subject to the approval of the Engineer, both layers may be cored together and the resulting core split prior to testing.

Cores shall be extracted without the use of excessive force. Cores shall not be taken until the material has cooled to a temperature of 40°C or less at mid-depth of the course to be cored. The walls and base of all holes from which core samples have been cut shall be dried and painted with hot binder or cold applied polymer modified intermediate or premium grade emulsion immediately prior to making good. Core holes shall be backfilled with asphalt. The backfill material shall be compacted to refusal with a circular headed vibrating hammer, in layers not exceeding 75 mm. Where cores have been cut through the wearing course, the last layer of backfill material shall comply with the Employer's Requirements for the wearing course.

Two copies of the final nuclear density test results obtained and their correlation with insitu air void contents shall be passed to the Engineer within 24 hours.

P2.13.4.13 Compliance Requirements

For material from each mixing plant:

- The average bulk density calculated from any six consecutive nuclear density readings shall not be less than 98% of the Job Mixture Bulk Density. If the average in situ bulk density is less than specified limits then six cores shall be taken from the same locations and the bulk density and in situ air void contents determined. The average in situ air void content of the cores shall not fall outside the limits: 3.0% to 7.0% for surface course and 3.0% to 8.0% for binder course and base. If the average in situ bulk density and air void content of the cores does not comply with specified limits then defective lengths shall be removed and replaced such that compliance is re-established. Lengths of not less than 15 linear meters shall be removed and replaced unless otherwise agreed by the Engineer.

- The average bulk density of each pair of cores taken every 1,000 square meters shall not be less than 98% of the Job Mixture Density. The average in situ air void content of the cores shall fall within the limits: 3.0% to 8.0% for surface course and 3.0% to 9.0% for binder course and base. If the average bulk density and in situ air void content of a pair of cores exceeds the specified limits then density readings with the nuclear density gauge and if necessary further cores shall be taken to determine the extent of the defective area to be removed. Lengths of not less than 15 linear meters shall be removed and replaced unless otherwise agreed by the Engineer.
- Nuclear Density Meter field density results shall be passed to the Engineer at the end of each working day.
- The compositional analyses of aggregate grading and binder content carried out shall demonstrate compliance with the requirements set out in the Employer's Requirements.
- The horizontal alignments, surface levels and surface regularity of the finished surface shall comply with the tolerances given in the Employer's Requirements.

P2.13.4.14 Crushed Rock Base and Sub-Base

Material gradation shall be in accordance with the Standard Specifications for Highway Construction' by the BC Ministry of Transportation and Infrastructure.

Testing of crushed rock base and sub-base materials and workmanship shall be carried to the prove compliance with the Employer's Requirements. Crushed rock base and sub-base material shall comply with the requirements of the ASTM D2940. Laboratory maximum dry density tests shall be in accordance with ASTM D 1557 and liquid limit shall be determined in accordance with ASTM D 4318 in-situ CBR testing shall be in accordance with ASTM D 4429.

The testing requirements for sub-base are as listed in Table 10 and Table 11.

Table 10: Laboratory Tests to Monitor the Consistency of the Approved Material During Construction

Layer	Property	Frequency of Test (not less than one test per…)
Sub-base	Maximum dry density	5,000 m2
	Optimum dry density	5,000 m2
	Grading	1,500 m2
	CBR	1,500 m2
	Sulphate content	3,000 m2
	Chloride content	3,000 m2

Table 11: In-Situ Tests to Confirm the Required Degree of Compaction is Being Achieved During Construction

Layer	Property	Frequency of test (not less than one test per…)

Sub-base	Dry density	500 m2
	In-situ CBR	1,500 m2

P2.13.4.15 Mixing

The hot aggregate and binder shall be thoroughly and intimately mixed together in the correct proportions until every particle of aggregate is completely coated.

P2.13.4.16 Transporting

Hot materials shall be transported in clean insulated vehicles, unless otherwise agreed by the Engineer and shall be covered while in transit and awaiting tipping. To facilitate discharge of the mixed materials, dust, coated dust, water or the minimum of liquid soap, vegetable oil, or other non- solvent solutions may be used on the interior of the vehicles to the approval of the Engineer. When a fluid coating is used then, prior to loading, the body shall be tipped to its fullest extent with the tailboard open to ensure drainage of any excess. The floor of the vehicle shall be free from adherent asphalt materials or other contaminants. The temperature of the mix shall be recorded at departure and then arrival at the work face.

P2.13.4.17 Laying

On each day, at each location where hot asphalt material is laid, at least 300 tonnes from a plant approved by the Engineer shall be placed before material from another approved plant is used. If the Contractor demonstrates that the materials from different plants are of equivalent quality and possess equivalent laying and compaction characteristics, this requirement can be waived.

Wherever practicable, asphalt materials shall be spread, levelled, and tamped by a self-propelled paving machine, which may be equipped with an averaging beam. As soon as possible after arrival at Site the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of materials to the paver shall be regulated to enable the paver to operate continuously and it shall be so operated whenever practicable.

The travel rate of the paver and its method of operation shall be adjusted to ensure an even and uniform flow of materials across the screed, so that the material is free from dragging, tearing and segregation of the material.

The paver shall be capable of laying the asphalt continuously to produce an even and compact surface to the required widths, thicknesses, profiles, cambers and crossfalls without causing segregation, dragging, burning, surface defects or irregularities and of being operated at such a speed as to permit continuous laying as far as supply and Site conditions allow.

Narrow strips remaining alongside machine work, if laid by hand, shall be rolled at the same time as the machine laid work. Allowance shall be made for extra compaction of hand laid strips.

Material remaining in hoppers, conveying, and spreading mechanisms, tampers and screeds shall be cleaned off at the end of each working day. On no account shall cleaning solvent be allowed to come into contact with any asphalt layer.

Hand placing of asphalt materials shall only be permitted in the following circumstances:

- For laying regulating courses of irregular shape and varying thickness;
- In confined spaces where it is impracticable for a paver to operate;
- For footways; and
- At the approaches to expansion joints at bridges, or other structures.

Hand-raking of asphalt material or the addition of such material by hand-spreading to the paved area, for adjustment of level, shall only be permitted at the edges of the layers of material and at gullies and manholes and at the approaches to other structures.

If on delivery to the Site the asphalt material is to be deposited in heaps, they shall be on a clean hard surface and be protected from adverse weather and loss of heat. Alternatively, it shall be permissible to take material direct from the delivery vehicle. The material shall be spread in a layer of uniform thickness and even texture and compacted immediately. Every precaution should be taken to minimize segregation and to avoid contamination.

The temperature of the mix shall be recorded in the paver and commencement and completion of laying of each particular load. Asphalt materials shall only be laid on well compacted base course or lower asphalt layer. Any damage or segregation by truck turning or similar shall be repaired before overlaying with hot mix. Asphalt materials shall not be laid on standing water or on surface-wet layers. The Contractor shall make adequate provisions for cold / adverse weather working and prepare methodologies accordingly for the approval of the Engineer as part of detailed design package.

P2.13.4.18 Nominal Course Thickness

The nominal thickness of each course of surfacing shall be as required by the design. The minimum thickness shall be after compaction. Where the nominal course thickness exceeds the maximum nominal layer thickness shown in Table 12, the course shall be laid and compacted in two or more layers as agreed with the Engineer.

Table 12: Specified Nominal and Minimum Layer Thickness for Asphalt

Material Description	Nominal size (mm)	Nominal layer thickness (mm)	Minimum thickness at any point (mm)
Hot Mix Asphalt Dense Mixture	25	60-80	50
Hot Mix Asphalt Dense Mixture	40	90-110	80

P2.13.4.19 Compaction

Asphalt materials shall be laid and compacted in layers that enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of asphalt materials shall commence as soon as the uncompacted material will bear the effects of the rollers without undue displacement or surface cracking. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in Table 13. Rolling shall continue until all roller marks have been removed from the surface.

Table 13: Minimum Rolling Temperatures

Binder Grade	Maximum Temp. at any Stage	Minimum Delivery Temperature	Minimum Rolling Temperature
60/70 pen	370°F	270°F	250°F

Except where otherwise specified compaction shall be carried out using 8-10 tonnes dead-weight smooth wheeled rollers having a width of roll not less than 450 mm, or by multi-wheeled pneumatictyred rollers of equivalent mass, or by vibratory rollers or a combination of these rollers. Contractor to establish rolling patterns to achieve required compaction at a temporary demo area before the start of the works and will obtain approval of its methodologies from the Engineer for different whether conditions.

Surface Course, Binder Course and Base material shall be surface finished with a smooth-wheeled roller which may be a dead-weight roller or a vibratory roller in nonvibratory mode.

Vibratory rollers may be used if they are capable of achieving at least the standard of compaction of an 8-tonnes dead-weight roller. They shall be equipped or provided with devices indicating the frequency at which the mechanism is operating and the travel speed, which can be read from the ground.

Asphalt materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least half the width of the rear roll or, in the case of a pneumatic-tired roller, at least the nominal width of one tire.

Rollers shall not be permitted to park or stand on warm compacted materials.

Unless otherwise noted, the design, compaction assessment and compliance requirements for asphalt shall be as given in this Employer's Requirement.

P2.13.4.20 Joints

LONGITUDINAL LANE JOINTS

Surfacing materials shall be laid to break joints with underlying joints by at least 600 mm.

The longitudinal lane joints shall be truly vertical in straight lines, which are continuous for the full length of the pavement, or in smooth curves around bends.

The exposed vertical edges of the longitudinal lane joints in the surfacing materials shall be carefully cut back and trimmed to firm material in the compacted lane, or for a minimum of one-half times the layer

thickness, whichever is the greater. All loose material arising from this operation shall be removed from the pavement before the cut edge is painted.

Edge rolling shall only be used as an alternative to cutting back if it can be demonstrated during the trials to the Engineer that satisfactory standards of compaction surface/joint finish and adhesion can be achieved.

Cutting back and trimming will not be required when two or more spreading units operate in echelon in close proximity permitting adjacent lanes to be continuously compacted before the material around the joint between the lanes falls below the minimum compaction temperature given in Table 13.

After cutting back and trimming, the exposed vertical edges of the longitudinal lane joints shall be thoroughly cleared of all adherent material and shall then be painted with a uniform thickness of hot bitumen just ahead of the spreading unit laying the adjacent lane. Painting shall completely and uniformly cover the exposed edge for its full depth. Excess material to the top and base of the joints, streakiness and blobs, shall be avoided.

On completion the joints shall present the same density and texture as the remainder of the surface and the accuracy of the surface across the joints shall meet the criteria specified.

Longitudinal joints in materials subject to density testing procedures shall not be situated in wheel track zones.

TRANSVERSE JOINTS

Transverse joints are required at the end of the day's work and following any interruption in laying which prevents continuity of rolling at, or above, the specified minimum temperature.

They shall be formed at right angles to the longitudinal joints and be truly vertical.

The exposed vertical edges of the transverse joints of all layers shall be cut back for at least 300 mm and trimmed. Arisings from this operation shall be removed from the pavement and the underlying surface cleaned to the satisfaction of the Engineer.

The exposed joint edges shall then be cleaned and painted with bitumen immediately before the laying of the lane continues.

On completion the joints shall present the same density and texture as the remainder of the surface and the accuracy of the surface across the joints shall meet the criteria specified.

SURFACE LEVEL TOLERANCES

The level of any point on the constructed surface of the pavement course(s) shall be the design level ±6 mm.

ACCURACY OF FINISH

The maximum permissible depth of the gap beneath a 3m straightedge used longitudinally or a template used transversely shall be as given in Table 14.

Table 14: Minimum Gap Beneath a 3m Straight Edge

Course	Minimum Gap
Surface Course	6mm
Binder Course	6mm
Base	10mm

P2.13.4.21 Cold Milling

Where cold milling of asphalt pavement is required, the area of pavement to be milled shall be removed to the specific depth by a suitable milling machine. The process shall be carried out so as not to produce excessive quantities of dust, which shall be minimized by damping with water sprays.

The cut edges shall be left neat, vertical and in straight lines. The Contractor shall brush and sweep the milled surface by mechanical means to produce a clean and regular running surface with a groove depth not greater than 10 mm and with a uniform texture.

Pavement shall be milled to the tolerance for surface levels as specified herein for binder course. If the tolerances specified are exceeded, the full extent of the area that does not comply shall be rectified by further milling or by regulating as agreed with the Engineer.

Existing ironwork (gullies, manhole covers and alike) shall not be disturbed by the milling action. Where necessary, surfacing in the vicinity of ironwork and in small or irregular areas shall be cut out by pneumatic tools or other suitable methods and removed.

Where milling is carried out on a pavement open to traffic, temporary ramping to ensure the safe passage of vehicles shall be provided.

If the milled surface profile varies by more than 10 mm, when measured transversely or longitudinally by a 3-metre straight edge, adjustments or replacements shall be made to the cutting teeth on the milling drum before work continues. Any discontinuity between adjacent milling passes exceeding 10 mm, when measured transversely or longitudinally by a 3-meter straight edge, shall be rectified by further milling or regulating before placing asphalt materials.

Where milling is required over extensive areas, the Contractor shall programme the work to allow removal of full lane widths unless this is impracticable. The Contractor shall notify his proposed programme of milling to the Engineer prior to commencement of the work.

Immediately after milling, surplus material shall be removed by a machine of suitable and efficient design and the milled surface swept to remove all dust and loose debris.

Pavement closed to traffic shall be resurfaced after milling prior to reopening the pavement unless otherwise agreed by the Engineer.

P2.13.4.22 Tack Coat

Where a tack coat is required, it shall be cut back asphalt complying with class RC-70

ASTM D2028, applied at a uniform rate of spread of no less than 0.3 to 0.5 l/m2. A tack coat should be applied between all layers. Prior to emulsion application the substrate shall be clean. After application, the emulsion shall not be permitted to collect in hollows and shall be allowed to 'break' (turn from brown to black) before the asphalt is laid.

A tack coat shall be applied under a wearing course unless this is being placed on a newly laid, untrafficked base course. When directed, the Engineer may require the application of a tack coat spray to the surface on which laying is to take place.

Asphalt materials shall be kept clean and uncontaminated. Except by prior agreement with the Engineer the only traffic permitted to run on asphalt materials to be overlaid shall be that engaged in laying and compacting of the next course.

If the binder film on an asphalt surface onto which a wearing course is to be laid becomes visibly worn or impregnated with dust as a result of additional trafficking, then a tack coat spray complying with RC-70 ASTM D2028 shall be applied before laying takes place.

Should any asphalt material become contaminated the Contractor shall make it good by cleaning and, if this proves impracticable, by replacement.

A tack coat complying with RC-70 ASTM D2028 may be substituted with material specified and applied in accordance with BS4987-2:2003.

P2.13.4.23 Seal Coat

Where a seal coat is required, it shall be cut back asphalt complying with class RC-70.

ASTM D2028, applied at a uniform rate of spread of no less than 0.5 l/m2. Prior to application, the substrate shall be clean.

P2.13.5 Design Method

Included above.

P2.13.6 Workmanship

Included above.

P2.13.7 Quality Control

Included above

P2.13.8 Monitoring

Included above.

P2.14 Curbs, Sidewalks, Road Markings and Signage

P2.14.1 Work Scope

Comprehensive curbs, sidewalks, road markings and signage are required to allow the safe and satisfactory operation of the facilities and accesses thereto.

P2.14.2 Function

The Contractor shall provide road signs, including posts and foundations for both traffic and directional signing, to achieve a comprehensive road system.

The Contractor shall provide clear, durable road markings to the road areas to control the movement and parking of vehicles and equipment.

A concrete curb with sidewalk shall be provided between the operations parking area and the MCC building. The sidewalk shall have letdowns suitable for pedestrian routes as well as a vehicle letdown for forklift access into the stores building.

P2.14.3 Materials and Structural Form

P2.14.3.1 Definition Dimensions and Layout

The minimum layout and extent for the required emergency access, service road and parking area are shown on the Drawings. This layout shall be developed by the Contractor for approval by the Engineer and Employer.

P2.14.4 Requirements and Design Criteria

Painted and thermoplastic pavement markings shall be in accordance with the BCMoTI Manual of Standard Traffic Signs & Pavement Markings and constructed in accordance with Section 02580 Painted Pavement Markings of the Master Municipal Construction Documents (MMCD).

All pavement markings shall be thermoplastic. No painted pavement markings shall be permitted within trafficked areas. All pedestrian crossings and walkways shall be marked.

P2.14.4.1 Curbs & Sidewalks

Curbs and sidewalks shall be constructed in general accordance with the Master Municipal Construction Document (MMCD) Design Guideline Manual.

P2.14.4.2 Pavement Markings

Painted and thermoplastic pavement markings shall be in accordance with the BCMoTI Manual of Standard Traffic Signs & Pavement Markings and constructed in accordance with Section 02580 Painted Pavement Markings of the Master Municipal Construction Documents (MMCD).

All pavement markings shall be thermoplastic. No painted pavement markings shall be permitted within trafficked areas. All pedestrian crossings and walkways shall be marked.

P2.15.4.3 Road Signs

Standard reflectorized road signs shall be in accordance with the BCMoTI Manual of Standard Traffic Signs & Pavement Markings. Road signs whether mounted on posts or fixed to a structure shall be mounted at a height specified in the BCMoTI Manual of Standard Traffic Signs & Pavement Markings. Proposed road sign layout and details are indicated on the Drawings.

Timber or plywood components will not be permitted for roadway signage substrates or supports.

P2.14.5 Design Method

The Contractor shall submit for review by the Engineer full technical details of the proposed layout and materials for the curb, sidewalk, road markings and signage. Changes requested by the Employer to ensure operational safety and shall be deemed to be included within the scope of the Works.

P2.14.6 Workmanship

The Contractor shall ensure consistent high-quality workmanship is achieved. A detailed method statement shall be submitted to the Engineer and field trials shall be completed to ensure quality installation.

Markings shall be applied strictly in accordance with Article 3.0 of the MMCD, the manufacturer's instructions and these Employer's Requirements.

The user shall be aware of weather conditions, surface preparations and condition of equipment prior to casting concrete or applying road markings.

P2.14.6.1 Surface Preparation

Pavement surfaces shall be dry and free from dust, frost, ice, oil, grease, and other foreign materials.

P2.14.6.2 Application

Unless approved otherwise by Engineer, paint shall only be applied when air temperature is above 10o Celsius and no rain is forecasted for the duration of the works. An application rate of 3 m2/L shall be used to evenly apply the paint. Apply glass beads at a rate specified by the manufacturer.

Paint shall be stored and applied strictly in accordance with the manufacturer's instructions. Minimum and maximum temperatures of paint and surfaces to be painted shall be observed.

Markings shall be free from raggedness at their edges and be uniform and free from streaks, splattering or overspray.

The Contractor shall control traffic to protect fresh markings from damage. The traffic control shall cause minimum interference to traffic and not affect port operations. Signs, barricades, flagmen and control devices shall be supplied by the Contractor. A system of spaced warning flags or blocks shall be used to protect the fresh markings until dry. Markings defaced by traffic shall be repaired by the Contractor at his expense.

P2.14.6.3 Trials/Testing

Trials using the selected line marking systems shall be conducted in the presence of the Engineer and shall determine:

a. the required surface preparation;
b. the optimum application conditions;
c. the thicknesses of the resulting applications;
d. the suitability of the proposed equipment and operators;
e. and the accuracy of setting out methods.

P2.14.6.4 Removal Of Existing Markings

Where required existing markings shall be removed using either wet or dry abrasive blasting. Precautions shall be taken to avoid damage to adjacent areas where the markings are to remain. Any such damage shall be rectified by the Contractor at his own expense.

P2.14.6.5 Tolerances

Paint markings to be within plus or minus 10 mm of specified dimensions.

P2.14.7 Quality Control

Included above.

P2.14.8 Monitoring

Included above.

P2.15 Security Fencing

P2.15.1 Work Scope

The contractor is required to maintain the Canadian Border Services Agency (CBSA) and Transport Canada security perimeter of the operating terminal throughout the Works and shall be responsible for all related Temporary Work.

New security fencing enclosing the Canola Oil Storage Facilities will be built as part of the FSPL-TI project. As such new security fence is not specifically required as part of the Permanent Works.

The Contractor will be required to remediate any existing or new fence that is damaged during the Works or is required to be relocated, modified or is otherwise impacted. All perimeters security fence must meet the International Ship and Port Facility (ISPS) requirements.

P2.15.2 Function

The terminals ISPS security perimeter must be maintained to meet all Authority requirements throughout the Works.

P2.15.3 Materials and Structural Form

Temporary and permanent security fencing shall both be in accordance with the International Ship and Port Facility Security (ISPS) Code and shall be constructed in accordance with Section 02831 Chain Link Fences and Gates of the Master Municipal Construction Documents (MMCD) -2009 Platinum Edition. As a minimum chain link security fence shall be 2.4m high with 5 strands of barbed wire fixed on top in a “V” shape to bring the full fence height to 3.0 meters.

All new vehicular access gates through the perimeter security fence shall comply in all respects with the International Ship and Port Facility Security (ISPS) Code.

P2.15.3.1 Design Criteria

Concrete shall be designed in accordance with Section 03300 Cast-in-Place Concrete of the MMCD.

P2.15.3.2 Workmanship

Samples of fencing materials shall be submitted for approval by the Engineer.

Materials and installation layout shall be in accordance with Section 02831 and 03300 of the MMCD. Straining posts shall be provided at all ends and corners of the fence, at changes of direction and at intervals not exceeding 30 m on straight lengths of fence.

Fencing shall be erected to the lines shown on the Definition Drawings, to the approval of the Engineer. The top of the fence shall present a smooth line parallel to finished ground levels, with no discernible dips, humps, or sudden changes in alignment.

P2.15.4 Requirements and Design Criteria

The design shall be in accordance with the ISPS Code and shall comply with Marine Transportation Security Regulations of TC.

The Contractor shall prepare and submit for approval detailed working drawings. Fencing material orders and upstand details shall not be finalized until working drawings have been approved. Concrete for the security fence shall be provided in accordance with Section 03300 Cast-in-Place Concrete of the MMCD.

P2.15.5 Design Method

The Contractor shall submit for approval by the Engineer's full technical details of the proposed layout and materials for the temporary and permanent security fencing system and the foundations.

P2.16 Structural Steelwork

Structural steel work includes but is not limited to steel piles, the railcar unloading platform, access stairs, the marine gangway and walkway.

P2.16.1 Function

All structural steelworks shall be fit for use and designed to support a first class, highly efficient liquid bulk terminal that maximizes the safety of operating personnel in all respects.

P2.16.2 Materials

P2.16.2.1 General

The supply, fabrication and erection of structural and miscellaneous steel shall be in accordance with the requirements of CAN/CSA S16 Standards and the Employer's Requirements. Structural steel used shall comply in all respects to the requirements of CSA G40.20/G40.21.

a. High strength bolts nuts and washers shall conform to ASTM A325.
b. Anchor bolts nuts and washers shall conform to ASTM A307.
c. Welding electrodes shall conform to CSA W59-18.
d. Steel pipe pile for marine piling shall be seamless or welded pipe conforming to API 5L or CSA Z245.1.

The Contractor shall perform tests and provide test certificates or obtain the manufacturer's test certificates, which shall be submitted for the materials to be used in the work. The tests shall be carried out by an approved testing authority, and shall include the following, all in accordance with Canadian standards defined above:

a. Chemical analysis;
b. Tensile tests;
c. Impact tests;
d. Bend tests; and
e. Flattening test.

If any sample fails a test the consignment it represents may be rejected in part or in total as decided by the Engineer.

P2.16.2.2 Protective Coatings to Steel

Corrosion damage will be minimized by providing protective coating as defined in this section for all structural steel including piling.

For practical purposes the corrosion regions are divided into Atmospheric, Heavy, Moderate and Mild corrosion zones.

- Atmospheric corrosion zone is located onshore and offshore above the splash zone.
- Heavy corrosion zone include splash, tidal and low water zone.
- Moderate corrosion zone consist of the immersion zone.
- Mild corrosion zone is the buried part of the pile below the seabed.

Where structural steel is not easily accessible for maintenance coating and coating repairs (including all steel below loading deck, trestle and immersed steel) thickness of structural steel members will consider corrosion allowance based on rate presented in table 25 of BS 6349-Part 1 but minimum 3mm.

Unless hot-dip galvanizing is specified, all structural and miscellaneous steel will be provided with protective coating to suit corrosion zone.

All steelwork described in the Employer's Requirements or on the Drawings as galvanized shall be hot-dip galvanized conform to CAN/CSA G164-18.

The required minimum life to first maintenance is 15 years and any coating damage in transportation to site, storage, handling, or installation shall be repaired to the satisfaction of the Employer.

P2.16.3 Structural Steel Painting

All structural steel, except for marine piles, the paint system for which is specified under the Marine Structure and Fittings, shall be primed and coated in accordance with specification as follows or approved equal:

Surface preparation: commercial blast clean to SSPC SP6

Prime coat: 2-3 mil zinc rich epoxy primer

Topcoat: 12-16mil high-build epoxy

P2.16.4 Requirements and Design Criteria

All structural steel shall be designed to resist the superimposed loads according to the design standards and design load specifications.

All marine piles should be installed outside the future tunnel crossing Right of Way.

P2.16.5 Design Method

All structural steel shall be designed in accordance with CAN/CSA S16 latest edition or equivalent approved standard.

The Contractor shall be responsible for producing detailed fabrication designs and drawings for approval which shall include the following:

a. Plans, sections and details indicating profiles, sizes and the specified location of structural members;

b. Connection details (welded connections identified using CAN/CSA S16 recognized welding symbols, with net weld lengths indicated); and

c. Supporting calculations.

P2.16.6 Workmanship

P2.16.6.1 General

The Contractor shall submit the following information prior to commencement of fabrication:

a. Manufacturer's Mill Certificates certifying that steel members meet the specified requirements;

b. Mill Test Reports indicating structural strength, destructive and non-destructive test analyses;

c. Welder's Test Certificates shall verify that welders employed on the Works are qualified within the previous 12 months for the weld procedures they will be required to undertake in the fabrication process. Welders may also be subject to approval by on-site practical testing.

P2.16.7 Welding

P2.16.7.1 Reference Documents

Metal-arc welding of steel shall be in accordance with the requirements of Canadian Standards for the grade of steel to be welded. Consumables for use in metal arc welding shall comply with Canadian Standards as applicable.

The Contractor shall be required to submit his proposals for metal-arc welding for the prior consent of the Engineer. Consent to the welding procedure shall not relieve the Contractor of his responsibility under the Contract.

P2.16.7.2 Workmanship

Butt Welds

The ends of the butt welds shall have full throat thickness. Run-on / run-off plates shall be used during butt welding adequately secured on either side of the main plates. Additional metal remaining after the removal of the plates shall be removed by machining or by other approved means. Ends and surfaces of welds shall be smoothly finished. All main butt welds shall have complete penetration.

Fillet Welds

Fillet welds shall be continuous to form a complete seal where two members join or about. During fabrication of steelwork, the Contractor shall take all necessary measures to prevent distortion occurring during or as a result of welding. Work showing distortion in excess of the appropriate tolerances shall be rejected, and the Contractor shall replace such work at his own expense. The minimum leg length of fillet welds shall be 6mm (throat thickness shall be greater than 4.3mm).

P2.16.7.3 Non-Destructive Examination of Welds

The Contractor shall appoint an independent weld inspector who will be approved by the Engineer and who will co-operate fully with the Engineer in all aspects of inspection and Non-Destructive Examination (NDE) of welds. Where such cooperation is not forthcoming, the Engineer may withdraw his approval and a new independent inspector shall be appointed subject to further approval of the Engineer. The Contractor shall give adequate notice to the Engineer of any required fabrication inspection stages.

The Contractor shall arrange and be responsible for supplying all NDE equipment, tools and materials to enable the Engineer to conduct any inspection and undertake any further NDE that he may deem necessary. Any such examination and inspection shall not absolve the Contractor from his responsibility to exercise such quality control as will ensure that the Employer's Requirements, including related Codes, Standards and Specifications, are satisfied.

After completion of NDE, all NDE reports shall be submitted to the Engineer within two working days. These reports shall detail a complete history of the NDE and inspection sequences. The NDE shall form part of the Quality Documentation and shall be approved prior to commencement of any fabrication.

The Contractor shall note that the standards which will finally be employed for each NDE procedure shall be determined and agreed with the Engineer, including the clarification of all acceptance criteria, prior to any NDE method statements, trials or testing being undertaken by the Contractor. The procedures outlined in the following Clauses are to be taken as indicative of the level and type of testing that will be required. The Contractor shall demonstrate that all NDE procedures are able to consistently identify flaws as defined in the approved standard. Each NDE procedure shall be demonstrated to be suitable for its intended purpose. If satisfactory, the Engineer shall consent to these procedures and all NDE shall be performed in accordance with these procedures.

Fabrication may proceed on the basis of preliminary NDE results. However, final NDE shall not be carried out prior to 48 hours after completion of welding, except when post weld heat treatment is performed, in which case NDE may commence on cooling to ambient temperature.

The Engineer reserves the right to test, monitor and record all NDE operators and equipment and to reject any NDE operator or equipment if deemed unsuitable.

The equipment used by the Contractor during NDE shall be capable of performing the required tasks. The Contractor shall calibrate, test, monitor and record all equipment and shall remove from production use any equipment which in the opinion of the Engineer is not satisfactory for the intended purpose.

The Engineer reserves the right to re-examine any production welds submitted for approval and to employ other independent NDE personnel and whatever equipment the Engineer considers necessary to enable evaluation of the production welds. The Engineer reserves the right to undertake further independent NDE at any stage of fabrication.

All welded joints shall as a minimum be visually inspected by the Contractor at the following stages:

a. Edge preparation and fit-up prior to welding;
b. After back-gouging;
c. On completion of welding before and after pre-heat removal;
d. After defect removal prior to repair welding.

The Engineer may also wish to undertake inspections at these stages, and the Contractor shall allow the Engineer access to carry out such visual inspections.

Visual inspection shall be carried out by the Contractor after the removal of all slag, mill scale, dirt, grit, weld spatter, paint, oil or other foreign matter from the weld(s). On completion of welding, all welded items shall be presented in a suitable condition for the Engineer to perform a visual inspection. Visual inspection shall be done after any weld grinding has been completed. This shall also apply to any weld repair. Visual inspection shall ensure the requirements of the Employer's Requirements have been met and shall ensure that:

a. All welds meet the profile requirements and weld reinforcement requirements as specified on the Drawings;

b. All arc strikes wherever located have been removed in accordance with the requirements of this Specification; and

c. Toe burr grinding has been carried out in accordance with an approved procedure.

The welds to be subject to inspection will be randomly selected by the Engineer. In addition to the visual inspection, the following NDE inspections may be required:

P2.16.7.4 Magnetic Particle Inspection

Magnetic particle inspection (MPI) shall be carried out by the Contractor, as directed by the Engineer in accordance with the procedures to the consent of the Engineer. These procedures shall be written in accordance with ASME Section V, except as modified in the Employer's Requirements, or to an alternative standard proposed by the Contractor and approved by the Engineer. The Contractor shall submit procedures to the Engineer for consent prior to their implementation.

MPI shall be conducted after acceptance of initial visual inspection and any weld profile grinding and prior to and after any toe burr grinding. The method for MPI shall be AC Yoke with articulated legs using white background paint and black ink. All weld areas that are to be examined by MPI shall be sufficiently smooth to avoid false defect indications. MPI shall be used to detect both longitudinal and transverse defects. The applied magnetic field strength and sensitivity shall at all times meet the ASME V requirements. Magnetic particle operators shall be qualified to a minimum standard of CSWIP 3.1 Tester (Magnetic Particle) or to an alternative standard to the consent of the Engineer. Acceptance levels shall be in accordance with approved standard, or similar levels as agreed by the Engineer. Spurious indications may be removed by grinding to a maximum depth of 1.0mm at weld toe locations. Weld metal indications may be removed by grinding provided the weld profile requirements are maintained.

Light surface grinding may be carried out before or during MPI examination to provide a satisfactory surface finish on which to carry out the test or to assist the operator in the interpretation of any possible indication. If surface indications cannot be removed by light dressing to a maximum depth of approximately 1.0 mm, the Engineer shall be informed and shall witness any further grinding required to remove the indication. The repair by welding of any location where grinding is carried out to a depth greater than 1.0 mm shall be at the discretion of the Engineer and shall be carried out to an approved procedure.

The operator shall produce a test report for each weld joint arc strike examined in addition to a sketch showing the locations and lengths of rejectable flaws. Each magnetic particle inspection report shall detail as a minimum the information listed below:

a. Joint identification number;

b. Type of joint or area i.e. face penetration butt joint, 'T' butt joint, fillet weld, area of arc strike, scar area etc.;

c. Welder(s) and welding operator(s) identification(s);
d. Welding procedure(s) identification(s);
e. Operator identification and signature;
f. Method of magnetization and consumables (ink, powder, etc.) used;
g. Date and time of weld completion and MPI;
h. Original weld or repair;

i. Applied magnetic field strength;
j. Heat treatment and sizes discovered and location(s);
k. Conclusions; accept or reject with respect to the Employer's Requirements;
l. Flaw excavation profile (mimic).

All MPI reports shall be submitted to the Engineer.

P2.16.7.5 Ultrasonic Examination

Ultrasonic examination (UT) of welded joints shall be carried out by the Contractor, as directed by the Engineer, in accordance with procedures to the consent of the Engineer. These procedures shall be in accordance with ASME Section V except as modified by the Employer's Requirements, or an alternative standard to the approval of the Engineer. The Contractor's proposed UT procedures shall include a procedure for the testing of welds at elevated temperatures, (i.e. up to the minimum preheat temperature) and a procedure to enable the accurate sizing of embedded flaws. Each weld shall be examined with sufficient probe angles to guarantee full coverage of the joint, with scanning from both sides of the joint if geometry permits.

Prior to shear wave examination, a compression probe search shall be conducted to confirm that no lamination type defects exist within the continuous members at T-butt weld locations, which will mask the shear wave examination.

Prior to conducting ultrasonic examination, the operator shall ensure that the weld deposit and surrounding areas are sufficiently smooth to avoid false or misleading defect indications. The maximum surface correction factors shall be 6dB. If this correction factor is exceeded additional surface grinding shall be performed prior to final ultrasonic examination. All flaw indications which exceed the 20% reference level when examined with the dB increased gain shall be investigated and detailed in the operator's report.

Planar flaws are unacceptable regardless of length or amplitude and shall be weld repaired. When examining for Chevron cracking any indication which equals or exceeds 20% of the reference curve shall be cause for rejection.

Slag indications are acceptable if:

a. Defect length is less than that permitted by approved standard, regardless of DAC.
b. Defect length exceeds requirements of approved standard, but response level is less than or equal to 50% DAC calibrated on the appropriate 2.4 mm or 3.2 mm hole.

Slag indications are unacceptable if defect length exceeds requirements of the Approved Standard and response level is greater than 50% DAC calibrated on the appropriate 2.4mm or 3.2mm hole. The standard on which the slag indication acceptability is to be finally determined is to be agreed and confirmed prior to the commencement of any UT.

When positive flaw type interpretations cannot be ascertained in any instance the flaw shall be considered planar and in need of repair. All ultrasonic operators shall be qualified in accordance with the Certification Scheme for Weldment Inspection Personnel (CSWIP) to the level of CSWIP 3.6 unless consent is otherwise given by the Engineer. All supervisors shall be qualified to CSWIP 3.9.

During production examination the Contractor shall produce a test report for each weld joint or weld repair examined in addition to a sketch of all flaw sizes and location and dB level for each flaw required.

Each ultrasonic examination report shall detail as a minimum (using joint diagrams to indicate scans) the information listed below:

a. Joint identification number;
b. Welder(s) and welding operator(s) identification(s);
c. Welding and ultrasonic procedure identification numbers;
d. Operator identification and signature;
e. Sketch showing location(s) face width, length and location of all indications exceeding the 20% DAC reference curve and signal amplitude;
f. Date and time of welding completion and NDE;
g. Original weld or repair;
h. Heat treated condition or "as welded";
i. Plate thicknesses;
j. Probe angles and frequencies;
k. Equipment identification serial numbers. The basic sensitivity;
l. The primary reference level sensitivity - basic plus transfer value;
m. State if "hot" or ambient temperature examination. Surface correction factor adopted during examination and calibration;
n. Conclusions; accept or reject with respect to the Employer's Requirements.

The Contractor shall make an initial assessment of defects against acceptance criteria and all ultrasonic reports including recommendations shall be reviewed and approved by the Engineer.

P2.16.8 Quality Control

Marine piles should have weld testing performed by a 3rd party agency.

P2.16.9 Monitoring

Not used

P2.17 Rail Works

P2.17.1 Work Scope

To support the construction of the new railcar unloading facilities the existing intermodal yard 6 will need to be removed and disposed. Track 6 will be replaced with two new railcar sidings to support a combined concurrent unloading capacity of 32 railcars. The railcar unloading area shall be outfitted with Continuous spill containment pans under and extending outside unloading tracks with containment collection system.

The scope shall also include:

- The restoration of rail area including re-ballasting of existing Intermodal Track 5 and any other tracks impacted by the Works.
- Shortening of Intermodal rail tracks 3, 4 or 5 for temporary construction access as may be required and subject in all respects to Engineers approval and the Employers safety review and continued operational access. For any temporary shortening of intermodal rail tracks the Contractor shall be responsible for all temporary works, and to fully restore the track to their prior working length, and in all other respects, to their original or a better condition.
- Shortening of Intermodal rail tracks 3, 4 or 5 to provide permanent emergency access as may be required by the Engineer or an Authority to provide emergency access and safety routes to the new Canola facility.

P2.17.2 Function

The rail works shall support all contemplated operational functions, design loads and safety requirements.

P2.17.3 Materials and Structural Form

Ballast shall conform to the following gradation:

- For 19mm nominal size, with 40-75% passing by weight
- For 25mm nominal size, with 90-100% passing by weight
- For 38mm nominal size, with 100% passing by weight

Bumping post shall be Hayes Type WG or HD and shall be submitted to the Engineer for approval. Bumping posts must be installed in conformance with manufacturer best practices and technical requirements.

Lap switch configuration:

- No. lap 8 turnout
- Intermediate strength 115# re rail
- Sampson switch points
- No. 1 HW switch ties
    - W/36E switch stand and connecting rod
    - W/cast plates
    - W/point protectors

P2.17.4 Requirements and Design Criteria

Track systems shall be designed for Cooper E90 live load Track curves are defined by chord definition.

P2.17.5 Design Method

Rail geometry, materials, turnouts & switch stands, and technical specifications shall be designed by the Contractor and submitted for approval by the Engineer.

P2.17.6 Workmanship

Prior to the construction of any railway extensions, all asphalt, concrete, loose fill, and other deleterious materials should be removed from the construction areas to expose a subgrade of compact to dense sand fill. Subgrade to be inspected and approved by a Geotechnical Engineer prior to construction.

If excavation is required inside the zone of influence of working tracks, then shoring plans are required and must include the live Cooper E90 loading from passing trains.

Positive drainage of existing rail shall be maintained during construction.

P2.17.7 Quality Control

All work shall be done in accordance with AREMA standards.

The Contractor shall provide a copy of all test results to the Engineer.

The Contractor shall notify the Engineer at least two (2) working days before the Contractor intends to perform the tests.

P2.17.8 Monitoring

Not used.

P2.18 Concrete

P2.18.1 Work Scope

This section applies to the design, fabrication, and construction for the concrete structures and foundations and any other concrete work within these Employer's Requirements.

P2.18.2 Function

All concrete structure shall be fit for use and designed to support a first class, highly efficient liquid bulk terminal that maximizes the safety of operating personnel in all respects.

P2.18.3 Materials and Structural Form

P2.18.3.1 Materials

The supply, fabrication and construction of concrete structures shall be in accordance with the requirements of Canadian Standards.

a. Concrete used shall comply in all respects to the requirements of CAN/CSA A23.1, A23.2, A23.3.
b. Reinforcing Steel shall conform to CSA G30.18 Standard.
c. Tolerances and surface finishes shall comply with the requirements of the 2016 Standard Specifications for Highway Construction issued by the British Columbia Ministry of Transportation and Infrastructure.

P2.18.3.2 Concrete Durability Requirements

Concrete shall meet the following requirements:

Reinforced cast in place concrete marine structure over water, submerged or in tidal or splash zone
Durability and Class of Exposure: C1

Minimum cementitious content: 430 kg/m3

Maximum water-cement ratio: 0.38

Aggregate size: 20 mm max

Minimum Compressive Strength at 28 Days: 35 MPa

Permeability 1000 coulombs at 56 days

Marine piling infill

Durability and Class of Exposure: C1

Minimum cementitious content: 370 kg/m3

Maximum water-cement ratio: 0.40

Minimum Compressive Strength at 28 Days: 35 MPa

Aggregate size: 14 mm max.

Reinforced precast concrete marine structure over water, submerged or in tidal or splash zone

Durability and Class of Exposure: C1

Maximum water-cement ratio: 0.35

Minimum Compressive Strength at 28 Days: 40 MPa

Aggregate size: 20 mm max

Volume Stability: acceptable volume change range 1% due to shrinkage, creek and freeze thaw cycle.

Permeability 1000 coulombs at 56 days

Pre-stressed precast concrete marine structure over water, submerged or in tidal or splash zone

Durability and Class of Exposure: C1

Maximum water-cement ratio: 0.35

Minimum Compressive Strength at 28 Days: 45 MPa

Aggregate size: 20 mm max

Volume Stability: acceptable volume change range 1% shrinkage,due to creek and freeze thaw cycle.

Reinforced Concrete

Minimum cementitious content: 370 kg/m3

Maximum cementitious content: 425 kg/m3

Maximum water-cement ratio: 0.45

Un-reinforced Concrete

Minimum cementitious content: 325 kg/m3

Maximum cement content: 375 kg/m3

Maximum water-cement ratio: 0.50

Concrete cover to reinforcement shall be checked for all concrete units, prior to incorporation into the Works. A minimum of 35mm measurements shall be taken per unit using a cover-meter calibrated by direct measurement and checked by direct measurement. No more than 5% of readings shall be less than the specified minimum cover and no single reading shall be less than 10mm below the specified minimum cover. Units failing to comply with these criteria shall not be incorporated into the Works. In the event of non-compliance, the Contractor shall propose suitable remedial measures that will ensure that the required design working life of 50 years is achieved. The Engineer shall be given the opportunity to review any remedial measures prior to them being implemented.

Admixtures shall be of the high-range water-reducing/super plasticizing type, complying with CSA A3001 through A3005; set-accelerating and hardening-accelerating admixtures shall not be used. The total calculated acid-soluble chloride content shall not exceed 0.2% chloride ion by mass of cement for reinforced concrete.

All concrete shall be wet cured for a minimum of seven days and shall not be in contact with seawater or seawater spray for a minimum of fourteen days after casting.

The time between addition of water to the concrete mix and placing of the concrete shall not exceed one hour.

At the time of placing, the temperature of the concrete shall not exceed 30°C and the maximum Internal temperature following casting shall not exceed 65ºC. During the cooling period from peak hydration to ambient temperature, the temperature difference between the surface and the core of the element shall not exceed 20°C. Temperature monitoring shall be undertaken to demonstrate compliance with these temperature limits. All cold and adverse weather concreting requirements shall be as per the 2016

Standard Specifications for Highway Construction issued by the British Columbia Ministry of Transportation and Infrastructure.

All concrete incorporated into the Works shall be supplied by a plant having 3rd party accreditation for the production of ready-mixed concrete supplier, unless approved otherwise by the Engineer.

The Contractor shall submit the following information prior to commencement of work:

PRODUCT DATA:

Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and additives and include product characteristics, performance criteria, physical size, finish and limitations.

Submit 2 copies of WHMIS SDS in accordance with Health and Safety Requirements.

Site Quality Control Submittals:

Provide testing results reports for review by Engineer and do not proceed without written approval when deviations from mix design or parameters found.

Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature, concrete temperature prior to placement and test samples taken as required.

Concrete hauling time: provide for review by Engineer deviations exceeding maximum allowable time of 120 minutes for concrete delivered to site and discharged after batching.

P2.18.4 Requirements and Design Criteria

All concrete foundations shall be designed to resist the loads superimposed on them by the structure above according to the design standards and design load specifications. Settlements shall be limited so as not to hinder the performance of the supported structure.

The Contractor shall be responsible for producing detailed fabrication designs and drawings for approval which shall include the following:

a) Work Method Statement for the production, transport, placing, and curing of concrete giving details for the proposed plant, equipment, methods, and products.

b) Outline contingency plans for adverse weather conditions.
c) Method statement for making good to defects including details of the proposed materials.
d) Proposed sequence of pours indicating the position and nature of joints including details of expansion joints.

e) Plans, sections and details indicating profiles, sizes and the specified location of Reinforcing steel;

f) Connection details for anchor bolts to be placed in the concrete foundations;

g) Supporting calculations.

P2.18.5 Design Method

All structural concrete shall be designed in accordance with CAN/CSA A23.1, A23.2, A23.3 and CAN/CSA S6 for loading deck and trestle or equivalent approved standard.

P2.18.6 Workmanship

Provide Engineer, minimum 4 weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.

Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture meet specified requirements.

At least 4 weeks prior to beginning Work, inform Engineer of source of fly ash.

Changing source of fly ash without written approval of Engineer is prohibited.

Minimum 8 weeks prior to starting concrete work, provide proposed quality control procedures for review by Engineer on the following items:

- Falsework erection.
- Hot weather concrete.
- Cold weather concrete.
- Curing.
- Finishes.
- Formwork removal.
- Joints.

Quality Control Plan: provide written report to Engineer verifying compliance that concrete in place meets performance requirements of concrete as the Employer's Requirements.

P2.18.7 Quality Control

The Contractor shall perform tests and provide test certificates or obtain the manufacturer's test certificates, which shall be submitted for the materials to be used in the work. The tests shall be carried out by an approved testing authority, and shall include the following, all in accordance with Canadian and US standards defined above:

- Concrete pours;
- Slump;
- Air Content;
- Compressive Strength; and
- Air and Concrete Temperature.

If any sample fails a test the consignment it represents may be rejected in part or in total as decided by the Engineer.

P2.18.8 Monitoring

Not used.

P2.19 Marine Structure and Fittings

This specification sets out the additional requirements and details for the marine loading platform, access trestle, walkway, dock furniture including fenders, bollards, bull rail, marine emergency ladders, and liquid bulk tanker access systems.

P2.19.1 Function

The marine structure is required to:

- Provide a platform for the loading, operation, and maintenance of the canola oil marine loading system and supporting utilities.
- Provide vehicle access to the loading platform to support the canola oil marine loading operation and maintenance of the canola oil marine loading systems.
- Provide for safe berthing and mooring of the design vessels.
- Provide for walkway access for mooring crews from the existing Berth 9 to the new Berth 10 loading platform.
- Provide for ship gangway access from the loading platform to support canola oil marine loading operations. Provision of the ship gangway unit is not in the Contractors scope of work.
- The ship gangway shall be compatible for the freeboard of both loaded and unloaded vessels, outlined in the attached sample vessels, during all tidal flow conditions. Refer to Appendix 4 – Canola Sample Vessels.
- Provide for containment/collection of potential spills/drips at the marine loading arm.

- Provide for drainage of the marine structure deck.
- Provide an enclosed operator shelter to support the canola oil marine loading operation.

P2.19.2 Structural Form

The marine structure shall be of the form of construction selected by the Contractor and approved by the Engineer. Included within this document are illustrative concepts prepared by the Employer, but which the Contractor is not obliged to adopt, and do not present a full accounting of potential design concepts.

Acceptable structural forms for the marine loading platform and access trestle but are not necessarily limited to: Pile supported concrete deck, and/or pile supported deck slabs / beams and pile bents.

Acceptable piles are steel pipe piles.

Transition slabs shall be provided along the rear of the access trestle to accommodate differential settlement and meet the performance criteria.

The existing seabed under the marine structures shall consider and include future dredging, over dredging, and the effects of scour due to vessel propeller wash.

All marine piles should be installed outside the future tunnel crossing Right of Way.

P2.19.3 Layout

The layout of the marine structures shall be as described below. The Contractor shall abide by the definition dimensions and setting out criteria, as follows:

- Marine Loading System include arms and associated piping and utilities. One marine loading arm shall be allowed for as shown on the Illustrative Drawings and as further defined herein. Adequate space shall be allowed for routing of piping and associated utilities.
- Fenders: minimum of two new fenders as shown on the Illustrative Drawings, and further defined herein, and as required through design. The berth face shall be in-line with the existing berths.
- Bollards: minimum of two new bollards as shown on the Illustrative Drawings and further defined herein, and as required through design.
- Access trestle: geometry to suite single lane traffic with pedestrian access and pipe racks and cable trays. The concrete trestle width shall be 4m and shall provide a minimum of 3m width between curbs. The location of the piles and in water footprint has been agreed with relevant Authorities and shall not be materially changed by the Contractor without approval by the Engineer, refer to requirements in Volume 2 Part 1. Indicative geometry is shown on the Illustrative Drawings and further defined herein, and as required through design.
- Marine Loading Platform: geometry to support effective loading of product, berthing and mooring of vessels, access for operation and maintenance vehicles, operation and storage of a vessel access gangway, ancillary equipment, and service. The platform shall be a minimum length of 26m along

the berth and a minimum width of 14 m. The platform deck structure shall be a solid deck. The location of the pile bents and overall in water footprint has been agreed with relevant Authorities and shall not be materially changed by the Contractor without approval by the Engineer, refer to requirements in Volume 2 Part 1. Indicative geometry is shown on the Illustrative Drawings and further defined herein, and as required through design.

- The walkway between the Berth 9 and the Marine Loading Platform shall be a minimum 1.2m wide. Pile support locations show on the Illustrative Drawings and in water footprint shall not be materially changed by the Contractor without approval by the Engineer.
- The elevation of all marine structure top of deck shall be above the design flood level and shall consider the operating envelope of the marine loading arm and berthing and mooring of the range of design vessels over the design tidal ranges.

P2.19.4 Codes and Standards

For design of the marine structures, the following codes and standards shall be used:

- CSA S6 Canadian Highway Bridge Design Code shall be used as a primary standard for structural design, supplemented by National Building Code of Canada (NBCC 2020) where applicable.
- Canadian codes and standards, where applicable, govern on this project. In cases where information is not available in these documents, or where the Canadian standards do not provide sufficient or applicable information with respect to the facility use, the British Standard (BS 6349) shall be used as a marine code of practice. When the Canadian and British standards do not provide sufficient information or are not applicable, other international codes/standards/guidelines may be used by the Contractor at the approval of the Engineer. Guidelines produced by PIANC and OCIMF are considered acceptable guidelines for design of marine fenders and bollards.
- For seismic design, NBCC 2020 shall be used for Seismic Hazard classification. The seismic design principles of ASCE 61 Seismic Design of Piers and Wharves may be adopted to suit the seismic design of the marine structures.

As part of the design basis development, the Contractor shall provide a listing of all codes, standards, and guidelines for which the marine structure design shall be based upon for approval by the Engineer.

Should the Contractor understand there to be a conflict between two or more standards/codes listed above such that it is unclear as to the design process to follow, the Contractor shall immediately inform the Engineer and request clarification.

P2.19.5 Design Criteria

P2.19.5.1 Water Levels

Water levels at the site are influenced by tidal variations in the Strait of Georgia and river discharge rates.

The New Westminster tidal station shall be used to establish the tidal level ranges for design purposes in accordance with the latest edition of the Canadian Tide and Current Tables. Design water levels referenced to Chart Datum are summarized as follows.

Parameter	Water Level (m CD)
Higher Water Level High Discharge	3.5
Lower Water Level Low Discharge	-0.1

P2.19.5.2 Flood Level

The Works shall be designed to withstand extreme water levels associated with a 1 in 200-year flood level of +5.48 m CD (includes 0.5m of sea level rise) without material structural damage.

Marine structure top of deck shall be designed to be located above the flood level with a minimum freeboard of 0.3 m.

P2.19.5.3 Sea Level Rise

A minimum sea level rise of 0.5 m shall be considered in the design of the marine structures.

P2.19.5.4 Wind

For assessing the mooring loads, the following minimum wind speed shall be applied to the vessel:

- 1 in 50-year, 1 min Gust: 35 m/s

P2.19.5.5 Wave Conditions

Wind generated waves at the Site Location are limited. Shore protection shall be designed to resist waves generated by vessel wake. The Contractor shall make an assessment of the vessel wakes to be considered in the design of the shore protection and marine structure.

P2.19.5.6 Currents

The site will experience currents. The Contractor shall make an assessment of the currents to be considered in the design of the marine structures and mooring analysis of the design vessels.

P2.19.5.7 Debris

The site is frequented with debris and is an active log storage and sorting location. The Contractor shall consider debris loading on the marine structure including piles, deck, fenders, ladders, ancillary components that may be impacted by debris loads (e.g. piping or cable trays near high water levels).Seismic Structural Design Refer to Section 0 and 0.

The deck/beam on pile structure shall be designed such that energy dissipation during a seismic event occurs from plastic hinges forming in the piles and not the deck structure. The formation of plastic hinges below mudline is permitted.

P2.19.5.8 Geotechnical Design

Geotechnical design shall include assessment of liquefaction potential and soil improvement as required to meet slope stability requirements, settlement criteria, and seismic performance levels.

An accredited geotechnical engineering specialist approved by the Engineer will be retained to perform geotechnical design.

The Contractor shall undertake any additional investigation, which may be necessary to establish the design.

A non-linear time-history dynamic method of analysis of soil structure interaction using finite difference or finite element methods shall be used to model seismic response of the structure and foundation soils. The results of this analysis may not be used in place of methods described in the relevant codes but shall be used to supplement and confirm the final design is in accordance with the code.

The Contractor shall assess the soil structural interaction including inertia forces, and the effects of soil liquefaction, ground displacements, lateral spreading, kinematic loading, soil softening, etc. Geotechnical design will follow LRFD limit states design methods and recommendations given in the codes listed above.

P2.19.5.9 Marine Loading Platform Deck Level

The Marine Loading Platform Deck level shall be determined by the Contractor and approved by the Engineer.

The deck level shall consider:

- Design flood levels

- Existing Berth 9 elevation

- Tidal conditions and sea-level rise

- Continuity of the mooring and fendering for the range of design vessels.

- The MLA operational envelope

P2.19.5.10 Design Berth Depth and sub-sea slopes

The design berth depth is –11.5m CD.

The design shall consider a minimum over dredge of 2m.

The Contractor shall assess additional scour at the base of the piles and consider in the structural design.

The Contractor shall design and ensure that the sub-sea slope is stable in a non-seismic event.

P2.19.5.11 Oil Spill Boom

The Contractor shall provide an oil spill boom that can be deployed around the vessel that meets VFPA requirements.

P2.19.6 Loading

Design loads, other than specified below shall be in accordance with Canadian Design Codes.

P2.19.6.1 Dead Loads

Dead load shall consist of the self-weight of structural and permanent materials, and the weight of permanently attached equipment, fixtures and fittings.

P2.19.6.2 Live Loads

Uniform Live Load

Minimum uniform distributed live loads shall be:

- Loading platform 12 kPa
- Access roadway on the trestle structure 2.4 kPa
- Catwalks and gangways 2.4 kPa or 5 kN point load

Vehicle Load

Approach trestle and platform structures shall be designed for the following vehicle loading:

- Design Vehicle HS-25.

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P2.19.6.3 Piping and Equipment Loads

The loading platform structure shall be designed to resist the reaction loads for the loading system including equipment, piping, cabling, and associated support systems. Design shall consider all pipes full of product.

P2.19.6.4 Berthing Loads

The loading platform structure shall be designed to resist the reaction of the fenders and restraint chains.

P2.19.6.5 Mooring Loads

The loading platform structure shall be designed to resist a maximum line pull force equal to the capacity of the bollard (100 tonne) at any horizontal angle away from the berth plus a vertical component for a line pull as determined by a vessel mooring study.

P2.19.6.6 Current and Wave Loads

Current loads on the structures shall be considered in the design of the marine structures and vessel mooring study.

P2.19.6.7 Wind Loads

Wind load on the structures, equipment and piping shall be determined in accordance with CAN/CSA S6.

P2.19.6.8 Snow Loads

Loading due to snow and associated rain accumulation shall be determined in accordance with CAN/CSA S6.

P2.19.6.9 Thermal / Temperature

Thermal / temperature loads shall be considered.

P2.19.6.10 Vessel Access Gangway

The platform shall be designed to allow for the installation of a vessel access gangway.

P2.19.6.11 Seismic Loads

Marine structures shall be designed to resist loads due to seismic effects in accordance with Section 0 and 0 and 0.

P2.19.6.12 Water and Buoyancy Loads

Buoyancy loads shall include uplift forces due to submergence in seawater and shall be considered for all water level conditions including flood, as applicable.

P2.19.6.13 Structural Load Combinations

The structural detailed design shall be in accordance with Canadian codes and supplemented by international codes and guidelines as required.

The Contractor shall provide load combinations and related load factors for review and acceptance by the Engineer.

P2.19.7 Durability

The facility shall be designed, detailed and constructed for the design life specified in Section 0.

P2.19.7.1 Steel

All steel shall have a durability protection system for the design life, comprising a combination of:

- Paint system. All steel located above and below water shall be coated with paint or galvanized in accordance with the specified requirements.
- Corrosion allowance in the structural design shall be considered upon failure of the coating system for the duration of the service life defined.
- Allowances for future Cathodic protection system shall be used to protect all structures that get immersed, including the full tidal zone. All reinforcing steel and steel piles shall be electrically connected to facilitate the fitting of cathodic protection systems. Take off points for impressed current cathodic protection systems shall be provided. Notwithstanding this contingency requirement, design for durability should meet the specified criteria without implementation of a cathodic protection system.

Where dissimilar metals are used, measures such as electrical isolation shall be used to prevent galvanic corrosion.

The choice of stainless-steel materials shall consider the aggressive marine environment, susceptibility to chloride attack and galvanic corrosion. In particular workmanship shall avoid the possibility of carbon steel impregnation of stainless-steel materials during construction for example from weld spatter, grinding dust and incorrect construction tools and handling equipment. Allowance for corrosion of unprotected steel will be as given in BS 6349. The Contractor shall provide documentation to demonstrate the adequacy of any corrosion allowance and/or paint system with respect to providing the 50-year design life. A warranty shall be provided for any paint system. Close box/round sections for structural steel elements, located below quay deck level shall be used. Arrangements of steel that prevent access for inspection and maintenance shall not be used. Open rolled steel sections shall not be positioned in such a way as to hold moisture. Provision shall be made for drainage of all these members.

Fender panels, ladders, chain, shackles and fender connection hardware, steel and fasteners embedded in fresh concrete, and any grating shall be galvanized to ASTM A123/A123M or ASTM A153/A153M as applicable.

Handrails and guard rails are to be painted yellow. Alternatively, structural fibre reinforced plastic products may be used subject to the Engineer's approval.

Steel catwalks and bollards shall be painted. Aluminum structures do not require paint.

Use one of the following manufacturers of high solids epoxy paint systems or approved equivalent (current specific product names may vary from that specified) for painting of structural steel located above deck:

1 Ameron Amerlock 400

2 Jotun Valspar Jotamastic 87

3 Hempel Hempadur 4515

4 International Intergard FP Universal Epoxy

5 Sigma Colturiet TCP 7476

Paint system shall be as follows:

1	Surface Preparation:	Minimum blast clean to SSPC-SP6
2	Primer Coat:	2 mils to 3 mils DFT zinc rich epoxy
3	Topcoat:	4 mils to 6 mils DFT surface tolerant high-build epoxy
4	Total Dry Film Thickness:	6 mils minimum
5	Shop Touch-Up Preparation:	Spot blast to bare metal

Steel piles shall be painted from 2m below the seabed (after dredging and scour) to the top of pile.

Welds shall be treated with a protective coating to produce the same level of corrosion protection as the surrounding structural steel work.

Steel pipe pile coating systems shall be of a high durability (above 15 years), surface tolerant epoxy coating system designed for environments classified by ISO 12944-2 as C5-M very high corrosivity (Marine). All coating systems shall be reviewed and approved by the Engineer.

Pre-approved coating manufacturers are:

1. International Protective Coatings (AkzoNobel): URL: www.international-pc.com
2. PPG Protective & Marine Coatings (Sigma Coatings): URL: www.ppgpmc.com
3. Carboline: URL: www.carboline.ca

Coating products, coating thickness and number of coats shall be in accordance with manufacturer's recommendations to meet the service environment. Total dry film thickness not less than 24 mils. Stripe coat and touch up shall be in accordance with manufacturer's recommendations to meet the service

environment. Colour for pipe piles shall be black. The Contractor shall provide proposed corrosion protection systems to the Engineer for approval.

P2.19.7.2 Concrete

The concrete mix requirements shall achieve the required design life in reinforced concrete when exposed to the site environmental conditions. The concrete mix shall be designed with a very low permeability and/or developed with add mixtures to reduce water absorption, capillary rise, chloride ingress, and carbonation.

All reinforced concrete used in the marine environment shall have a minimum compressive strength of 40MPa (cylinder) for precast concrete and 35MPa for cast in place. Concrete cover shall be in accordance with the CSA S6 for marine exposure.

All reinforcing steel design shall be based on the adopted concrete grade and is to have sufficient ductility for seismic considerations.

Crack control will be in accordance with CSA S6, or other approved Codes.

Alkali-Silica Reaction shall be controlled by ensuring that only aggregate which has been adequately demonstrated to be non-reactive is used, unless the alkali content of the cement and concrete are limited.

P2.19.8 Materials and Workmanship

Per Sections 1 and 0 except where explicitly stated in this marine section 0. In case of conflict section 0 shall prevail.

P2.19.9 Fenders

P2.19.9.1 Work Scope

Two sets of cone style marine or similar fenders are required to be installed on the new marine loading platform as generally depicted on the Drawings. The fenders shall be designed to replace existing Dolphin 2 and must be compatible with the existing mooring fenders at berth 10 and compatible with the full range of design vessels. The design and performance testing shall be carried out in accordance with PIANC Marcom WG33. Guidelines for the Design of Fender Systems (2002-2004). The term fender is taken to mean the complete assembly comprising a rubber fender unit, steel fender panel, low friction facing pads, chains, inserts, connections, and all other items associated with design, manufacture, installation, certification and delivery to site of the complete assembly.

The fender supplier shall have minimum 10-year proven track record in supplying fendering systems. The fender supplier shall have the equivalent of an ISO-based quality assurance certification system. A reference list of similar types of fender installations shall be supplied to the Engineer.

The Contractor shall install the fender assemblies, including cast-in inserts. The Contractor shall ensure that the fender supplier delivers inserts, templates (for correct placement of inserts), detailed installation manuals and specifications in time for the required installation date.

The Contractor shall obtain from the fender manufacturer templates for installing cast-in sockets. The Contractor shall agree with the Manufacturer the delivery times of the templates to suit their program for installation of cast in sockets.

The Contractor shall obtain from the manufacturer a QMS (Quality Management System) plan for complete manufacture of the fenders for approval by the Engineer

P2.19.9.2 Function

The fendering system shall be designed in accordance with this specification to suit the Contractor's design of the marine loading platform and ensure compatibility with the existing berth 10 fendering system for the range of design vessels. The Contractor shall submit their design to the Engineer for approval.

The fender supplier shall verify the fender design carried out by the Contractor.

Calculation of berthing energies and design of fendering shall be designed in accordance with PIANC Report of Working Group 33 "Guidelines for the Design of Fender Systems: 2002".

Each individual fender shall be designed to absorb abnormal impacts, within the rated deflection. However, for multiple contacts, fenders shall be designed for the most unfavourable position of the ship's hull. Rated energy and deflections values shall be reduced, where necessary, using manufacturer 's factors, to take account of berthing and flare angles.

Fenders shall be designed to absorb berthing energy from impacts, within the rated deflection of the fender. The fender system shall be designed for the point of contact determined from the hull geometry and berthing angle.

In general, the fendering system for the main dock structure shall be designed for quarter point vessel impact.

The design shall demonstrate that the fender spacing is such that for abnormal impacts, vessels of the full design range can berth safely at the design angle at any state of tide, while maintaining a positive clearance (nominal 0.3 m clearance) between the vessel and the dock face and without the vessel contacting the marine loading arm. Full account shall be made of the following:

- The deflection characteristics of the fender system, with an appropriate allowance for variations in hull-radii
- Bulbous bows of vessels
- Bow and stem flare

Fender front panels shall be positioned to accommodate berthing of the full range of laden, partially laden, and unladen vessels at all states of the tide. The top of the fender panels shall not be above cope level.

Vessel DWT	Approach Velocity Perpendicular to Berth Face (m/s)	Approach Angle (degrees)
50,000 tonnes	0.15	8
20,000 tonnes	0.25	10

Minimum energy to be absorbed by the fender system will be based on the berthing criteria shown in Error! Reference source not found.15.

Table 15: Berthing Energy Design Criteria

The factor of safety on berthing energy for an abnormal berthing event shall be a minimum of:

- 1.5 for 50,000 DWT vessel

- 2.0 for 20,000 DWT vessel

Quarter point berthing is to be assumed.

Maximum Hull Pressure: 200 kN/m2.

The size and shape of the fender panel shall be in accordance with the World Association for Waterborne Transport infrastructure (PIANC) guidelines. Fender panels shall be designed to take the fender abnormal reaction force as a line load across the width of the face panel at any level. The effect of belting on vessel hulls shall be taken into account in the design of the fender system.

Chains and fixings shall be designed to resist horizontal and vertical shear using a friction factor of not less than 0.3 and must be designed to ensure that they do not limit the operation and deflection of the fender.

Fender design shall take account of manufacturing performance tolerances for rubber by reducing the manufacturers rated energy absorption by 10% and increasing the manufacturers rated reaction by 10% (or an approved manufacturing performance tolerance that shall be verified by the manufacturer). The design should also take into account berthing the PIANC Guidelines for the Design of Fender Systems (2002) performance factors for ambient temperature, berthing angles and berthing velocity.

Fender design shall take account of angular loading to allow for vessels berthing at a maximum angle of 10 degrees. A softness coefficient of 1.0 and a berthing configuration coefficient appropriate to the type of dock construction, in accordance with PIANC Guidelines for the Design of Fender Systems 2002. The design of fenders should take into account the effects on fender performance within the temperature range given in Table 16.

Table 16: Ambient Temperature Range

Parameter	Value
Max. Ambient Shade Temperature	+38°C
Min. Ambient Shade Temperature	-13°C

P2.19.9.3 Materials and Structural Form

Rubber Properties

The rubber raw material shall meet or exceed the performance requirements outlined in PIANC Report of Working Group 33: Guidelines for the Design of Fender Systems, 2002. The Fender Supplier may submit a "Type Approval" certificate as per PIANC 2002 to the Employer and Contractor for approval prior to commissioning the fender installation, or the fender testing shall be subject to third party inspection and witnessing by an accredited agency to certify that fender performance and physical property tests conform to this specification. The inspection and witnessing report for fender testing shall be approved by the Engineer.

Rubber for fender elements shall be resistant to deterioration by oil, grease, ozone, UV radiation, seawater and aging. Each type, size and grade of rubber for fender elements shall comply with the requirements of Table 17.

Table 17: Fender Rubber Properties

Property	Standard (or equivalent)	Basic Value	Aged Value
Tensile Strength	DIN 53504	15N/mm^2	12.8 N/mm^2 minimum for 168 hours at 70°C
Elongation at Break	DIN 53504	350% minimum	280% minimum for 168 hours at 70°C
Hardness	DIN 53505	75 Shore A maximum	+5 increase maximum for168 hours at 70°C
Tear Resistance	DIN 3507	80 N/mm minimum	-
Abrasion Resistance	DIN 3516	100 mm3	-
Compression Set	DIN 3517	-	40% maximum for 22 hours at 70°C
Ozone Resistance	DIN 53509	-	No cracks visible by eye (50 pphm at 20% for 40 hours at 40°C)
Seawater Resistance	DIN 86076	-	Shore A: ± 10 maximum Volume: 10% /5% maximum for 28 days at 95 C ± 2°C
Durability	ASTM D430- 95 Method B	15,000 cycles, grade 1	-

Bond Strength – Rubber to Steel	ASTM D429 Method B	7 N/mm minimum	-

Manufacturing dimensional tolerances for rubber shall be within ± 2 mm: Manufacturing performance tolerances for rubber shall be within 1-10%:

The following particulars of the proposed rubber fenders shall be submitted to the Engineer:

a) Manufacturer's literature, including a list of physical properties of the rubber for the fenders;
b) A report on compression load tests and characteristic load-deflection and energy-deflection curves.

The particulars shall be submitted to the Engineer for approval of the source and type of rubber fenders at least 40 days before the first delivery of the rubber fenders to the Site.

A certificate showing the manufacturer's name, the date and place of manufacture and showing that the rubber fenders, including the rubber used in manufacturing the fenders, comply with the requirements stated in the Contract, shall be submitted for each batch of rubber fenders delivered on the site.

Steel Fender Panels

Steel fender panels shall be fully sealed of closed box type construction and shall be water- and air- tight. Steel fender panels shall be pressure tested prior to shipment: Steel fender panels shall be designed to resist the rated external loads and environmental forces.

The design shall comply with the following minimum steel thicknesses:

- External plates exposed to the air/water on both faces: 12 mm minimum
- External plates exposed to the air/water on one face: 10 mm minimum
- Internal plates (not exposed): 8 mm minimum

The fender supplier shall advise the unit weight of the fender panel to the Engineer for approval. Manufacturing tolerances for steel dimensions shall be in accordance with: CAN/CSA S16:

Padeyes shall be provided for lifting and chain attachments and shall be designed in accordance with the requirement of API RP2A-Recommended Practice for Planning, Design and Constructing Offshore Platforms, Clause 05.5. Sufficient lifting padeyes shall be provided to allow easy handling, and the frame shall have sufficient rigidity and strength to avoid damage during handling and installation.

The design shall consider bending, shear and local buckling associated with the maximum reaction developed by the fender unit, including the simultaneous application of a friction force (not less than 30% of the rated reaction) in any direction and environmental forces. Panel rib spacing is to be minimized to ensure uniform pressure distribution on the vessel hull. Deflection of the faceplate is to be not greater than 2L/1000, , where L is the length or width of the facing panel.

Fender panels shall be designed to take the abnormal reaction force as a line load across the panel at any level. Front vertical edges of the fender panels shall be splayed to prevent damage to the low- friction

facing panels by vessels with intermittent belting. Minimum dimensions for front vertical edge splays shall be 100 mm by 100 mm.

Fender panels shall have a splayed bevel at the top of the panel to reduce damage to the fender panel from hull protrusions. Minimum dimensions for top edge splays shall be 300 mm by 300 mm. All holes shall be drilled. All free edges and corners shall be rounded by grinding, with radius greater than 2 mm. Washers shall be used under bolt heads in order to avoid damage to the paint. A water sealant compound shall be applied on all bolt thread connections to ensure water and air tightness of the fender panel

The Contractor shall submit steelwork shop drawings to the Engineer for review.

Fender Facing Pads

Fender units shall be faced with an approved Ultra High Molecular Weight Polyethylene (UHMW-PE) pads of minimum 40 mm thickness. UHMW-PE pads shall be manufactured using double sintering process for increased abrasion resistance.

UHMW-PE properties shall meet or exceed the performance requirements outlined in EAU—2004 (8th ed). The maximum coefficient of friction of the new facing pads with steel shall be 0.2. All UHMW-PE pads shall be from the same production run. The UHMW-PE pads surface shall be isotropic. All seaward edges of the UHMW-PE pads shall beveled/splayed to reduce damage. UHMW- PE pads shall be a coloured black, unless an alternative colour is approved by the Engineer. The size of the pads shall be such that they can be handled easily by one worker for future replacement.

Manufacturing tolerances for UHMW board are stated in Table 18.

Table 18: Tolerances

UHMW-PE Material	Tolerance
Length and width	± 5 mm
Thickness	± 0.3 mm
Out – of straightness of the finished panel surface	<1/1200

Chains

Fender panels shall be provided with weight and shear chains. Each chain assembly shall include a shackle and chain tensioning device which will also provide a ‘weak link’ (i.e., to prevent damage to other components in the event of chain overload).

Chains shall be galvanized high tensile Grade 4 steel. Chain breaking load shall be a minimum of three times the safe working load. Chains shall be open link. Special end links shall not be used. Each chain assembly shall include a shackle/chain tensioner to eliminate slack and provide a ‘weak link’ (i.e., to prevent damage to other components in the event of chain overload).

Chains shall be tested by an independent testing authority and certificates provided to the Engineer. Chains shall be galvanized in accordance with CAN/CSA G164-18 to provide the required design life. As a minimum, a coating of610 g/m2 of surface is required (85 microns minimum Dry Film Thickness (DFT)).

Fender Fixings

Fender chain fixings on the fender unit and associated nuts and washers shall conform to ASTM A325 and shall be hot dip galvanized in accordance with CAN/CSA G164-18. Fixings shall be centrifuged immediately after withdrawal from the zinc to remove any surplus metal. Threads shall be brushed out to conform to the ISO-fitting.

All fender fixings to the supporting structure shall be stainless steel and shall be cast in wherever possible;

Top hat isolating washers shall be provided to isolate stainless steel fender fixings from other materials.

Materials shall be delivered with certificates according to ASTM or equivalent.

Corrosion Protection and Maintenance

Corrosion protection of the fender system shall be designed to provide a life to first maintenance of 25 years. Protective coatings shall be an epoxy paint conforming to a C5M classification of ISO 12944. Any damaged paint shall be touched up to the approval of the Engineer.

The fender panel colour shall be approved by the Engineer prior to shipment.

Where possible. units of the fender shall be demountable enabling the replacement of one part of the system.

Fender panels shall be fitted with anodes for corrosion protection. Protective coatings shall be compatible with the cathodic protection system.

A detailed repair and maintenance manual shall be provided with details of the required inspection and maintenance programs based on maximum intervals of five years.

P2.19.9.4 Requirements and Design Criteria

The Contractor shall submit detailed calculations of the fender system and test certificates for the approval of the Engineer.

The Contractor shall submit details of similar fender installations (by the proposed fender manufacturer) for the approval of the Engineer.

If requested by the Engineer, the Contractor shall arrange a visit or visits for the Engineer to inspect the fender manufacturer's factory and to witness any testing and manufacture.

P2.19.9.5 Design Method

Not used

P2.15.9.6 Workmanship

The Contractor shall install the fender assemblies, including casting-in of all inserts. The Fender Supplier shall ensure that the complete fender assembly fenders including all necessary inserts and templates (for correct placement of the inserts), detailed installation manuals and specifications are delivered to the site in time for the required installation date.

Fender fixings shall be accurately set out to ensure that fenders are installed without distortion to the rubber. Installation tolerances are given in Table 19.

Table 19: Installation Tolerances

Installation Tolerance	Tolerance
Positioning tolerance of the fender assembly relative to the lines and levels shown on Definition Drawings	± 20 mm

Prior to shipment, all fenders shall be broken in by compressing each fender to the rated energy deflection value at least three times.

P2.19.9.7 Quality Control

Each fender shall be performance tested before shipment. The performance testing shall be carried out in accordance with PIANC Guidelines for the design of Fender Systems, 2002. Appendix A: Section 6: Verification/ Quality Assurance Testing and Section 7 Other Tests.

The fenders shall be subject to third party inspection and witnessing by an accredited agency approved by the Engineer to certify that fender performance and physical property tests conform to the specifications. The inspection report shall be approved by the Engineer, prior to shipment of the fenders.

A certificate showing the manufacturers name, the date and the place of manufacturer and showing that the rubber fenders, including the materials used in manufacturing the fenders, comply with the requirements stated in the Contract shall be submitted for each batch of rubber fenders delivered on the site.

The fender supplier shall supply either a Type Approval certificate in accordance with PIANC (2002),

Appendix A, or an equivalent certificate with evidence of witnessed testing to prove the fender performance under operating conditions and environment.

P2.19.9.8 Monitoring

Not used.

P2.19.10 Bollards

P2.19.10.1 Work Scope

The Contractor shall supply and install a minimum of two cast iron bollards to ASTM A148/148M-01 Grade 50-80 formed in a single casting operation and shall be free of cracks or other defects with a minimum yield stress of 348 MPa. Anchorages shall be by means of cast-in holding-down bolts and plates to be supplied by the bollard manufacturer.

Bollard supplier shall have a minimum of a 10-year record on similar projects and supplier is subject to Engineers' approval.

P2.19.10.2 Function

The marine loading platform shall be equipped with two 100t bollards.

The safe working load shall apply for vertical and horizontal angles as determined through a mooring study but shall not be less than a vertical load -30 degrees to +30 degrees relative to the horizontal and horizontal load ±90 degrees relative to the perpendicular axis to the berthing line.

The Contractor shall complete a mooring study to confirm 100tonne bollards (safe working load) are of sufficient capacity to resist the mooring line loads for the range of design vessels and tidal ranges.

P2.19.10.3 Materials and Structural Form

P2.19.10.3.1 Bollards

The Contractor shall supply bollards of new material. The bollards shall be provided with a full set of anchor bolts and accessories supplied by the bollard manufacturer.

The Contractor shall submit, in advance, for review and approval by the Engineer, all the manufacturer 's catalogue data and information, for the proposed type of bollards. The Bollards shall be reviewed by the Employers operations staff and are subject to rejection if they are not deemed at the Employers sole discretion to provide the utmost safe bollard form.

The supplied bollards shall include all manufacturer's certificates and test certificates issued by an approved specialized laboratory to demonstrate compliance with the specified standards.

P2.19.10.3.2 Bollard Anchor Bolts

Bollard anchorages shall be by means of cast-in holding down bolts and washer plates supplied by the bollard manufacturer. The material grade of bolts, washer plates, templates, nuts and washers shall be shown on the Construction Drawings. Bolts shall conform to ASTM F 1554 Gr 105 unless noted otherwise.

Bolts, washer plates, templates, nuts and washers shall be hot-dip galvanized to a minimum average thickness of 55 microns Dry Film Thickness (DFT), in accordance with CAN/CSA G164-18. Fixings shall be centrifuged immediately after withdrawal from the zinc to remove any surplus metal. Threads shall be brushed out to conform to the ISO-fitting.

P2.19.10.3.3 Bollard Protective Coating

Before installation, bollards shall be treated with a high-quality protective coating system. Protective coatings shall be an epoxy paint conforming to a C5M classification of BS EN ISO 12944. The corrosion protection system shall be designed to provide a life to first maintenance of 15 years.
The colour of the corrosion protection system shall be approved by the Engineer.

The protective coating system shall not be coal tar epoxy or bitumastic based.

P2.19.10.4 Requirements and Design Criteria

Not used.

P2.19.10.5 Design Method

Not used

P2.19.10.6 Workmanship

Anchorages shall be assembled according to the relevant drawing for the bollards. The use of grease when assembling the anchorage is not permitted.

The bollard supplier shall provide templates to be installed at the concrete surface to hold the castin bolts in position during concreting of the cope.

Galvanized bollard bolts shall not be placed in contact with any reinforcement either directly or using any material that would give electrical connectivity.

If the bollard is not placed immediately, the anchorage shall be protected from possible damage by screwing the nuts on the anchorage bars and covering them with plastic.

The bollard shall be placed over the anchorage by use of lifting equipment with soft slings. The bollard is set correctly when the upper side of the bollard base plate is level and is flush with the concrete top surface. The nuts shall be hand-fastened tight to prevent further movement of the bollard.

The space around the bollard base plate in the concrete recess shall be filled from the sides up to concrete level with an approved cementitious grout, incorporating an approved expanding agent to impart non-shrink properties.

After the non-shrink grout has hardened, the nuts shall be tightened. The torque applied to the nuts shall be in accordance with the Suppliers relevant calculations or specifications.

After one-week, further torque shall be applied to the nuts according to the Supplier's relevant calculations/specifications. All torques applied shall be subject to the Engineer ‘s approval.

Recesses in the bollard base plate around the anchor nuts shall be filled with bitumen. Recesses shall be free of grease, etc., and shall be clean before filling.

After assembly. the bollard shall be checked for possible paint damage, and when necessary, repair of the damage shall be carried out by the Contractor at their expense using a compatible paint repair system.

P2.19.11 Other Dock Furniture Items

P2.19.11.1 Marine Gangway

The marine loading platform shall include the option for a marine gangway to facilitate ship access by terminal personnel during ship loading. The marine gangway shall be compatible with each of the design vessels provided through the full range of possible tidal and vessel draft conditions. The marine gangway shall be able to rotate for stowage and powered by an electric winch system. This work is to be quoted as optional.

Full details of the marine gangway shall be submitted to the Engineer for review and approval.

P2.19.11.2 Ladders and Handgrips

Ladders, ladder supports, and handgrips shall be fabricated from rubber or steel from a supplier that has a 10-year record in similar projects and subject to the approval of the Engineer, with a flexible bottom part or equivalent.

A minimum of two safety ladders shall be installed along the length of the platform. Additional ladders shall be spaced at distances not greater than 30 m along the access trestle in areas where the ground is 1.0 m below MLLW.

The top rung of the ladders shall be 0.15 m below cope level and the bottom rung a minimum 1.0 m below MLLW.

Handgrips shall be fixed to the top of the cope to facilitate access onto the cope from the ladder. Ladders and handgrips shall be made of steel and in accordance with ANSI ASC A14. Ladders and handgrips shall be made of steel and in accordance with the ANSI ASC A14

P2.19.11.3 Handrails and Bull Rails

Bull rails and handrails shall be provided and are to be designed to best practices for marine facilities.

P2.19.11.4 Life Saving Equipment

Lifesaving equipment to be determined by Contractor based on Employer terminal safety requirements.

P2.20 Process Mechanical

P2.20.1 Canola Oil Storage Tanks

The following specifications and standards are referred to in this document and shall apply to the field erected canola oil storage tanks.

P2.20.1.1 Work Scope

This Specification covers the minimum requirements for the design, fabrication, inspection, and testing of the canola oil storage tanks.

Clarifications noted in Appendix 5, where applicable, shall supersede the below requirements as noted in the clarification log.

P2.20.1.2 Function

Detailed tank data sheets to be completed during the detailed engineering phase.

P2.20.1.3 Materials and Structural Form

General

- Corrosion allowances shall be as specified 1.6 mm (to be confirmed during detailed engineering) and shall be additive to the value determined from the design calculations.
- The level switch technology must be different than the level transmitter technology to minimize the likelihood of overfilling the tank.
- All clips and attachments are to be connected to pads, not welded directly to the tank.
- All tank materials must meet the requirements of Section 4 of API 650.
- Materials outlined in paragraph 4.1.3 of API 650 cannot be used.
- Unless noted on the datasheet, the minimum design metal temperature is to be 8 ^{o}C higher than the 1% coldest day in January per the National Building Code (NBC). The maximum design metal temperature is to be equal to the greater of maximum product temperature or July 2.5% dry temperature per NBC.
- Normal plate material shall be A36 as per ASTM A36/A36M, limited to a minimum design metal temperature of -28 °C (-18 °F). Tensile test shall be performed and provided for review on each heat number. Alternate plate materials may be used but must meet the requirements of API 650 and must be approved by the Engineer.

- It is the responsibility of the Contractor to ensure that all materials selected are suitable for

  the service in which the tank is to be used. A complete material listing shall be submitted, with the tank design, to the Engineer for approval.
- Use of new materials that cannot be identified, or previously used materials, shall not be permitted.

Bolting

- ASTM A193 Grade B7 bolts shall be used.
- ASTM A194 Grade 2H nuts shall be used.

Gaskets

- ASME B16.5 flanges shall be raised face and use spiral wound SS gaskets.
- Gasket materials for non-ASME flanges shall be selected by utilizing the guidelines listed below: ○ No joint sealing compound, gasket adhesive, adhesive positioning tape, or lubricant shall be used on the sealing surfaces of gaskets.

Tank Bottom

- The minimum nominal thickness for bottom plates is 6 mm (1/4”), excluding corrosion allowance.

- The tank bottom shall slope down (estimated at 1% slope but to be determined during detailed engineering) from the center to a sump at the tank shell.
- The bottom plate, under the first shell course, shall be an annular butt-welded ring of 10 mm (3/8”) minimum thickness; to be confirmed during detailed design. It should be designed in accordance with API 650 and shall be of the same material specification as the first course of the shell.
- All attachments to the tank bottom shall have repads seal welded to the tank bottom.
- Anchor chair requirements shall be determined by the Contractor and comply with minimum requirements of API 650.
- Floor plates are to be overlapped in a manner to direct liquid to sumps.

Tank Roof

- A frangible joint at the roof-to-shell junction shall be provided for supported cone and selfsupporting cone roof designs.
- When a self-supporting dome or umbrella roof design is specified, emergency venting per API 2000 shall be provided.
- Minimum nominal roof plate thickness shall be 5 mm (3/16”), excluding corrosion allowance.
- If the data sheet stipulates internal coating of the roof, rafters (if used), shall be installed externally, seal welded to the roof plates and center columns shall be installed with all joints seal welded. In addition, the interior roof to top angle joint shall be grouted with a material compatible with the coating material, and in accordance with the coating manufacturers specifications.

Tank Shell

- The minimum shell plate thickness must be as per paragraph 5.6.1.1 of API 650, excluding corrosion allowance (if any).
- The 1-foot method for calculation of shell thickness shall be used for all tanks equal to or less than 61 m in diameter.
- Shell plate welds shall be full penetration double welded butt joints. No corrosion allowance shall be added, unless otherwise specified on the tank data sheet.
- Shell-to-Bottom welds for all welding processes shall be made using a minimum of two passes on each side of the shell plate.
- Dimensional tolerance per API 650 must be performed every 10m (maximum) in circumference, per course or as requested by site inspector.
- For tanks with self-supporting fixed roofs, it must be ensured that no part of the floating roof seal can come in contact with the fixed roof.

Fixed Roof Vents

- The tank must meet the venting requirements as stipulated in API 2000, Venting Atmospheric and Low-Pressure Storage Tanks.

Tank Nozzles and Appurtenances

- The standard size for a suction/fill nozzle shall be NPS 24. Multiple nozzles shall be specified, as required, to accommodate higher flow rates. Smaller sized suction/fill nozzles may be used for special nonstandard tank applications only. The maximum size for a nozzle shall not exceed NPS 24.
- Multiple suction/fill nozzles shall be orientated parallel to each other, with the exterior flange faces along a common plane and at a common centerline elevation.
- All suction/fill nozzles must be equipped with a DB&B ball valve.
- The minimum nozzle projections must be as per Table 5.6a and 5.6b of API 650.
- All internal downcomers and diffusers are to be made removable.
- Multiplane stress loadings imposed on the suction/fill nozzles by the tank line piping must be calculated for the time of installation and the point of maximum settlement. These loadings must be given to the tank manufacturer for verification of the tank nozzle and repad design.
- Minimum connection size shall be Outside Diameter (OD) 33.4mm (NPS 1).
- All tank nozzle connections shall be flanged. Flanges shall be ANSI 150, RFWN and shall meet the requirements of API Standard 650. Threaded connections and threaded fittings are not permitted.
- Shell nozzles larger than 60.3 mm OD (NPS 2) must have repads. All shell repads shall be attached to the tank by full penetration welds and the repad plate shall be of the same nominal composition as the tank part to which it is attached.
- Tell-tale holes (6 mm diameter) shall be provided as follows:
    - One hole in all single piece reinforcing pads. Where pads are split, each section shall have one hole.
    - Enclosed areas formed by welding supports to the shell. ○ The telltale holes in repads at nozzles and manways shall be plugged with a plastic sealant after testing.
- Roof nozzles larger than NPS 6 that are used as process connections shall be reinforced in accordance with figure 5-19 and table 5-14 of API 650.
- A minimum of four, 60.3mm OD (NPS 2), flanged sampling connections shall be installed in the shell at 100mm vertical intervals.
- The installation of a still well is required when using guided wave radar level transmitters.
- Process connections 33.4 mm OD (NPS 1) through 600 mm (NPS 24) shall be minimum 150 ANSI raised face flanged unless otherwise noted on the Tank datasheet.
- Process connections larger than 600 mm (NPS 24) shall be CSA Z245.1, PN 20, raised face flanged (equivalent to ASME B16.47 Series A, Class 150) unless otherwise noted on the Tank datasheet.

Manways

- A minimum of three 914 mm (36”) diameter manway openings shall be supplied near ground level in the shell.
- Shell manways should be equally spaced around the circumference of the tank.
- Handles for the manway door cover plates shall be provided.
- A minimum of one 914 mm (36”) square roof access opening shall be provided with other dimensions as per figure 5-16 of API 650. It shall be accessible from the working platform.

Overflow Piping

- Overflow piping shall be designed to prevent overfilling above the tanks net capacity.
- Overflow piping cannot be above stairs.

Grounding Lugs

- Grounding lugs shall be provided on all tanks and shall be located on the bottom shell course adjacent to the bottom ring. An electrical ground connection shall be provided for every 4 meters of tank height or diameter, whichever is greater, with a minimum of four (4) ground connections, 90^{o} apart. Bonding clips shall be installed adjacent to manways.

Wind Girder

- The wind girder (stiffening ring) is required to stiffen the tank as per API 650.
- A painter’s rail should be included, as part of the wind girder, to facilitate painting the tank exterior.
- The wind girder and support brackets shall be seal welded to the tank shell.
- Access to the wind girder should be via a radial stairway and/or upper platform.

Platforms, Stairs, and Ladders

The stairways, ladders, walkways, and platforms must be in accordance with WorkSafeBC procedures and policies.

- A platform complete with fall arrest, railings, kick plates and safety gate shall be installed at the top of the tank.
- Fall protection/fall restraint is required and the API 650 and OSHA codes shall be fulfilled.
- Due to the size of the tanks, a spiral stairway including the resting platform in the middle, can be considered, subject to comply with all codes and standards applicable..
- The platform should have two (2) stairways to allow access to the wind girder.
- The platform shall be located in closest proximity to the service road/access.
- Platform, stairway, and ladder clips must be supplied with repads to attach to tank shell.

- A lifting davit should be installed on the roof platform to facilitate lifting materials from the ground onto the platform or into the tank.
- No internal ladders are specified.

Surface Preparation and Coating

- Internal and external coating and surface preparation shall be in accordance with coating the Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers international (NACE)
- Hoarding is a requirement when blasting and painting the storage tank externals
- The internal surface of all oil storage tanks shall be seeded with canola oil during commissioning as specified by the Employer.

- Interior Tank Cleaning and Seeding Procedure
  - General Notes
    - After completion of hydrotest and emptying of the tank
    - All movement of larger equipment into the tank will be carried out through a roof panel
    - All work will be carried out to the Protective Coatings (SSPC) specifications
    - Safe disposal of material used is part of the work
    - Mill scale to be removed using power brushing
    - All interior surfaces will be treated (including the interior roof and nozzle openings)
    - Employer to supply canola oil for seeding. Canola oil grade to be used is Type I Crude Super Degummed (CSD)
    - The tank needs to be hydrotested as per API 650. It will not need any cleaning afterwards if the construction (fabrication and installation) has already been done according to API 650.
  - Procedure
    - Set up cleaning equipment
    - Clean with high pressure water to SSPC specification
    - Pump out excess water
    - Remove cleaning equipment and set up ventilation and humidity (40%) control equipment
    - Abrasive blasting to provide a low surface profile and product suitable for landfill disposal
    - Vendor to follow SSPC-SP12 / NACE 5 Surface Preparation and Cleaning Standard
    - Remove bulk spent abrasives from tank (vacuum)
    - Final blow-down and hand vacuum of abrasives
    - Remove blast equipment and install painting equipment
    - Spray painting with canola oil (nozzle size suitable for the viscosity), to provide complete coverage to surface profile but ignoring streaking

- Remove painting equipment.

Cathodic Protection

Refer to the Cathodic Protection API RP 651.

Nameplate

- The nameplate must be made and installed as per API 650.
- The nameplate must, at a minimum, include the following information.
  - Tag Number ○ Manufacturer ○ Applicable API code ○ Serial number ○ Year built
  - Nominal diameter and height ○ Bottom thickness and type ○ Shell thickness and material ○ Roof thickness
  - Design pressure, design vacuum, MDMT and maximum temperature
  - Nominal capacity and design liquid level

P2.20.1.4 Requirements and Design Criteria

The canola oil storage tanks shall be designed, manufactured, sealed, and certified in accordance with the latest editions of the following regulations, codes, standards and specifications. The design criteria shall follow all the applicable requirements as specified in API 650 unless clearly stated otherwise in this specification.

American Petroleum Institute (API)

- API Standard 650, Welded Steel Tanks for Oil Storage
- API 650 Welded Tanks for Oil Storage Data Sheet Template
- API Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks
- API RP 651, Cathodic Protection of Above-Ground Storage Tanks
- API RP 652, Linings of Above-Ground Petroleum Storage Tanks
- API RP 2003, Protection Against Ignitions Arising Out of Static, Lighting and Stray Currents

American Society for Testing and Materials (ASTM)

- ASTM A36/A36M, Standard Specification for Carbon Structural Steel

American Society of Mechanical Engineers (ASME)

- ASME Section V, Non-destructive Examination
- ASME Section IX, Welding and Brazing Qualifications

Canadian Standards Association (CSA)

- CSA Standard Z259.2.1, Fall Arresters, Vertical Lifelines and Rails

National Fire Protection Agency (NFPA)

- NFPA 30, Flammable and Combustible Liquids Code

Codes, Regulations and Directives

- Energy Resources Conservation Board (ERCB), British Columbia – Directive 064, Requirements and Procedures for Facilities.
- National Building Code of Canada (NBC)
- British Columbia Occupational Health and Safety Code, Part 8 – Entrances, Walkways, Stairways, and Ladders
- British Columbia Occupational Health and Safety Code, Part 9 – Fall Protection Plan

Process Industry Practices

- Process Industry Practices (PIP) STF05501 – Fixed Ladders and Cages
- Process Industry Practices (PIP) STF05520 – Pipe Railing for Walking and Working Surface Details
- PIP VESTA002, Atmospheric Storage Tank Specification (Supplement to API Standard 650)

P2.20.1.5 Design Method

To be proposed by the Contractor and submitted to the Engineer for approval.

P2.20.1.6 Workmanship

- All welding procedures must be approved prior to start of fabrication.
- All tank welding shall be performed in accordance with the requirements of API 650, Section IX of the ASME Code and the Welding specification. Welding shall be performed in a manner that ensures complete fusion with the base metal.

P2.20.1.7 Quality Control

The Contractor shall be responsible to ensure that the canola oil tank supplier:

- Provides a copy of all approved QC manuals, procedures, test reports, permits, certificates, and any other data that is pertinent to the products or services.
- Sub-vendors meet the inspection and testing requirements.
- Provides a minimum of two weeks' notice to the Engineer before conducting any off-site inspection or test that may require witnessing.
- Does not deviate from the Works requirements including the applicable API standard. The Contractor shall provide inspection and hold points as part of the relevant Inspection and Test Plan for approval by the Engineer that covers the full scope of the tank Works including but not limited to the tank fabrication, construction, hydrotest and commissioning.

Inspection

- The Engineer shall be notified a minimum of five (5) business days in advance for any holds and witness points on site and ten (10) business days in advance of holds and witness points off site.
- Shell plates shall be inspected at the vendors shop by an approved inspector. The material test reports must be made available to the inspector at the time of inspection.
- Manways, nozzles, and flush-type cleanout fittings shop welded into a tank plate or repad shall be inspected by the Engineer, or delegate, at the tank fabricators shop.
- Impact test results shall be provided to the Engineer.
- The mill test data (including specification, chemical and physical properties, and rolled plate dimensions) shall be forwarded to the Engineer no later than when the plate is shipped to the field. All plates and data reports shall be readily identifiable with matching heat numbers.
- The Contractor shall develop an Inspection Test Plan for approval by the buyer and shall carry out all inspections and tests required by this specification.
- Butt-welds shall be inspected using either the radiographic method or ultrasonic method. All welds shall be subject to visual inspection by the Engineer or delegate.
- The welding inspector must be certified with the Canadian Welding Bureau (CWB).
- Annular plate butt joints shall be 100 percent radiographed or magnetic particle inspected from the topside after completion of the root pass and again after completion of the full weld.
- All fillet welds shall be inspected visually. Fillet welds attaching nozzles and manways/cleanouts to the tank shell shall be inspected using magnetic particle or ultrasonic methods.
- Shell-to-Bottom welds shall be examined using either Magnetic Particle or Dye Penetrant as per section 7.2.4.1 of API 650.
- The Engineer reserves the right to have X-Ray films audited by third party inspection. Findings of third-party inspection will be binding to the Contractor.

- For weld joint examination, the Contractor shall follow Section 8 of API 650. For NDE application refer to Annex T.

Testing

- The shell shall be tested by Dye penetrant test as per API 650.
- All bottom plate joints shall be vacuum tested using soap suds solution, per API 650.
- All repads shall be tested with air and soapsuds. Air pressure shall be no less than 103.4 kPag (15 psig) as per API 650, paragraph 7.3.4.
- The tanks shall be hydrostatically tested by filling with water as per section 7.3.5 of API 650.
- Transfer of water between tanks shall be the responsibility of the Contractor including necessary pumps and equipment.
- The cost of any repairs or tank re-testing shall be borne by the Contractor.
- The Contractor is responsible for planning the acquisition and disposal of test water which may take an extended period for approvals related to the large water volume required and potential treatment prior to disposal.

Repairs

Any repairs shall be performed as per API 650.

P2.20.1.8 Monitoring

Tank Settlement Measurements

- Shell and bottom settlement measurements shall be obtained and retained after tank erection.
- Shell settlement measurements shall be made at 10m (maximum) intervals around the tank shell and at the following stages; ○ Prior to hydrostatic testing of the tank when the tank is empty. ○ At stages throughout the filling process as per API 650 ○ When the tank is full ○ Post hydrostatic testing of the tank when the tank is empty.
- Duration of test and hold points to be agreed with the Engineer prior to hydrotesting
- Bottom internal settlement measurements shall be made prior to and post hydrostatic testing.
- Measurements of nearby infrastructure, including but not limited to piping, containment walls, sumps etc. shall be made prior to and post hydrostatic testing. Locations to be proposed by the Contractor and approved by the Engineer. Any damage, remedial work or stress relief required to maintain the works in like new condition shall be the responsibility of the Contractor.
- The Employer will not provide water for hydro testing. Options to be considered:

- City of Surrey Water Filling Stations: https://www.surrey.ca/services-payments/waterdrainage- sewer/water/water-fill-stations ○ City of Surrey Fire Hydrant ○ Tie-in to City of Surrey Water Main
- Contractor to contact the City of Surrey Engineering Department. Fees and permits for these services are the responsibility of the DB Contractor

P2.20.1.9 Operator Controls

Locations and design of kiosks at Berth 10 and rail unloading yard to be determined by DB contractor. Kiosks to contain remote connectivity with control systems and lights and to provide shelter to operators.

P2.20.2 Rail Unloading, Marine Loading and Sump Pumps

P2.20.2.1 Work Scope

This section covers the minimum required for designing and specifying the rail unloading, marine loading and sump pumps. Detailed pump data sheets will be completed by the Contractor during the detailed engineering phase. The Contractor has to provide data sheets information as part of the detailed design. The details in the following sections define what is required as part of the data sheets.

P2.20.2.2 Materials and Structural Form

General

- Pumping liquid characteristics are to be specified in datasheets.
- Operating conditions are to be specified in datasheets.
- Pumps that spare each other shall be identical
- Net Present Suction Head (NPSH) margin shall be 1m minimum. A NPSH test is required for pumps with NPSH margin less than 1m.
- In addition, the maximum acceptable combined noise level of the pump, driver and auxiliaries shall not exceed 85 dBA measured at 1 meter (3 ft.).
- Electrical area classification shall be as specified on the datasheet.
- The pump unit shall be designed for outdoor and unheated installation. Pump and seal materials, elastomers, driver, and other accessories selected shall be suitable for continuous operation in ambient conditions specified for the location. The operation includes the expected start-up and shutdown conditions.

Pressure Casings

- Unless otherwise specified on the datasheet, components (seal chambers, suction parts, etc.) that are considered as part of pressure casing, shall be designed to Maximum Allowable Working Pressure (MAWP).

- Unless otherwise specified, the suction region of the pump shall be designed for the same pressure/temperature rating as the discharge region. The suction can of vertical can pumps shall be designed for maximum suction pressure unless specified otherwise.

Nozzles and Pressure Casing Connections

- Pumps shall have both suction and discharge flanges of equal rating. The minimum pressure rating for flanged connections shall be ASME Class 150RF (raised face).
- For nonflammable, nonhazardous, liquids below 120°C and/or 2700 kPag, threaded auxiliary connections to the pressure casing are acceptable.
- Cylindrical threaded connections shall not be used.
- Pipe nipples 150 mm or longer shall be gusseted to the pump. Gussets shall be fabricated from 38mm × 6mm steel bar stock (minimum) and attached by welding. Gusseting to the baseplate, seal gland or valve bodies is not acceptable. Gussets shall provide rigid support.
- Only socket weld connections on the casing shall be permitted for use as auxiliary instrument connections. No drilled and tapped pressure measurement connections shall be provided on suction and discharge end of the casings. Drilled and tapped openings in the suction or discharge volutes or other high velocity areas are not permitted.
- Pumps shall be preferably self-venting. All casing drains shall be valved terminating with a flange at the edge of the skid. Drain piping shall be compatible with the pump casing.
    - (s) Pipe nipples shall be a minimum schedule 160 seamless pipe and 150 mm (6”) long minimum for pipe sizes up to and including NPS 1.
- Canadian Registration Numbers (CRN) shall be provided for the province of BC.

External Nozzle Forces and Moments

- All pumps and baseplates shall be suitable for twice (2X) the values in Table 5 API 610. Allowable forces and moments for flanges larger than Table 5 shall be linearly extrapolated.

Rotors

- Cast iron impellers and/or wear rings applied at fluid temperatures above 200°C are not acceptable.
- Impellers shall be individually secured against axial movement in either direction.

Wear Rings and Running Clearances

- Renewable front and back case and impeller wear rings are required for all pumps.
- Renewable wear rings shall be held in place by tack welding.

Mechanical Shaft Seals

- Mechanical Seals and sealing systems shall comply with API 682 4th edition
- Seal chambers on vertical pumps shall be ventable through valved vent ports at the highest point in piping where vapours can accumulate.

Bearings and Bearing Housings

- Anti-friction bearings shall be clearly marked to show the ABMA bearing class. Also required will be shaft and housing fits. This information shall be shown on the pump drawings.
- When hydrodynamic thrust bearings are furnished, the thrust collar shall be replaceable and shall be positively locked to the shaft. Thrust bearings shall be designed for loading in both directions.
- Oilers, when used, shall be Trico-Optomatic type or approved equal made of glass with wire cage.
- Material for cooling coils and fittings shall be austenitic stainless steel.
- For all pumps, bearing housings, load-carrying bearing covers, brackets between the pump casing or head and the bearing housing and driver supports for vertical pumps shall be steel.
- A flat surface with provision for mounting a vibration transducer on bearing housing shall be provided. Vibration transducer may be machined, drilled, and tapped or magnetic mount and to be specified on the data sheets.

Lubrication

- A constant level oiler with visible level indication for non-pressure fed bearings shall be provided for each bearing oil reservoir.
- Tapped and plugged inlets/outlets, suitable for future installation of flood lubrication systems, shall be provided at each bearing case.
- If the bearing lubricating oil needs cooling, it shall be cooled with process fluid. Contractor shall provide all the necessary piping and accessories for this purpose.
- Grease lubricated pump bearings shall not be provided. If provided in special circumstances, the Employer or Engineers approval is required.

Materials

- Unless otherwise agreed by the Employer or Engineer, material requirements shall be S-4.

  Mechanical seal components and gland plate shall be 316 SS unless it is not compatible with service fluid.
- Chemical and mechanical data shall be furnished for all material that cannot be identified by ASTM, AISI, ASME, or SAE numbers.

- Plugs, spacers, inserts, etc. added to the pump casing, if applicable, shall be compatible with casing material specification and rating. If materials specified are not suitable for corrosiveness of the liquid pumped, Contractor shall propose suitable materials for Employer or Engineers review and approval.

Nameplates and Rotational Arrow

- The text on the nameplates shall be in the English Language and the data shall be in SI units. Additional minimum information required on nameplates:

  ○ Employers Process Tag Number ○ Year of manufacture
  ○ Minimum design metal temperature (MDMT) ○ Pump service

Drivers

- Driver(s) shall be supplied and mounted by Contractors Vendor, and shall normally be squirrel cage induction motors, unless otherwise indicated on the datasheet.
- Driver(s) that are mounted at the Contractors Vendor's shop shall not be doweled.

Couplings and Guards

- Coupling spacers shall be removed for shipment
- Non-lubricated flexible disc spacer type couplings are required. The manufacturer and type are listed in Table 20 below.

Table 20: Pump Coupling Requirements

Supplier(s)	Type	Horsepower Range
John Crane	Metastream TS or TL	All
Thomas	Series71	All
Kopflex	Flexible Disc	All

Note: For special applications, involving higher Horsepower, Speed, and Torque requirements, and/or high criticality services, the Contractor shall propose high performance couplings with special materials, balance, and testing requirements. These requirements shall be discussed and mutually agreed by the Contractor and the Employer or Engineer.

- Couplings shall be dynamically balanced to ISO 1940-1, grade G6.3
- Couplings shall meet the requirements of API 671
- Keys extending past the hubs shall be machined flush with the shaft.
- A service factor of at least 1.5 shall be applied to flexible element couplings.
- Contractor shall quote a standard non-spark coupling guard with the proposal.

Base Plates

- The rim or pan surrounding the whole baseplate shall slope down by at least 1 in 120 towards the pump end, with a tapped drain connection of at least NPS 2 size, shall be located on the left-hand side to effect complete drainage.
- Earthing (grounding) clips shall be provided on the base plate preferably at two corners diagonally opposite to each other.
- If possible, base plates shall be of sufficient size to accommodate a motor of the next larger horsepower than that installed on the pump for its rated condition.
- The machined mounting pad surfaces of a base plate shall not deviate in level by more than 0.17mm/m (0.002”/ft.), along each pad and from pad to pad in any direction.
- For pumps larger than 186 kW (250 HP), Contractors Vendor shall test to demonstrate that the pump and its base plate assembly are in compliance with 7.3.5 of API 610, 11th Edition.
- Transverse and axial alignment positioning screws shall be provided for drive train components weighing more than 200 kg. Alignment screws shall be arranged to allow changing of shim pack without removal of equipment.

Instrumentation

- Temperature gauges (thermometers) with set screw outside case for external calibration and zero setting are acceptable.
- Vibration monitoring requirements to be listed on datasheet.
- Temperature monitoring requirements to be listed on datasheet.

Inspection, Calibration and Testing General

- Inspection, Testing, NDE and Quality Surveillance requirements are to be specified in the datasheets and Inquiry / Purchase order documents

Inspection

- Details of all repairs and records of heat treatment as part of repair procedure shall be kept

  for pumps.
- All material shall be subject to inspection by the Engineer as specified in the material requisition. Inspection shall include: ○ Certificate of compliance showing complete conformance to the Employers material specifications, inspection, and test requirements, etc. ○ Verification of the equipment dimensions ○ Compliance with base plate machining tolerances ○ Examination of test data ○ Checking preparation for shipment ○ End float clearances ○ Coupling dimensions

Testing

- Contractor shall propose a performance test for witness and approval by the Employer or Engineer. ○ Typically, one unit of each model pump on a particular order will be witness test. Witness testing shall be agreed by the Contractor and the Employer. ○ An observed or certified NPSH test will be mandatory if the margin between NPSHA and NPSHR is 1m (3.28 ft.) or less. Performance if specified shall be witnessed by the Engineer.
- Pumps that exceed the capabilities of the Contractors vendor's test stand regarding capacity, HP, and speed, shall be tested under reduced conditions only with the approval from the Employer or Engineer. Reduced test conditions shall be included in the proposal.
- Substitute seals during performance testing shall require Employers approval.
- When two hard seal faces, e.g., tungsten carbide and silicon carbide (or any combination) are furnished, the Contractor shall ensure that seal damage shall not occur during shop testing on water. Contractor's proposal shall state the method to accomplish this.
- All pumps shall be operated for at least one hour at rated capacity.
- Certified test curves and data shall be submitted to the Employer or Engineer for approval prior to shipment. For a pump with variable speed operation, expected performance curves shall be provided within the operating envelope. Curves shall include the water performance for head and efficiency and the density and viscosity corrections for head, efficiency, power, NPSH.
- Vibration records shall be submitted with test results.
- Any rotor which requires trimming of an impeller shall be rebalanced.
- The required shop tests shall be specified on the Contractors pump datasheet.
- Separate four-hour mechanical run test is not required unless otherwise specified by the Engineer.
- NPSH will be determined at each test point except shutoff. In the case of any pump for which there is no certified NPSH test data on record, the Contractor shall perform an NPSH test at no charge. When the NPSH test is run at an RPM other than the quoted RPM, the Contractor's method of correlating test performance to actual performance shall be included in the proposal.

Preparation for Shipment

- Pump and baseplate shall be painted with the Contractors paint system.
- Seal chamber shall be protected from entry of foreign material. Mechanical seal assemblies shall be fully protected from rusting and entry of moisture and dirt.
- Each pump shall be properly identified as required by the Purchase Order. All miscellaneous parts shall be suitably boxed and shipped with the unit.
- Orifice plates shall be identified with pump item number and exact size of orifice plate.

- Material safety data Sheets (MSDSs') shall be included in the shipping documents, affixed to the outside of the shipment, for all the regulated substances (chemicals, coatings, oil, etc.). These MSDS's shall be forwarded to the receiving facility before shipment.

Contractor Pump Vendor's Data General

- A post award meeting shall be held with the Employer or Engineer.
- In addition to API 610, 11th Edition Annex L requirement and this specification, the drawing and data requirements of the Inquiry/PO shall apply.

Proposals

- Technical Data - shall contain the following additional data:
  - Wear ring running clearances and diameters of proposed pumps ○ Minimum corrosion allowance provided in the pump casing
  - Spare parts prices shall be included as a separate item. Pump vendor's proposal for spare parts shall include proposed method of protection from corrosion during shipment and subsequent storage
  - Pump vendor's proposal shall specify the maximum dynamic and static pressure ratings of the mechanical seal
  - NPSH margin

P2.20.3 Welding

P2.20.3.1 Work Scope

This specification covers the minimum requirements for welding processes, procedures, practices, materials, and equipment that satisfy ASME Section IX and includes supplementary requirements for specific applications/practices.

P2.20.3.2 Materials and Structural Form

General

- Contractor is responsible to ensure materials used for welding qualifications and production is in accordance with the governing documents and this specification.
- All material shall be supplied with the applicable certified Material Test Reports (MTR's) or, at least a Certificate of Compliance, for both welding qualifications and production welding and shall be included in the Manufacturing Data Report. The identification, control, and handling of base metal and welding material/consumables shall be an integral part of the Contractors QA/QC program/documents.

Base Metal

- Base metals shall comply with the applicable ASME and CSA codes, ASME Section II where applicable, and governing documents. Base metal shall be identified by P - Numbers and Group Number as defined in ASME Section IX Table QW-422 (where applicable) for welding qualification and production welding. Base material used for fit – up/alignment, runoff tabs, back - up bars, and temporary attachments welded to pressure-containing parts shall be of the same P-Number, (nominal) chemical composition, metallurgical structure, and the mechanical properties as the pressure part. Correction of a plate-edge deficiency by weld metal build-up is not permitted.

Welding Consumables

- The Contractor shall submit written procedures prescribing the receiving, handling, storage, and issue, etc. of filler metals and shielding gases for Employer approval. All manufacturers' recommendations shall be followed in the development of these procedures which shall conform to the quality program for pressure welding registered in the appropriate jurisdiction.
- Damaged, contaminated, or undesignated electrodes shall not be used in welding procedure qualification and production welding.
- The welding consumables shall be suitable for the application and in accordance with manufacturers' recommendations.

Filler Metals and Fluxes • All filler metals shall comply with Part C of ASME Section II and the applicable CSA standard or AWS equivalent.

- Filler metals used in post weld heat treated welds shall be designated so suitable by the manufacturer.
- Welding on pressure – boundary shall be performed with low – hydrogen welding processes and consumables. All filler metals shall have a maximum diffusible hydrogen content of 4 mL/100-gram weld metal. The re-dry of basic SMAW low hydrogen electrodes is not permitted.
- The atmospheric exposure times of basic low hydrogen electrodes shall be as per manufacturers' recommendations.
- The use of vac-packs for the preservation of SMAW low hydrogen electrodes is preferred.
- Filler metals designed for single-pass welding shall not be used for multi – pass welds.
- When joining similar metals, the deposited weld metal shall closely match the chemical composition and mechanical properties of the base metal. For attaching non – pressure parts, the filler metal shall match the nominal chemical composition of the pressure boundary material.
- Filler metals within the F1 and F2 groups and G classification shall not be used on pressure-retaining welds. Group F4 electrodes shall not be used for the root pass of groove welds that are not back-gouged.

- Welding consumables shall be stored under clean, dry conditions in their original unopened moisture- proof containers. Upon opening, low hydrogen electrodes shall be stored in heated storage areas at the welding location and under controlled temperature conditions recommended by the electrode or flux manufacturer. Immediately before using, low hydrogen covered electrodes shall be placed in heated quivers and used as required. Storage in open containers shall be at a temperature no lower than 75°C for a maximum of four hours.
- Submerged Arc Flux shall be stored in factory packaging until time of use. Flux from damaged packaging shall be dried in accordance with the flux manufacturer's recommendations (where considered usable).
- For pipe butt welds in ASME P-No: 1 Group Number 1 material, the root and second pass of single groove welds, regardless of base metal thickness, may be welded with cellulose-type coated electrodes. Additionally, ASME P-No: 1 Group Number 2 material, may have the root and hot pass welded with cellulose electrodes, provided a preheat of 300°F/149°C minimum is maintained until the joint is completed or a maximum ½" weld is deposited.

Shielding Gases

- Shielding gas shall be in accordance with ASME SFA 5.32/AWS A5.32. All shielding gas shall

  be supplied with a Certificate of Compliance from the supplier, stating as a minimum the nominal composition, including tolerances, purity, and the dew point.
- Shielding gas to be used shall be of welding quality with a -40°C dew point.
- Welding gases consisting of two or more components shall not be field - mixed in their own containers. Field- mixing from separate containers through a suitable and calibrated gas mixer is permitted. Mixture tolerance shall be as defined in AWS A5.32 Para.6, Tolerance of Mixtures/Table 3.
- The use of 100% CO_2 shielding gas for the GMAW process is not permitted.

P2.20.3.3 Welding Processes

General

- The following welding processes are permitted within their limitations as specified.

GMAW-S (Gas Metal Arc Welding – Short Circuit Arc)

- The process shall not be used for branch connections, nozzle-to-shell welds, or socket welds.
- GMAW-S may be used for root pass welding on piping with downhill welding progression in non-critical service only. Root pass welding with GMAW-S for other applications is permitted provided the root pass is completely removed from the back-side prior to back-welding.

- For vertical welding, the root pass and second pass progression for a material of any thickness may be either uphill or downhill.
- Variations of GMAW-S (waveform controlled) are limited to root passes and otherwise shall have the same limitations as outlined above. The use of GMAW-S variations without back purging is only permitted for carbon and low alloy steels up to 2.25% Cr (P-5A).
- GMAW-S shall only be permitted for back-welding (of a single-side joint) or repair welding for both cases where a GMAW-S root is used.

GMAW-P (Gas Metal Arc Welding – Pulsed Arc)

- GMAW – P may be used for any material thickness in any position. Welding shall be performed with the same make and model of welding equipment using the same program settings as those used in the procedure qualification.

  Note: The need to specify the make and model, program, equipment settings, and pulse waveform is based upon the effects these variables have on welding arc performance, especially sidewall fusion and out-of-position welding. Studies have shown considerable variation in arc characteristics when one make or model of welding system is compared to another. This variation can lead to welding defects, some of which may be very difficult to detect by radiography.

GMAW-ST (Gas Metal Arc Welding – Spray Transfer)

- Use of this process in the spray transfer current range/mode is based on welding with solid wire electrodes.
- Use of this process is not permitted for the root pass of open-root groove welds.
- Use of this process is limited to 1G rotated and 1G position welding as well as fillet welds 1F/2F.
- Otherwise, the limitations for GMAW-ST are as per those for the foregoing GMAW-S.

GMAW-M (Gas Metal Arc Welding – Metal Core)

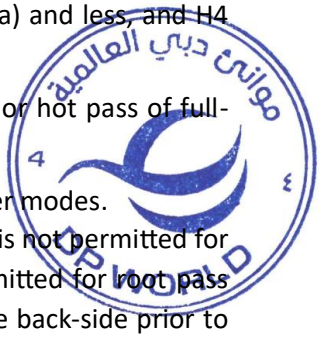
- Use of this process is subject to Employer approval.

FCAW (Flux-Cored Arc Welding)

- Self-shielding FCAW (FCAW-S) may be used only for welding carbon steel structural items and those not welded to pressure boundary. The following guidelines and restrictions apply: ○ Only those electrode types identified by the consumable manufacturer for multipass application are permitted. ○ Only those electrode classifications which have specified minimum impact test requirements are permitted. ○ FCAW-S shall not be used with other welding processes without qualifying the specific combination.
- FCAW with external gas shielding (FCAW-G) may be used for either groove or fillet welds (except vertical downhill progression) for pressure boundary or structural welding. The following guidelines and restrictions apply: ○ For procedures requiring either impact or hardness testing,

weld metal properties shall be reviewed with the consumable manufacturer to ensure the original qualified properties continue to be met. When rutile type (i.e., E71T-1) electrodes are used as-welded or in the post weld heat treated condition with impact testing required, the specific brand/trade name electrode and wire size used in production must be qualified in supporting PQRs with impact test results meeting the minimum design code requirements. ○ Welding consumables shall be limited to the ASME/AWS classification used in the PQR. Shielding gases shall comply with AWS A5.32.

- For welding pressure-containing equipment with wall thickness in excess of 3/8 in. (9.5 mm), the diffusible hydrogen limit designation for FCAW electrodes (as manufactured) shall be H16 for base metal tensile of 70 ksi (483 Mpa) and less, H8 to 85 ksi (587MPa) and less, and H4 otherwise.
- This process is not permitted for single-side root pass (without backing) or hot pass of full-penetration welds.
- This process shall not be applied in the short-circuit or globular arc transfer modes.
- Certified MTRs shall be submitted for FCAW consumables. ○ This process is not permitted for Category D nozzle to shell welds less than NPS 6. ○ This process is permitted for root pass welding of double-side joints provided the root pass is removed from the back-side prior to back-welding.
- This process is not permitted for welds in vibrating service. ○ Welding must be executed under wind-sheltered conditions.



SMAW (Shielded Metal Arc Welding)

- SMAW is permitted for all welding positions provided consumables manufacturers' recommendations for weld progression and position are strictly followed.

GTAW (Gas Tungsten Arc Welding)

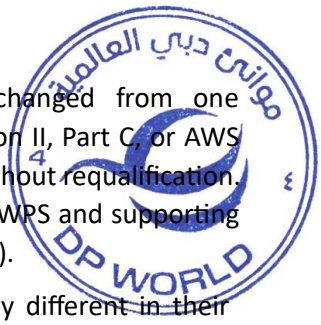
- GTAW is permitted for all welding positions except for downhill welding progression.
- GTAW is permitted for all passes within the qualified thickness range.
- Autogenous welding (where base metal is fused without the use of filler metal) is not permitted for pressure-retaining welds.
- GTAW power sources shall use inverter-based high-frequency (HF) arc starting technology where appropriate in providing a non-contact starting method. Scratch start is not permitted.
- GTAW root pass is the process of choice for heater coil/piping and for corrosive service piping otherwise.

GTAW-P (Gas Tungsten Arc Welding – Pulsed Arc)

- When used for root pass welding of single-side joints, welding shall be performed with the same make and model of equipment using the same program settings as those used in the procedure qualifications.

  Note: The need to specify the make and model, program, equipment settings, and pulse waveform is based upon the effects these variables have on welding arc performance, especially sidewall fusion and out-of-position welding. Studies have shown considerable variation in arc characteristics when one make or model of welding system is compared to another. This variation can lead to welding defects, some of which may be very difficult to detect by radiography.

SAW (Submerged Arc Welding)



- SAW procedures shall be requalified whenever the welding flux is changed from one manufacturer's trade name to another. Equivalence under ASME BPVC Section II, Part C, or AWS filler metal specifications shall not be considered adequate for substitution without requalification. The electrode and flux brand name combination shall be stated on both the WPS and supporting PQR (brand name and grade and flux shall be considered an essential variable).

  Note: It is recognized that fluxes having the same classification can be very different in their composition. However, nominal flux composition is not included in AWS or ASME specifications/codes, and flux suppliers do not normally provide this information. Differences among fluxes of the same classification can result in different and unanticipated weld properties when these fluxes are used interchangeably over the range of variables typically stated in weld procedure specifications.

- Manually held/semiautomatic SAW is not permitted for welding pressure-containing parts and shall not be used for repair welding.

- Passes are limited to 10 mm (3/8”) for base material less than 32 mm (1¼”) thickness and 13 mm (½”) for thickness 32 mm (1¼”) and greater.

- Removable starting and runoff tabs of sufficient length and of the same P-Number as the base material shall be used on all longitudinal seams.

- Where CVN impact and/or hardness requirements must be met, the use of active fluxes is not permitted. Neutral flux (non-voltage sensitive and non-alloying) is required and shall not contribute alloying elements to the weld.

- SAW procedures for carbon steel shall incorporate the wire and flux combinations recommended by their manufacturer and shall not result in manganese content in the weld greater that 1.60% nor silicon build-up in excess of 0.80%.

- Where SAW flux is recycled it shall be free of fused flux, slag, mill scale, dirt and any foreign matter. Manufacturer’s recycling procedure (re-sieve, clean, and rebake) is imposed before any flux reuse.

Reuse is limited to 10% recycled flux content to avoid the undesirable build-up of fines. Re-crushing of fused flux is not permitted.

- Electrode and flux combination designated for as-welded condition, (e.g., F7A2) shall not be used for a PWHT application. The converse also applies, combinations designated for PWHT conditions (e.g., F7P2) shall not be used in the as-welded condition.
- For single-side welds, SAW shall be used for only fill and cap passes. Where SAW is used for back-welding, the process shall be considered a double-side weld.

SW (Stud Welding on Pressure – Retaining Parts)

- Arc and resistance stud welding on pressure-retaining parts shall be qualified with the same base material thickness, or greater, as is used for production welding.
- The qualifying welds shall be made in the orientations described in ASME Section IX, QW-121 for plate and QW-122 for pipe (exclusive of QW-122.1 addressing rolled pipe during welding). The stud shall be perpendicular to the surface of plate or pipe in all cases.
- Preheat for this process must satisfy the requirements of the WPS as well as this standard.
- Automatically timed arc and resistance welding of load-carrying studs shall conform to ASME Section VIII, Div.1 Paras. UW-27, 28, and 29. A pre-production test of at least five consecutive welds shall be performed at shift start or following any welding equipment maintenance. Performance is voltage sensitive and could be adversely affected over shift duration with increased power draw otherwise.
- Similarly, non-load-carrying attachments such as external heat transfer surfaces or insulation pins shall be qualified on similar chemical composition materials as the production welding. Pre-production testing is required as for the foregoing load-carrying studs.
- Production welds shall be hammer-tested in accordance with ASME Section IX, QW-192.
- Acceptance of joints with less than 100% fusion requires Employer or Engineer approval.

Orbital/Mechanized Welding

- Joint geometry shall be described in detail on both the WPS and the PQR.
- PQR development must use the proposed/stated orbital or mechanized welding system and shall record all welding variables in accordance with ASME Section IX and this standard.

P2.20.3.4 Welding Procedure Qualification

General

- The Contractor is responsible for the qualification of all welding procedures as well as their conformance to applicable codes such as ASME Section IX.
- Welding procedures and supporting procedure qualification records shall be appropriately registered with Technical Safety BC.

- The use of Standard Welding Procedure Specifications (refer ASME Section IX, Article V) is not permitted. Procedure Qualifications by Others (refer ASME B31.3 Para. 328.2.2 and ASME B31.1, Para. 127.5.3 (A)) is not permitted.

Welding Procedure Specifications (WPS)

- Welding procedures shall be developed and qualified in accordance with ASME Section IX and shall contain, at a minimum, the following information: ○ Welding process (Processes shall not be added or removed from the procedure). ○ Welding position and direction. ○ Standard, grade, composition, or CE (carbon equivalent) where appropriate and any deviations of materials.
    - Nominal thickness and diameter.
    - Joint or groove design sketches with data for bevel angle, land size, root gap, and symbology etc.
    - Welding consumables and filler materials specified by 'F' number, 'A' number, SFA number, and AWS classification. Fluxes shall be identified by manufacturer and flux designation/ trade name.
    - Number of passes (range), welding technique, stringer weave, and weave width (range). ○ Voltage, amperage, type of current, polarity, travel speed, and heat input (range). ○ Preheat and interpass temperature range and monitored as addressed in the applicable Code of construction. ○ Post weld heat treatment temperature range including procedure used and including aggregate time and hold temperatures as well as heating/cooling rates.
    - Non-consumable electrode type. ○ Arc initiation device. ○ Composition and flow rate range of shielding and purging gases, gas cup size, use of diffuser lenses, and use of trailing purge. ○ Special requirements such as constant potential power sources, pulse setting, wire feed/oscillation rate, and electrode stick-out, etc.
- All essential, supplementary essential and nonessential variables shall be addressed for each applicable weld process. Essential variables are those in which the described change is considered to affect the mechanical properties of the weldment and therefore requires requalification of the WPS (refer QW-250). Supplementary essential variables are required for metals where CVN testing is specified and are additional to the essential variables for each process. Nonessential variables are those in which the change described in the specific variable may be made in the WPS without requalification. Additionally, the procedures shall address the following requirements: ○ Use of backing rings which remain in place is not permitted;
    - Use of consumable inserts, commercially available or by means of welding rod substitution, is not permitted; and
    - Maximum thickness of plain cut/unbeveled joints is 3 mm for single-side welds and 6 mm for double-side welds.

Welding Procedure Qualification Record (PQR)

- The PQR shall be a record of the weld process, base metals, welding consumables, welding parameters, essential and supplementary essential variables, heat treatment, examinations, and test results all in accordance with a Employer-approved Contractor QA/QC program. The PQR shall be representative of the production weld sequence and shall demonstrate that welds meet the required mechanical properties. Root pass substitution by means of PQR combination shall not be permitted. Recording/measuring equipment shall be calibrated, in good working condition, with records available for review by Employer. Digital recording of welding parameters shall produce printouts as a permanent record.
- Change in progression from that qualified in the PQR is only permitted where it otherwise conforms to ASME Section IX, QW-250 and Article IV.
- Weldments subject to single or multiple heat treatments during manufacture and subsequent assembly shall require qualification duplicating the heat treatment cycle.
- For those welding procedures incorporating PWHT, the PQRs shall include sufficient hold times to qualify at least one post weld heat treated repair weld consistent with the applicable Code of construction.
- Regardless of material impact test exemptions permitted by the applicable Code of construction, weld procedure qualification testing must include impact tests of the weld and HAZ of all materials.
- Test specimen selection and number of tests shall be conducted in accordance with SA-370, Charpy V-notch impact test (CVN).
- Charpy impact tests shall be conducted at the minimum metal temperature, or lower, as specified on the equipment data sheet and shall meet or exceed the specified energy absorption values. Other acceptance criteria, such as lateral expansion considerations may be specified for high strength material by the applicable Code of construction.
- When joining base metals having different notch toughness requirements, the weld metal shall meet the more stringent requirement (no less than the equivalent matching base metal) and each heat affected zone shall meet the requirement of the adjacent base metal.
- All welding procedures shall be qualified by hardness testing in base metal, weld metal, and HAZ.

Essential Variables

- A change in essential variables outside their qualified range, dictates that the WPS be requalified. The significant amount of detail is defined in ASME Section IX, Articles II, III, and IV which cover the various welding processes under QW-250, welder and welding operator performance by welding process under QW-300, and the change of a welding condition which will affect the mechanical properties of the weldment under QW-400, also by welding process.

Repair Welding

- The weld repair WPS shall provide all the relevant information required for repair welding and shall be compatible with the process used for the original weld where the same process cannot be used.
- At least one repair procedure shall be qualified for all-position welding.
- Repairs shall have NDE performed using the method by which the initial defect was disclosed.
- All weld repairs shall be documented.

P2.20.3.5 Non-destructive Examination of WPQs

General

- All procedure qualification welds shall pass 100% visual examination prior to any NDE (RT, UT, and MT) on the full weld circumference or length.

P2.20.3.6 Mechanical Testing of WPQs

General

- The Contractor is responsible to ensure all required testing conforms to ASME Section IX and the applicable ASME code.
- All mechanical testing shall be performed by an independent accredited laboratory approved by Employer.
- The Contractor shall provide sufficient weld coupons produced by the relevant WPS to be qualified to provide sufficient material for the required tests as well as any possible re-tests.

Tensile Testing

- Tensile properties of the weld shall in no case be less than the minimum specified properties of the base metal. Tensile and Bend tests shall be performed on specimens prepared, positioned, and accepted in accordance with Part QW, Article I and II. These tests must include all weld processes. Round bar specimens are not permitted where the root pass is excluded.

Impact Testing

- Impact testing in accordance with ASTM E23 shall be performed on all WPS used in production welds except for single-pass welds, branch connections, and fillet welds.
- Testing must include all welding processes and shall be performed on those coupons with the highest recorded heat input. Where high heat inputs are developed more than 10 mm away from the root of multi-pass welds, a second set of impacts shall be taken.

- The minimum required absorbed energy at the specified MDMT shall meet the specified requirements. Other acceptance criteria, such as lateral expansion considerations may be specified by the applicable Code of construction.
- Where a test specimen fails, two additional sets from the same weld location are required to meet the average value specified.
- Full-size specimens shall be used where available. The results interpretation using sub-size specimens shall be in accordance with the applicable ASME code.

Welder and Welding Operator Qualifications

- All welders and welding operators shall be holders of valid pressure welding certificates and shall be tested and qualified in accordance with ASME Section IX and the regulatory requirements of the local jurisdiction.
- In the event that differing material groups are to be welded, or when special welding procedures are to be adopted to meet unusual conditions, the welder shall be required to satisfactorily pass additional qualification tests as directed by the Employer.
- The Contractor shall maintain file records of the welder or welding operator unique identifier and his performance qualification results/records.
- The facility or site where the qualifications are performed shall be under the operational, technical, and quality assessment control of the Contractor.

P2.20.3.7 Production Welding

General

- The Contractor is responsible that preparations and production welding activities are fully qualified, Employer-approved, and in accordance with the governing documents and applicable codes.
- Production welding shall commence only after the fit-up has been subjected to VT and all applicable requirements are satisfied.
- Welding under conditions that could impair the weld quality or those that jeopardize the safety of personnel such as field welding under extreme low temperatures, adverse weather (wind, rain, snow, frost, wind-driven sand, etc.) shall be avoided.

Weld Joint Preparation

- Preparation of plate edges and other components may be by mechanical means such as machining, chipping, grinding, or thermal cutting/ grinding. Thermal processes should be avoided for Quenched/Tempered (Q&T) and Thermo-Mechanical Control Process (TMCP) materials.
- Slag and other detrimental/discolored material shall be removed by mechanical means.

- Welding surface shall be free of moisture, dirt/grit, oils, grease, paint, mill scale/varnish, rust/oxides, acid and foreign material within 50 mm of weld toe which could adversely affect weld quality.
- Bevel preparation must be in accordance with the WPS, shall be cleaned to bright metal, and shall be smooth, uniform, and free from detrimental defects.
- Plate preps and nozzle cut-outs in material thickness in excess of 19 mm shall be checked for linear discontinuities/laminations by MT & UT. All preps shall be subjected to VT.
- Where materials of unequal thickness are joined and the internal/ external offsets permitted by the applicable code are exceeded, excess thickness of the heavier material shall be machined or ground back from the bevel on a 1 to 4 taper. Care must be exercised to ensure remaining thickness is no less than minimum allowable including corrosion allowance.
- Category D nozzle attachment welds to pressure boundary shall be complete penetration.
- Single-pass welds are not permitted on pressure-containing fittings such as socket and slip-on joints.
- Line-up clamps shall be used for pipe joints where practical.
- The angular offset of maximum 3° between jointed parts specified in ASME B31.3 Para. 328.4.2 (b)(6) requires prior Employer approval. In no case shall a mitered connection be permitted for joint correction.
- Hammering on pipe that would result in observed pipe damage during fit-up/alignment is not permitted.
- Pipe heating for the correction of misalignment is not permitted.
- Correction of misalignment or excessive root gap by weld build-up is not permitted.
- Pipe girth weld toe minimum spacing shall be the greater of 2 pipe OD's or 300 mm except where prohibited by piping physical design and shall be Employer approved. Where the specified separation is not achieved, such adjacent welds shall be RT and/or UT examined if not so examined otherwise.
- The minimum weld toe spacing of girth to branch connection or its repad fillet shall be the greater of 5 times base metal thickness or 75 mm.
- The minimum weld toe spacing of longitudinal to branch connection or its repad shall be the greater of 5 times base metal thickness or 100 mm.
- The minimum toe spacing of adjacent fillets otherwise shall be the greater of 5 times base metal thickness or 100 mm.
- Pipe with longitudinal seams or of spiral-weld manufacture shall be joined with a minimum 30°seam stagger across the butt weld.

- Pipe longitudinal seams shall be positioned in the top quadrant of the circumference.

Welding Details

- All pressure welding shall be performed in accordance with an approved and qualified welding procedure.
- Each weld shall be uniform in width and size throughout its full length.
- Each layer of welding shall be smooth and free of slag, cracks, pinholes, undercuts (internal and external), lack of fusion, burn-throughs, porosity, hollow bead, excessive beads, and concave beads and shall be completely fused to the adjacent weld beads and base metal. Stop/start locations of subsequent weld passes shall be staggered to avoid through-wall continuation of button defects or microstructure irregularities.
- The cover pass shall be free of coarse ripples, irregular surface, non-uniform pattern, high crown, and deep ridges or valleys.
- Butt welds shall be slightly convex, of uniform height, and have full penetration, unless otherwise approved.
- For piping, limitations on weld reinforcement shall apply to the internal surfaces as well as to the external.
- Fillet welds shall be of a specified size with full throat and the legs of uniform length.
- Arcs must be struck only in weld areas. A close arc must be maintained while welding.
- After each pass, the layer of weld metal must be cleaned to remove all slag, scale, dirt, grease, and paint. Use wire brushes, grinder, or chipping hammer as needed to prepare proper surface for succeeding pass. Flame gouging is not permitted.
- Repair, chipping, or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the base metal thickness.
- No welding shall be done if the temperature of the base metal is not at least 15°C nor shall there be any welding done if there is moisture, grease, or any foreign matter on the joint to be welded. Where coincident ambient temperatures are below 0°C, additional measures shall be employed to avoid rapid cooling. These could include elevated preheat, insulation wrapping, coil or resistance pad heating, and hoarding, etc.

P2.20.3.8 Welding Technique

Horizontal Fixed Welds

- When shielded metal arc welds are made with the pipe in the horizontal fixed position, the first pass or stringer bead shall be deposited by the "uphill" method of welding. All subsequent passes shall be deposited by the "uphill" method of welding.

- The "downhill" method of welding for all passes may be used depending on the requirements of the local jurisdiction.
- Oxy-acetylene welds on pipe in the horizontal fixed position shall be deposited uphill by either the forehand or backhand technique. The welder shall use the same technique in production as used in the qualification test.

Vertical Welds

- When shielded metal arc welds are made with the pipe in an approximately vertical position, weld metal shall be deposited by the “uphill” method of welding.
- The “downhill” method of welding for all passes may be used depending on the requirements of the local jurisdiction.
- All oxy-acetylene welds on pipe in the vertical position shall be made by the backhand technique.
- Refer to QW-460 for the graphics defining the many alternatives of the foregoing categories.

Fillet Welds

- When slip-on flanges are attached to pipe by welding and the weld is required to be made in either rolled or fixed positions, the inside weld shall be made first, followed by the weld at the reverse or back side of the flange.
- When coupling and socket weld type fittings are attached to piping, the weld size shall be 1.4 "T" where "T" is the nominal pipe wall thickness.
- All fillet welds shall be slightly concave and the length of each leg approximately equal.
- Fillet welds attaching supports and other non-pressure attachments shall not exceed 9.5 mm (3/8") weld size for attaching plates up to 19 mm (3/4") thick. For attaching plates greater than 19 mm (3/4") thick, weld metal shall be 1/2 T minimum. All fillet welds shall be multi-pass. The first pass may be cellulosic to ensure adequate penetration.

Treatment of Underside Welds

- Excessive inside reinforcement of the root pass shall be removed by grinding where accessible.

Cleaning

- All rough irregularities in the cover pass and weld spatter shall be removed upon weld completion. Grinding or filing clean-up of welds shall not result in wall thickness reduction. Grinding or filing to remove undercut is not permitted.

Marking

- Each finished weld shall be clearly marked on the outside of the vessel or piping to identify the portion made by each welder. The stamp shall be on the weld button, not on the vessel or piping directly. Low stress stamps shall only be applied to the outside of the vessel.

P2.20.3.9 Thermal Control

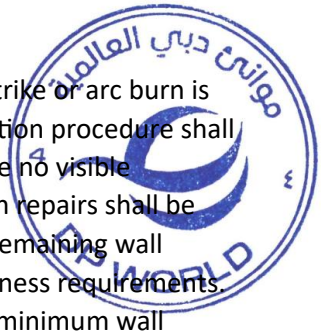
Preheat

- Preheat for pressure vessels shall be as recommended in the Code Para PW-38 of ASME Section I or Appendix R of ASME Section VIII.
- Preheat for pressure piping and furnace tubes shall be in accordance with ASME B31.3.
- In addition to governing Code requirements, carbon steel pipe having a wall thickness greater than 9.5 mm (⅜") shall be preheated to 150°C (302°F) prior to welding when the ambient temperature is less than 4.5°C (40°F).
- Preheating shall be done with an approved torch system or with electrical equipment which will provide uniform heating.
- The Contractor shall inspect electrical blankets prior to each use. If the blanket shows any sign of wear which could impair its proper operation or otherwise ground-out, it shall be discarded immediately.
- Electrical sources for heating blankets shall be protected by a GFCI breaker (ground-fault circuit interrupter).
- The preheat area shall be at least 203.2 mm (8") wide, where possible, centered about the weld, and shall extend around the entire circumference of the pipe.
- Preheat temperatures shall be checked with temperature sensitive crayons, such as “Tempilstik", or by other approved methods.

Repair Welds

- Repair welds shall be made using a written repair scope that has been reviewed and accepted by the Employer prior to repair commencement. The procedure shall state, as a minimum, the following information:

- Means of excavating defects from the weld area;
- NDE methods used to verify complete defect removal before repair; ○ Welding procedures to be used for weld repair;
- Any special repair welding controls relating to preheat temperature, interpass temperature, preheat maintenance, low hydrogen properties, welding electrical characteristics, and any dehydrogenation heat treatment/bakeout (DHT) or intermediate stress relieving (ISR) requirements; and
- NDE methods used to verify satisfactory completion of the repair.



- Arc strikes and burns on pressure boundary are not permitted. When an arc strike or arc burn is removed by grinding, sanding, or filing, a suitable etching reagent and application procedure shall be used to verify complete removal. After etching of the surface, there shall be no visible difference between parent material and the area of the strike. Arc strikes/burn repairs shall be wet MT examined for the detection of any associated unpermitted cracking. Remaining wall thickness shall be UT measured to verify compliance with minimum wall thickness requirements. Corrosion allowance shall not be considered part of the grinding tolerance. If minimum wall thickness requirements are not satisfied, the affected component shall be removed and replaced, or the weld repaired using a qualified WPS with Employer approval, as indicated in Employer's construction specification and Arc Strike repair procedures.

P2.20.3.10 Quality Control

General

- Prior to start of fabrication Contractor shall supply an Inspection & Test Plan (ITP), which will detail the steps for procurement, receiving materials, fabrication, PWHT, and testing. The Employer shall review the ITP to identify witness and hold points.
- Nondestructive examination shall be in accordance with ASME Section V and shall meet the stipulations of applicable ASME Codes and Employer purchase documents. The Contractor shall make available the quality assurance data, material certificates, test certificates, welding procedure specifications, and welding procedure qualification records and all other documentation deemed necessary to carry out inspection.
- Nondestructive examinations shall be performed by qualified personnel.

Accessibility

- The Employer requires unrestricted access to all facilities where the work scope, fabrication, and testing are carried out.

P2.20.3.11 Inspection and Non-destructive Examination (NDE)

Visual Examination (VT)

- Visual examination shall be performed in accordance with ASME BPV Section V, Article 9 to the parameters/requirements of the applicable Code of construction/local jurisdiction all as set out in the Employer-approved Contractor's written procedure.

Radiographic Examination (RT)

- Radiographic examination of welded joints shall be performed to the extent specified in the equipment data sheets.
- Radiographic examination procedures shall be in accordance with Code Section V, Article I and Section VIII, Division 1.
- All radiographs taken during fabrication shall be available for review/examination.
- Where nozzles and manways necks are fabricated from rolled plate, the longitudinal seam weld shall be 100% RT.
- Where spot radiography has been specified, all joint intersections shall be radiographed, and one additional spot shall be radiographed in each longitudinal and circumferential seam.
- For unfired steam drums, nozzle-to-vessel weld shall also be radiographed. Fine grain film shall be placed to cover the entire periphery of nozzle-to-vessel attachment weld area. Areas where radiographic interpretation is questionable owing to weld configuration shall be UT examined where such examination provides meaningful interpretation.
- Inspection personnel performing and evaluating radiographic examinations shall be qualified to a minimum of Level II in accordance with SNT-TC-1A or CAN/CGSB-48.9712.
- The buried canola oil pipe must be 100% x-rayed and then hydrotested in place to ASME B31.3.

Ultrasonic Examination (UT)

- Ultrasonic examination procedures shall be in accordance with ASME VIII - Division 1, Appendix 12.
- Where full radiography of nozzle attachment welds is specified on equipment data sheet and radiographic interpretation is questionable owing to weld configuration, such areas shall be UT examined.
- When nozzles require ultrasonic examination, weldment shall be examined prior to fitting the reinforcement pad.

- Inspection personnel performing and evaluating radiographic and/or ultrasonic examinations shall be qualified to a minimum of Level II in accordance with SNT-TC-1A or CAN/CGSB48.9712.

Magnetic Particle and Liquid Penetrant Examination (MT and PT)

- Magnetic particle examination procedure shall be in accordance with ASME Section V, Article 7 and shall comply with jurisdictional requirements.
- The evaluation of indications and acceptance criteria for magnetic particle examination shall be in accordance with the ASME Section VIII, Division 1, Appendix 6 and the applicable Code of construction.
- Where magnetic particle examination is called, and material is not magnetic, liquid penetrant examination shall be substituted.
- Liquid penetrant examination procedure shall be in accordance with ASME Section V, Article 6 and shall comply with jurisdictional requirements.
- The evaluation of indications and the acceptance criteria for liquid penetrant examination shall be in accordance with ASME Section VIII, Division I, Appendix 8 and the applicable Code of construction.
- The maximum acceptable levels· by weight of Halogen and Sulphur are as follows:

  o Water Soluble Dye Halogen 0.08% Sulphur o Developer Halogen 0.07% Sulphur 0.011 % o Chemical Cleaner Halogen 0.05% Sulphur 0.06%

- All finished pressure welds in vessels designed with full radiography, shall be examined by magnetic particle or liquid penetrant methods after PWHT.
- All Category D welds shall be subject to magnetic particle examination at the root and on the finished surfaces.
- External and internal attachments welds shall be examined by magnetic particle or liquid penetrant methods after PWHT.
- When magnetic particle examination is required, the DC/AC yoke or permanent magnet method shall be used prior to PWHT while the AC yoke method shall be used after PWHT.
- The skirt to shell weld shall be examined by magnetic particle or liquid penetrant methods for the full circumference.

Weld Identification and Traceability

- NDE reports shall be complete, accurate, and legible and shall contain the weld/item number, unique identifier of welder/welding operator, WPS, PWHT where applicable, the NDE equipment and materials used, and the location, type, and size of recordable imperfections.

- All NDE reports shall be checked and signed by a Level III inspector.

P2.20.3.12 Standards of Acceptability for Pressure Piping

General

- These standards of acceptability apply to pipe welds based on the ASME B31.3. The Employer may use any method of inspection necessary to establish/confirm quality control and ensure adherence to welding procedures as well as require repairs and re-welds where deemed unacceptable.
- In those cases where the Employer specifies 100% radiographic examination of less than 15% of welds, interpretation shall be in accordance with the Random or Spot Radiography requirements as set out in ASME B31.3.

Weld Defects and Repairs

- All repairs shall be treated in the same manner as an original weld. Preheat to 150°C (302°F) is mandatory and weld joint must be insulated after repair if ambient temperature is below 10°C (50°F).

Defects as defined in the applicable Code of construction and the following:

- Cracks: Pipe welds containing cracks shall be cut out and replaced.
- Lack of penetration: These defects shall not exceed 0.8 mm (1/32") in depth, the total length shall not exceed 38 mm (1½ ") and individual defects shall be separated by 152 mm (6") of sound weld metal.

Undercutting

- Undercutting adjacent to the root bead shall not exceed 0.8 mm (1/32") in depth and shall not exceed 38 mm (1½ ") in length. Individual defects shall be separated by 152 mm (6") of sound weld metal.

Slag Inclusions

- Slag inclusions within the weld metal shall not exceed 3 times the pipe wall thickness in length and shall not exceed 1.6 mm (1/16") in depth and width. Individual defects shall be separated by 152 mm (6") of sound weld metal.

Porosity

- Acceptable limits of porosity for welds in sweet service shall be in accordance with ASME B31.3.

Repairs

- All repairs shall be radiographed, and the film shall accompany the original X-ray film as proof that repair has been made.

P2.20.4 Min Requirements ID Buried Pipe and Cables Guideline

P2.20.4.1 Pipeline Identification Requirements

Pipeline Warning Requirements

- A pipeline warning sign is required for the railway crossings. A warning sign must be on both sides of the crossing.
- When installing a warning sign, it must face the railway.

Installation Requirements

- The installation of pipeline warning signs must adhere to the strict guidelines listed below: ○ All warning signs must be installed before the pipeline is in operation.
  ○ If a fence exists, the warning signs cannot be installed more than 300 millimeters from the fence line.

○ Warning signs should be installed in an area that is not obscured by brush or other objects. ○ Warning signs must be independent and free-standing. They cannot be attached to any other structures except fencing surrounding the licensee's facilities.

P2.20.5 Coatings and Paint Colours Specification

P2.20.5.1 Work Scope

General

- Contractor is fully responsible for the quality of their work and shall deliver blasting and coating application logbooks, and internal inspection records.
- The Contractor shall ensure that the volatile organic compound (VOC) content of coatings shall not exceed the maximum levels specified in current National, BC or local government regulations.
- The following requirements shall be included as part of, but not limited to, the Contractor's responsibilities unless otherwise noted on the purchase order; ○ Observance of Employer and site's safety requirements, as applicable; ○ Supply of all labor along with documentation of their current qualifications; ○ Supply of all coating materials and cleaning fluids; ○ Supply of all abrasive blasting equipment and abrasive media; ○ Provision of Manufacturer's documents including products and safety data sheets; ○ Supply of necessary air compressors, hoses and coating application

equipment; ○ Supply of necessary scaffold or other lifting devices necessary to carry out the work in a safe manner;

- ○ Supply of all quality assurance testing equipment required to implement the Inspection and Test Plan (ITP);
- ○ Supply of all energy (i.e. fuels, electricity) for application equipment such as compressors, heaters, dehumidifiers;
- ○ Clean-up, removal and legal disposal of blasting grit, splatter, all coating materials, all surplus materials, containers and protective devices, and discarded containers and equipment supplied during the contract; ○ Disposal of any spent blasting material.

P2.20.5.2 Materials

General

- Materials shall be stored, mixed, thinned, applied, and cured in strict accordance with the Manufacturer's recommendations and procedures. Therefore, these are considered to be an integral part of this Standard and shall take precedence over requirements specified in this Standard.
- For all coating work performed on Employer's facilities; coatings, solvents, thinners, and surface preparation materials brought onto the project site shall be pre-approved by the Employer or facility Industrial Hygienist. The following documents shall be submitted to the Employer or Engineer for approval:
  - ○ Safety Data Sheet (SDS) ○ Product technical data sheet (TDS)
  - ○ WHIMIS labeling requirements
- For coating work off-site, applicable industrial hygiene standards shall be followed.
- All coatings, thinners, solvents, and cleaners shall be supplied by the same Manufacturer.
- All coatings, thinners, solvents, and cleaners shall be delivered to the project site in their originally sealed, identified, and undamaged Manufacturer's containers.
- No material that has exceeded its shelf life recommended by the Manufacturer shall be used.
- All material shall be stored in a clean, dry, shaded, and well-ventilated area in compliance with the Employers, National, BC, and local government or applicable environmental and safety regulations. Highly flammable or toxic solvents, i.e., chlorinated hydrocarbons, benzene (benzol), toluene (toluol), xylene (xylol), or gasoline shall not be used for cleaning. The storage area shall be protected from sparks, open flames, direct sunlight, and temperature extremes. Outdoor storage of material is unacceptable.
- Materials shall not contain hazardous chlorofluorocarbon (CFC) and lead chromate that cause air, soil, and water pollution.
- Coatings shall be power mixed in accordance with the Manufacturer's mixing procedure.

- Components shall be mixed at the specified ratio and after mixing allowed the specified induction (setting) time specified prior to application. The coating shall be applied within the prescribed working pot lifetimes for the temperature conditions prevalent at the job site, as specified in the Manufacturer's product data sheet.
- Use of thinners shall be per the Manufacturer's recommendations. Addition of thinner that is outside the specified levels of the Manufacturer shall require written approval of the Manufacturer.

P2.20.5.3 Surface Preparation

General

- Prior to surface preparation the Contractor shall inspect all surfaces. Surfaces shall be cleaned of all welding flux, splatter, lamination, and mill scale not removed during fabrication. Hand or power tools shall be used to remove protrusions, smooth edges, and provide flush, uniform surfaces. Special care shall be taken that corners, inside surfaces, weld seams or other limited access areas, are prepared to the same standards as the main body of the surface. Sharp edges shall be ground to a minimum smooth radius of 1/8" (3.2 mm).
- Dry abrasive blasting shall be the preferred method. Where abrasive blasting is impractical, impossible or unsafe; alternate procedures using power and hand tool cleaning, or water blasting in accordance with SSPC-SP 2 or SSPC-SP 3, SSPC-SP 11, SSPC-SP12SSPC-SP WJ1, SSPC-SP WJ2, SSPC-SP WJ3, and SSPC-SP WJ4 shall be proposed by the Contractor and shall require the prior written approval of the Employer.
- Abrasives used for surface preparation shall be free of dust, dirt and contaminants and shall be kept dry at all times and shall not be recycled.
- The use of silica sand abrasives or abrasives containing silica shall not be permitted.
- Mineral and slag abrasives shall conform to SSPC-AB 1, Type II, Class A, Grades 1 to 5. Steel, iron, or copper slag abrasives shall not be used on stainless steels, Alloy 20 or any nickel-based alloy material.
- The compressed air supply for abrasive blast cleaning and spray paint equipment shall be equipped with suitable oil and water separators that drain continuously. During blasting or painting air supply shall be blotter tested in accordance with ASTM D4285 at the start of each shift and a minimum of every four hours. No traces of oil or water shall be allowed in the air supply. Where contamination is detected, it may result in removal and replacement of paint applied since the previous successful test.
- Total soluble salts contamination of Chlorides, Nitrates, and Sulfates, after abrasive blasting shall not exceed levels recommended by the coating manufacturers. If required levels are not achieved, the substrate shall be repeatedly washed with potable water or Employer Coating SME approved proprietary cleaning products until the required levels are achieved.

- At the conclusion of surface preparation, all final surfaces shall be vacuum cleaned or blown down with clean, dry compressed air The Contractor shall repair or make good at their own expense, any defect or non-conformities noted during the guarantee period.
- The prepared surface shall meet the required surface cleanliness immediately prior to coating application.
- A 12" (30 cm) wide strip of uncoated blasted surface shall be left between coated and un- blasted surfaces. When blasting operations are resumed, the 12" (30 cm) wide strip of previously blasted surface shall receive a light brush-off blast to remove rust bloom. This re- blast shall be accomplished by directing the blast nozzle away from the coated surface.
- White metal blast to SSPC-SP5/NACE #1 is the only acceptable surface preparation for insulated carbon steel or low alloy steel surfaces. The choice of inferior surface preparation will result in lower service life and/or a premature coating failure. Insulated austenitic or duplex stainless-steel surfaces shall be prepared according to SSPC-SP 16.

P2.20.5.4 Coating Application

General

- The Contractor shall install the coating system as per the Manufacturer's application guide.
- For insulated equipment and piping, it is the Contractor's responsibility to ensure no insulation is installed on surfaces where coating application is incomplete.
- No coating application shall occur during the following conditions:
  - Surface temperature is below minimum recommended by the Manufacturer; ○ Atmospheric temperature is below minimum recommended by the Manufacturer;
  - Relative humidity is below minimum or above maximum recommended by the Manufacturer.
  - Windy conditions over 25 km/h (15.5 mph) for spray applications. ○ Substrate temperature of less than 3oC (5oF) above the atmospheric dew point.
  - Work atmosphere contaminated by dirt, dust, oil, or other forms of pollution.
- When required by structural design contact faying surfaces of structural steel members joined by high tensile bolting in friction style joints shall be left unpainted except for the application of organic zinc primers qualified by the Manufacturer as Class B Slip Coefficient when tested in accordance with ASTM A490.
- The Contractor shall ensure that all openings in the equipment or piping are shielded to prevent entry of abrasive materials or coating materials. Such openings include flanges or threaded fittings. After the paint application the Contractor shall remove the shielding.
- The Contractor shall exercise caution and take appropriate measures to ensure that abrasives, coatings, or other debris do not drift and damage any surrounding facilities or properties.

- No coating shall be applied within 50 mm (2 inches) of edges that are to be welded. Welded joints of fabricated equipment and piping shall not be coated until completion of final pressure testing. After completion of final pressure test, the area shall be coated with the same coating system.
- The substrate shall have no visible signs of rusting or contamination. Any rust bloom or other contamination shall require a brush off blast cleaning
- The air supply shall be frequently retested at a minimum every four hours or whenever coating application recommences after equipment shut down periods
- The Manufacturer's mixing instructions and induction time, if any, shall be followed
- Viscosity control using pot and line heaters is preferred to addition of thinners.
- Where possible, successive coats shall be a different shade or colour to enable indication that successive coats have been fully applied.
- Each successive coat shall be applied within the overcoating time limits specified by the Manufacturer.
- coating application must be checked for thickness, cure, and surface contamination prior to the application of the next coat as per the Manufacturer's recommendations. Degree of cure shall be determined using a solvent wipe test per ASTM D5402.
- Curing times and temperatures shall be in accordance with the Manufacturer's recommendations.
- Dry film thickness; ○ Dry film thickness of each coat shall be as per the Manufacturer's recommendations. ○ Dry film thickness shall be determined in accordance with SSPC-PA 2. ○ Dry film thickness measurement gauges shall be properly calibrated with certificate of calibration available for review by the Inspector upon request.
- Following the coating application, all coated surfaces shall be inspected for dry spray, over spray, under spray, runs, sags, inclusions, and other visible defects. Unacceptable deficiencies, as determined by the Coating Inspector shall be removed or repaired. The Coating Inspector shall have the final decision on acceptance of coating systems.
- The Employer or Engineer shall not accept the coated work until the coatings are cured and final inspection has been performed by a Coating Inspector. Coated surfaces shall be protected against damage until they are cured. All shop coated work shall be inspected and any damage repaired before being put into service.
- Repairs to the coating shall be performed in strict accordance with the Manufacturer recommendations.

P2.20.5.5 Quality Control and Inspection

- At the discretion of the Employer or Engineer, and prior to job commencement, the Manufacturer shall submit Infrared Spectroscopy fingerprints of all coating material batches to be supplied.
- The Contractor is fully responsible to ensure that the requirements of this specification are fully complied with.
- The Contractor shall submit to the Employer or Engineer their quality assurance, and Inspection and Test Plan (ITP). Work shall not commence until the Employer or Engineer advises the Contractor of the required hold and witness points for quality surveillance by the Employer or Engineer.
- The Contractor shall be responsible for quality control including inspection of their work. The Contractor's designated quality control supervisor shall be responsible for the implementation of the approved ITP.
- The Contractor shall coordinate a pre-job meeting with the Employer or Engineer, and the Coating Inspector prior to commencement of any work.
- For insulated equipment and piping, insulation shall not be installed until all coated surfaces are fully cured, inspected, and approved by the Coating Inspector.
- The Coating Inspector shall notify the Employer or Engineer of all hold point inspections.
- The following are the minimum hold points that are required during all coating applications, for some projects additional hold points may be specified by the Employer or Engineer or Coating Inspector and the Contractor shall be advised. The Contractor shall notify the Employer or Engineer or Coating Inspector when the hold points are ready for inspection. Subsequently, hold point inspections will be per agreement between Employer or Engineer and Coating Inspector; ○ Hold Point 1: Prior to commencing surface preparation, to verify that the surfaces are free of oil, grease or other contaminants that might not be adequately removed by abrasive blasting. Note: Any other surface anomalies such as excessive weld splatter, rough weld beads as identified by the Contractor shall be brought to the Employer or Engineer attention for repair
    - Hold Point 2: After blasting to verify that the degree of cleanliness and suitable surface profile, prior to painting.
    - Hold Point 3: After coating system application to verify that the specified total dry film thickness has been achieved, to visually assess the overall application quality of the coating system, to verify the coating system has properly cured as per the Manufacturer's product data sheet and is free of any holidays or discontinuities.
- The Contractor shall provide all the testing equipment required to implement the ITP, that includes but not limited to the following;

- Assessing surface cleanliness using SSPC-VIS 1 reference photographs. ○ Measuring surface profile. ○ Measuring soluble salt contamination. ○ Measuring surface temperature. ○ Measuring wet film thickness.
- Measuring dry film thickness (non-destructive) ○ Measurement of atmospheric temperature and humidity. ○ Holiday detection equipment

- The Employer or Engineer's acceptance of the job shall not relieve the Contractor's or the Manufacturer's responsibility for the performance of work to this specification.
- All materials and work shall be subject to inspection by the Employer or Engineer. Work shall be accessible to the Employer or Engineer at all times. The Employer or Engineer reserves the right to reject any work which does not comply with this Standard.
- The Contractor shall maintain a record of their inspections and shall submit this to the Purchaser upon completion of the work.
- As a minimum, the Contractor's inspections records shall include the following; ○ Manufacturer's product data sheets and batch numbers.
  - Daily ambient weather conditions ○ Steel substrate temperature tests;
  - Surface preparation inspections including surface profile measurements and residual soluble salt contamination checks; ○ Air supply quality tests;
  - Records of equipment calibration for each use; ○ Wet film thickness of each coat; ○ Dry film thickness for each coat; and
  - Repair of any holidays and discontinuities.
- Daily weather conditions shall be checked as follows; ○ At the start and completion of surface perpetration; ○ At the start and completion of coating application;
  ○ Any time when weather conditions are changing.
- Repairs shall be inspected to ensure they have been satisfactorily carried out and are in accordance with the Manufacturer's specified requirements.

P2.20.5.6 Documents and Deliverables

- At the conclusion of the external coating application project, the Contractor shall provide the Employer with the documentation of application and inspection records as outlined herein as well as the joint guarantee as outlined herein.
- The Manufacturer shall warrant that the applied Manufacturer's coating system shall provide the necessary corrosion protection as outlined in the project specification. The Contractor shall warrant that the surface preparation and the coating system application were in accordance with both the project specification and the Manufacturer's instructions as set forth in the

Manufacturer's data sheet for the product. Upon acceptance of the project, the Contractor shall deliver their warranty of the applied coating systems along with the Manufacturer's warranty. The warranty period shall be for a minimum of 5 years from the date of the acceptance of the complete coating system.

P2.20.5.7 Coating System Selection Guideline

- New Construction Systems ○ System 1A (as defined in the table in the following section) provides ultimate corrosion protection with expected service life over 20 years.
    - ○ The service life of a protective coating system depends on several parameters, such as;
        - Type of coating system;
        - Design of structure
        - Condition of the substrate before surface preparation
        - Effectiveness of the surface preparation
        - Standard of the application work;
        - Conditions during application;
        - Exposure conditions after application.

Coating Systems for New Construction

System 1A: New Construction – Uninsulated carbon steel operating up to 120°C (248°F)						
Typical Application: Structural steel, aboveground storage tanks, vessels, piping, equipment,						
Minimum Surface Preparation: SSPC-SP6/NACE No. 3 (which includes SSPC-SP1)						
Surface Profile: Per Coating Manufacturer						
Manufacturer	Primer Organic Zinc Epoxy Primer	DFT, mil	2nd Coat Epoxy	DFT, mil	3rd Coat Polyurethane	DFT, mil
Akzo Nobel	Interzinc 52	– 6	Barrust Series	– 8	Devthane 389H	– 3
Cloverdale	ClovaZinc 3	2 – 3	ClovaGuard HB Epoxy	4 – 6	Gemini ArmourShield	2 – 4
Hempel	Hempadur Avantguard 550	3	Hempadur Fast Dry 17410	4	Hempathane HS 5561 Series	4

Jotun	Barrier 90	1 - 5	Penguard Express	3 – 10	Hardtop AX	2 – 4
PPG	Amercoat 68HS	2 – 5	Amerlock Series	4 – 8	Pitthane Ultra	2 – 3
Sherwin-Williams	Fast Clad Zinc HS	3 – 5	Macropo xy 646	3 – 10	Hi-Solids Polyurethane	3 – 5

Underground Carbon Steel Piping and Over Water Marine Loading Line Corrosion Protection

For the underground Carbon Steel related to Canola Oil unloading, these are two workable options:

1. 100% solids two component Liquid Epoxy (LE) coating – (Dry Film thickness (DFT) 25 mils nominal). These coatings have excellent chemical and cathodic disbondment resistance – Surface preparation becomes critical for quality coating; this can be applied in the shop (CSA Z245.30-2022 System FC1); these coatings are more susceptible though to mechanical damage (gouging, impact) so, select backfill is an important consideration. Multiple options from suppliers such as 3M, Seal for Life, Denso, Specialty Polymer Coatings for Liquid Epoxy (LE) coatings.
2. Low viscosity, semi-solid polyisobutene visco-elastic wrapping system and, polyethylene outerwrap (e.g., Seal for Life STOPAQ Wrappingband CZ /PE Outerwrap), can be used for buried, transition, above grade (with cross linked PE) coatings and requires minimal surface preparation. Can be applied in the shop (CSA Z245.30-2022 System FC7) and will provide added mechanical protection with the PE outerwap if backfill is of concern (i.e., impact damage).

- For the buried Carbon Steel trenchless section (~500 -600 meters) canola oil loading line to MLAs:

1. Plant-applied two-layer fusion bonded epoxy with an abrasion-resistant overcoat (ARO) (DFT, anti-corrosion coat 16 mils nominal, ARO, 28 mils nominal, total DFT 44 mils) (CSA Z245.20 Series 22 Plant-applied external fusion bond epoxy coating for steel pipe); girth weld joint coating can use 100% solids liquid epoxy coating suitable for abrasion resistance (DFT nominal 44 mils)

- For the overwater double-walled piping external coating (~100 meters). Assuming just air between the carrier pipe and the containment pipe with a centralizer (no insulation) with end seals for the pipe in pipe design to mitigate any moisture/water ingress as worst case from a corrosion standpoint:

1. Option for anti-corrosion coating on NPS 16 carrier pipe – 100% solids two component liquid epoxy (shop applied)

2. NPS 20 Containment pipe – Low viscosity, semi-solid polyisobutene visco-elastic wrapping system with added UV resistant mechanical protection composite outerwrap – e.g. Seal for Life STOPAQ Wrappingband CZ and Outerglass Shield XT Grey (Impregnated with polyurethane) – shop applied

Corporate Colour Policy

• The corporate logo and the corporate colours of Employer are key visual elements representing these corporate entities. Therefore, it is imperative to guide and control their use in all situations • All equipment and structures shall be finished or painted in accordance with table 21 in the section below.

Facility Colour Designations

Table 21: Facility Colour Designations

Equipment/Structure	Colour Code	Colour Description
Handrails	23785*	Canary Yellow
Structural Steel, supports, stairways, catwalks	17038*	Black
Piping and painted equipment	17295*	White
Piping, Valves, Motors, Electrical Fittings, Operations	17295*	White
Horizontal Pumps	17038*	Black
Vertical Pumps (Heads)	17038*	Black
Trim (Hand wheels)	31350*	Employer Red.
Storage Tanks (exterior)	17295*	White
Building Exterior Wall Panels	QC18273**	Bone white (see Westman Steel Cht)
Building Interior Wall Panels	QC18273**	Bone white (see Westman Steel Cht)
Building Roof Panels & Door Trim	QC18228**	Metro Brown (see Westman Steel Cht)
Interior Concrete & Floors	RAL 7040 36373*	Grey Light gray #37 (Optional)
Fire Equipment	31350*	Employer Red.

P2.20.6 Hydrostatic Testing Standard

P2.20.6.1 Work Scope

This section provides technical guidelines for hydrostatic testing of equipment and piping defined as pressure-retaining components by the relevant ASME B31.3 Code of construction and legislative regulations of BC.

The purpose of this section is to define responsibilities for the testing performed and documentation representing the verification of compliance for Contractor and the Employer's Inspector. The Contractor shall be responsible for the following:

- Piping system pressure test activities shall be performed as referenced in the Purchase Order to the Contractor (Contractor) and shall be defined by any jurisdictional requirements and, as a minimum, the Code of construction specific to the project.
- Piping system pressure test activities shall be performed under the direct continuous supervision of the Engineer who shall ensure that the following occurs as a minimum: ○ All the basic information/documentation required for Test Pack preparation is available as follows:
    - System Piping and Instrumentation Diagrams (P&ID's) schematically reflecting equipment items and their design conditions, interconnecting piping with numbered/sized lines and their respective class, incorporated tagged instruments, associated process notes, and any required mechanical execution requirements, etc.
    - P&ID (Contractor Package) is supplied to define interconnection details/package limits in order to ensure package is properly isolated and not retested where not required/desired.
    - Line Designation Table (LDT) by line number including design, operating, upset, and test conditions; mechanical features such as paint, insulation, heat tracing, pipe schedule, and post weld heat treatment; and NDE, etc. Note that the listed test pressure is determined using the ratio of component allowable stress at test temperature to that at design temperature. Note that all piping systems/lines are carried on the LDT including those lines exempt from testing.
    - Piping Line Class/Specifications reflecting various governing standards, design requirements, post weld heat treatment, materials and valve selection, and connectivity, etc.
    - Piping Isometrics with the complete fabrication details, design conditions, interconnections, and supports, etc. Note that items such as break flange pairs or vents and drains at system high and low points may not be carried on the P&ID's until design development of piping isometrics which would define the requirements.

- Information/documents related to system fabrication which may be relevant and could include weld detail/procedures/history/mapping, post weld heat treatment, and NDE reports of radiography, ultrasonics, toughness, and hardness, etc.
- Reinforcing Pad Pressure Test Certificate.

P2.20.6.2 Contractor/Test Operator Responsibilities

The purpose of this section is to define the Contractor and Test Operator responsibilities for the testing performed and documentation representing the verification of Contractor compliance as verified by the Employer's Inspector.

The following describes, but is not limited to:

- Ensuring that compliance with any jurisdictional requirements and Code(s) of construction specific to the project has been completed.
- All welded joints are tested in the unpainted condition to allow 100% visual examination.
- Sourcing and assembly of the basic information/documentation required for test procedure preparation as addressed in the foregoing.
- Preparation of the Pressure Test Plan.
- Preparation of individual Pressure Test Packs as follows: ○ Review and mark P&ID's to determine extent of each Test Pack and define the total number of Packs. Individual Packs include as large a piping system as practical limited to design pressure difference not exceeding 15% of the lowest design pressure. ○ Where piping systems are of welded connectivity, a cascade test may be used on the higher-pressure portion prior to closure welding and followed by a complete test repeat of the combined systems at the lowest pressure. Note, FOR EXAMPLE, that while B31.3 permits hydrotest to material specified minimum yield strength (SMYS) at test temperature as per Para. 345.2.1, this Recommended Practice imposes test pressure not exceeding 90% SMYS as per Para. 345.5.4 (providing the same margin to avoid yielding as for pneumatic testing). ○ Although there will be exceptions based on welded connectivity etc., this Recommended Practice imposes that the following be excluded from piping pressure tests/Test Pack configuration as reflected on the Test Pack Diagram:
    - Storage tanks.
    - Rotating equipment - pumps
    - Where equipment item "test-through" cannot be avoided, confirm that structure/foundation is designed to support water - filled equipment and supported piping.
    - Safety valves, expansion joints, control valves, locally – mounted pressure/level gauges and flow meters, in-line process valves (particularly those soft – seated), and check valves (alternately, flapper/piston removed/blocked open).
    - Packaged equipment/piping systems otherwise tested.
    - Plumbing systems otherwise tested.

- Lines and systems open to atmosphere including drains, vents, open discharge of relief valve, and atmospheric sewers/building drains.
- Instrument lead/impulse lines from first process block valve to instrument shall be otherwise tested to associated process piping standards but shall exclude the instrument. Instrument take-offs, process lead lines, sample lines, etc. shall be tested to first block valve with the associated process piping.

- Rationalizing test pressures as a result of maximizing test limits to 90% SMYS is permitted in the interest of test efficiency improvement gained by reducing the number of Test Packs.
- Line blinds/blanks shall conform to ASME B16.48 as applicable or may otherwise be calculated by the rules of B31.3 Para. 304.5.3.
- Note that the requirements for temporary pipe supports and spring support blocks/chocks shall be clearly identified on piping isometric's (ISO's) with the facility blaze-ribbon tagged to high-light their post – test removal requirement.
- Preparation of detailed Test Pack Diagram schematically depicting:
  ○ Marked P&ID's and piping ISO's reflecting extent/limit of test. ○ Fill/vent/drain locations. Specific reference shall be made to the provision made to prevent system vacuum build upon draining of the test medium post-test. ○ Test head/manifold arrangement and hook-up/temporary piping. ○ Water supply pumps hook-up.

  ○ Pressure pump hook-up. ○ Blowdown compressor hook-up (as required). ○ Location and range of pressure gauges. A minimum of two calibrated devices are required - one located at an accessible low point and the other on the high point of the test configuration.

P2.20.6.3 Test Pressure and Duration

- Test pressure is determined as per the applicable Code of construction and shall be clearly stated on the LDT (on P&ID's and piping ISO's only as required).
- As a minimum, the Designated Engineer shall approve the P&ID's and Line Designation Table (LDT). The Contractor shall verify that the piping ISO's clearly reflect the required information from the applicable P&ID's and LDT.
- The Employer's Inspector shall verify Contractor compliance with the Code of construction and the review of the approved P&ID's and LDT at the time of test.
- The Employer's Inspector is required to and shall perform a 100% visual inspection of all joints subject to test pressure.
- The Contractor shall perform a 100% visual inspection of all joints subject to test pressure.

- While a 10 minute hold may suffice for simple/individual spools, this standard recommends a 60 minute minimum hold for piping systems to permit the required examination. Test duration will be confirmed at the discretion of Employer's Inspector.
- Deviation from this recommendation shall only be allowed under approval of Employer's Inspector.

P2.20.6.4 Test Medium and Test Temperature

- Test medium is determined as per the applicable Code of construction and shall be clearly stated on the LDT (on P&ID's and piping ISO's only as required), and is subject to the approval of Employer's Technical Services Manager.
- Test medium should be water at metal temperatures not less than 2°C.

P2.20.6.5 Site Preparation and Contingency Plan

Pressure testing must be conducted with due regard for the safety of life and property and the planning and implementation must therefore mitigate unnecessary exposure to procedural hazards. This shall be reviewed and approved by the Contractor as well as the Engineer.

P2.20.6.6 Hazard Mitigation, Safety Precautions, and Environmental Issues

All involved personnel have "Stop Work" authority whenever there is a concern for safety. Hazard assessment is to be performed and an appropriate personnel exclusion zone identified and signed/barricaded. Test team members only are permitted within the exclusion zone. Equipment/materials are so arranged as to provide unobstructed access/egress during testing and in the event of an emergency.

P2.20.6.7 Special Alternate Test, Tie-in Welds, Closure Welds, and Hydrotest Waiver

When required by the Contractor, the following guidelines may apply on approval by the Employer or Engineer:

Alternates to the mandated hydrostatic test required by ASME B31.3 Para. 345.1 are listed as follows:

- Alternative Leak Test for the extenuating circumstances defined in Para 345.1 (c) is permitted in accordance with Para 345.9 and although onerous, includes: ○ Para 345.9.1 Examination of Welds. ○ Para 345.9.2 Flexibility Analysis.

- Para 345.9.3 Test Method is the Sensitive Leak Test mandated under Para 345.8.

- Tie-in welds as discussed under c) closure welds following.
- Closure welds when allowed, are for example as per ASME B31.3 Para. 345.2.3 (c), the final weld connecting piping systems or components otherwise successfully tested need not be leak tested provided the weld is examined in process as per Para. 344.7 and passes 100% visual with 100% radiography or 100% ultrasonic examination.
- Hydrotest Waiver-lines open to atmosphere such as vents or drains downstream of last shutoff valve need not be leak-tested.

P2.20.6.8 Pressure/Volume (PV) Plot

When required by the Designated Engineer, the following guidelines may apply on approval by the Employer or Engineer:

- Development of a pressure/volume plot may be required for those systems where the otherwise determined hydrotest pressure would result in a pipe stress of 90% SMYS at test temperature.

P2.20.6.9 Pressure Test Equipment and Components

Verification for Contractor compliance with the following is to be performed by the Engineer: The Contractor's responsibilities include compliance with the Code(s) of construction, all applicable requirements, as well as the following (compliance to be verified by the Engineer):

- The required test equipment including, such as Master gauges, gauges, and time/temperature recorders (digital or analog) shall be as per the contractors Quality Manual or, as a minimum, be calibrated to a traceable/known National Standard.
- Test gauges and recorders shall be verified at test pressure against a properly ranged Master Pressure Gauge prior to each use. A Test Gauge Verification Log shall be used to document this verification by recording date, test pressure, Test Gauge number, Master Pressure Gauge number and the initials of the person accepting the verification of the Test Gauge.
- The maximum interval between pressure measuring device calibrations shall be twelve months. All other equipment used for Code-required measurement or inspection shall be calibrated at intervals as recommended by the manufacturer or as established by the Engineer.

P2.20.6.10 Miscellaneous Components:

- Special length bolting and test gaskets may be required during testing and shall be removed after test completion and replaced with standard line class bolts and new service gaskets.
- A field procedure must be established, and care taken to ensure the installation and removal of material which is specified for testing only.

- Spectacle blinds/blinds and spacers as per Piping Line Class, extra length bolting, and gaskets for testing shall be otherwise furnished as part of the installation contract.

P2.20.6.11 Test Guidelines

General

The following information is provided for guidance and shall be applied in conjunction with the Contractor's Quality Program. When a Contractor is not required to have a Quality Program, the Engineer shall determine the extent and application of this Recommended Practice to the specific project.

- Subsequent to repairs, heat treatment, NDE, and examination, the Contractor must inspect the pressure piping system to ensure materials, construction, and installation comply with the regulations. Prior to initial operation, all installed piping shall be pressure tested except as otherwise noted.
- When required, the jurisdictional local inspector shall be notified at least 48 hours in advance of pressure testing of piping under its jurisdiction for witnessing at his/her option.

The test shall be hydrostatic using water unless there is a possibility of damage due to freezing; or if the operating fluid or piping material would be adversely affected by water. Any other suitable liquid or additives may be used on approval by the Engineer.

- If testing with glycol-water mixture to prevent freezing, the safety, leakage, and disposal considerations of the test fluid shall be considered.

Test Water

- Clean water that will not corrode and/or damage the test system shall be used for hydrostatic tests. If municipal water is not available, supply water may be obtained from native water supply (e.g. dugout). Water containing silt or suspended material shall not be used, and a suitable 40 mesh filter should be provided in the filling line. The Engineer shall approve the proposed source of test water.
- If water source is not potable, the Engineer shall consider adding inhibitor to reduce risk of pitting corrosion or introduction of Microbiologically Induced Corruption (MIC). The Engineer should also consider biodegradable inhibitor to allow test fluid disposal to the environment.
- Chlorides content exceeding 25ppm is not permitted.
- A mixture of glycol/water shall be used where the ambient temperature may reach less than 0°C (32°F) during testing or prior to dry-out.

Test Preparation – Field Guidelines

- Joints, including welds, shall be left uninsulated and exposed for examination during the test, except that joints previously treated may be insulated or covered. All joints that require a leak test shall not be primed/painted prior to leak testing.
- Underground portions of piping systems may be tested and covered before testing aboveground portions.
- Piping designed for vapour or gas shall be provided with additional temporary supports, if necessary to support the weight of the test liquid. Where required, temporary supports shall be used as specified in the pressure test documents.
- Lines that are counterweight-supported shall be temporarily blocked during testing in order to sustain the weight of the test fluid. Spring hangers that have been provided with stops for carrying the test load normally do not require additional temporary supports.
- Before testing, the following procedures shall be carried out: ○ Verify that any required heat treatment has been performed and that all NDE requirements are complete.

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    - Piping systems shall have been thoroughly checked for completeness. ○ Piping systems shall be checked to ensure that the entire system can be completely drained after testing.
    - Vents or other high point connections shall be opened to eliminate air from lines, and system shall be purged of air before hydrostatic test pressure is applied.
    - Short pieces of piping that must be removed to permit installation of a blind or blank shall be tested separately.
    - Flanged joints at which a blank is inserted to isolate other equipment during a test need not be tested after blank is removed. ○ Lines containing check valves shall have the source of pressure located in the piping upstream of the check valve so that the pressure is applied under the seat. If this is not possible, remove or jack up the check valve closure mechanism or remove check valve completely, and provide necessary filler piece or blinds. Removed internals shall be bagged and placed nearby in order that inspectors may verify that the internals have been removed for the test. ○ When conducting tests at freezing temperatures, the test shall not take more than 4 hours, and special precautions, such as using glycol/water mixture, shall be used to avoid freezing damage. Follow precautions to minimize the risk of brittle fracture as otherwise noted. ○ Systems that include expansion joints, which have been removed for pressure testing, shall be investigated to see that any required temporary restraints, anchors, or guides are installed or removed prior to test.
    - When a pressure test is required to be maintained for a period of time during which the testing medium in the system would be subject to thermal expansion, provision shall be made for relief of any pressure greater than the maximum test pressure.
    - Drain and vent valves are to be in open position and plugged during test to permit testing of valve packing.
    - Bypass valves on gate valves provided with centre cavity pressure equalizing bypass shall be open during the test.

Hydrostatic Test Guidelines

- Piping systems shall be pressurized slowly and evenly to prevent vibrations. When the pressure has been raised to 1000 kPa, a leak check shall be done to check all valves and fittings. If leaks are found, system must be depressurized prior to repairs.

- In order to hydrostatic test as much piping as possible at one time, a systems test may be employed. The minimum test pressure for a system test shall be such that each line in the system is subjected to its required minimum test pressure.
- The maximum system test pressure shall not exceed the pressure test rating of any piping component. Maximum test pressures for valves conforming to ASME B16.34 are as specified in Appendix D.

  Where a suitable valve is not available for closed valve isolation, vessels, equipment, or other piping not included in the system pressure test shall be either disconnected from the system or isolated by blinds or other means during the test.
- The normal location for the pressure test gauge is at grade near the pressure test pump. Readings may be made at higher points providing the gauge pressure reading and the static head [9.79 kPa/m (0.433 psi/ft.) for water] between grade and the point of measurement do not exceed the maximum test pressure. Gauges shall be tagged with the date last calibrated, and this activity shall be recorded.
- Gauges shall be a minimum 100 mm (4 inch) diameter face and shall be graduated over a range of approximately double the intended test pressure but in no case shall the range be less than 1.5 times nor greater than 4 times that pressure.
- At least two gauges shall be used per test. One gauge shall be located on the test head and one on the system being tested. Gauges must read within 5% of each other.
- The use of NDE in lieu of the hydrotest for the final closure weld requires a hydrotest waiver.
- Test Plan procedures, and schedules shall be reviewed by Employer prior to commencement.
- All tests shall be witnessed and accepted by the Inspector. The test results shall be recorded, and a copy shall be provided to Employer.

Test Records

- The completed test record shall be retained in the Construction Contractor's QC file as a permanent record. A copy of each piping pressure test system record form shall be given to the Engineer for verification of compliance.
- Employer's record retention policy shall be consulted for the requirements on the submission and retention of piping pressure test records within each local jurisdiction.

Test Completion

- All tests are to be witnessed by an Employer-qualified inspector.
- If leaks are found, their location shall be marked, the pressure shall be gradually released, and the piping shall be drained or vented. Appropriate repair or replacement shall be made in accordance with approved procedures. The affected piping shall be retested at the pressures originally specified for the test.

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- All tests where potential freezing of the test medium may occur shall be evaluated by the Contractor and a plan shall be submitted in writing to the Employer and Engineer for review and approval prior to testing.
- After lines have been drained, temporary supports shall be removed, and insulation and painting completed. Spring hangers provided with stops to carry the test load shall have these stops removed except those identified to be removed after system is charged.

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  Instruments which were removed or blocked out for test shall be reinstalled and blocks placed in the normal operating position.
- Temporary bolting and gaskets used for pressure testing shall be removed and replaced with line class bolts and gaskets.
- Check valves that were jacked open or had the internals removed for pressure testing shall be returned to their proper operating position.
- Instruments and process lead lines that were subjected to the hydrostatic pressure test shall be blown out with dry air (dew point -60°C) or nitrogen.
- Vent and drain connections that were added solely for pressure testing shall be closed and seal welded as required. Drains shall have either the valve closed and plugged or, if the valve is removed, the connection plugged, and seal welded as required.
- Painting and insulation shall be completed after inspection of seal welded vents and drains. Strainer screens shall be removed, cleaned, and reinstalled.

P2.20.7 Meters and Gages for Mechanical Piping

P2.20.7.1 Summary

This Section includes meters and gauges used in mechanical systems.

Related Sections: piping Sections contain requirements that relate to this Section.

Meters and gauges furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other related Sections.

Section "Fire Pumps" for flow meters for testing fire pumps.

P2.20.7.2 Submittals

General: Submit the following according to the Conditions of the Contract and Section 1 Specification Sections.

Product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

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Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

Maintenance data to include in the "Operating and Maintenance Manuals" specified in Section 1 Section "Project Closeout". Include data for the following:

- Test plugs.

  Flow measuring systems.

- Flow meters.

P2.20.7.3 Quality Assurance

Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards or other British equivalent standards pertaining to construction and installation of meters and gages.

P2.20.7.4 Manufacturers

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work shall be as approved by the Engineer.

P2.20.7.5 Thermometers, General

Scale Range: Temperature ranges for services listed as follows: Domestic Hot Water: 0 to 115 deg C, with 1 degree scale Sections. Domestic Cold Water: Minus 18 to 38 deg C, with 1 degree scale Sections. Hot Water: 0 to 150 deg C, with 1 degree scale Sections.

Accuracy: Plus or minus 1 percent of range span or plus or minus one scale Section to maximum of 1.5 percent of range span.

P2.20.7.6 Liquid-In-Glass Thermometers

Description: ASTM E 1, liquid-in-glass thermometer.

Case: Die-cast and aluminum-finished in baked-epoxy enamel, glass front, spring secured, 230 mm (9") long.

Adjustable Joint: Finished to match case, 180 degree (3.1rad) adjustment in vertical plane, 360 degree (6.3rad) adjustment in horizontal plane, with locking device.

Tube: Red-reading mercury-filled with magnifying lens.

Tube: Red-reading, organic liquid-filled instead of mercury-filled, with magnifying lens.

Scale: Satin-faced non reflective aluminum with permanently etched markings.

Stem: Copper-plated, steel, aluminum, or brass for a separable socket of length to suit installation.

P2.20.7.7 Direct-Mounting Filled-System Dial Thermometers

Description: Vapor-actuated universal-angle dial thermometer.

Case: Drawn steel or cast aluminum, with 115 mm diameter glass lens.

Adjustable Joint: Finish to match case, 180 degree (3.1rad) adjustment in vertical plane, 360 degree (6.3rad) adjustment in horizontal plane, with locking device.

Thermal Bulb: Copper with phosphor-bronze Bourdon pressure tube.

Movement: Brass, precision geared.

Scale: Progressive satin-faced non reflective aluminum et.

Stem: Copper-plated steel, aluminum, or brass for a separable socket of length to suit installation.

P2.20.7.8 Remote Reading, Filled-System Dial Thermometers

Description: Vapour-actuated remote-reading dial thermometer.

Case: Drawn steel or cast aluminum, with 115 mm diameter glass lens.

Movement: Brass, precision geared.

Scale: Progressive satin-faced non reflective aluminum with permanently etched markings.

Tubing: Bronze double-braided armour-over-copper capillary of length to suit installation. Bulb: Copper with separable socket for liquids; averaging element for air.

P2.20.7.9 Thermometer Wells

Description: Stainless-steel thermometer well.

Pressure Rating: Not less than piping system design pressure.

Stem Length: To extend to centre of pipe.

Extension for Insulated Piping: 50 mm (2") nominal, but not less than thickness of insulation. Threaded Cap Nut: With chain permanently fastened to well and cap.

P2.20.7.10 Bimetal Dial Thermometer

Hermetically sealed all welded stainless steel construction with glass dial. +/- 1% full span accuracy.

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76 mm dial face with 13 mm NPT lower stem attachment and 150 mm rod length.

P2.20.7.11 Pressure Gauges

Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.

Case: Drawn steel, brass, or aluminum with 115 mm (4-1/2") diameter glass lens.

Connector: Brass, 6 mm (1/4") NPS.

Scale: White-coated aluminum, with permanently etched markings.

Accuracy: Plus or minus 1 percent of range span.

Range: Conform to the following:

Vacuum: 30 inches Hg of vacuum to 15 psig of pressure. Vacuum: 100 kPa of vacuum to 100 kPa of pressure.

Fluids Under Pressure: 2 times operating pressure.

P2.20.7.12 Pressure-Gage Accessories

Syphons: 6 mm straight coil of brass tubing with threads on each end.

Snubbers: 6 mm brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

P2.20.7.13 Test Plugs

Description: Nickel-plated brass-body test plug in 15 mm fitting.

Body: Length as required to extend beyond insulation.

Pressure Rating: 3450 kPa (500 psig) minimum.

Core Inserts: 2 self-sealing valve types, suitable for inserting a 3 mm outside-diameter probe from a dial thermometer or pressure gage.

Core Material: According to the following for fluid and temperature range:

Air, Water, Oil, and Gas: Minus 7 to 93 deg C , neoprene rubber.

Air and Water: Minus 35 to 136 deg C, ethylene-propylene-diene-terpolymer (EPDM) rubber.

Test-Plug Cap: Gasketed and threaded cap, with retention chain.

Test Kit: Provide test kit consisting of 1 pressure gage and gage adapter with probe, 2 bimetal dial thermometers and a carrying case.

Pressure Gage and Thermometer Ranges: Approximately 2 times systems operating conditions.

P2.20.7.14 Water Meter

Turbine, in-line, dry dial, magnetic drive type, manufactured from corrosion resistant materials and suitable for a working pressure of 10 kg/cm2 and a cold water temperature of up to 50 deg.C. Meter to be sized for the specified flow rate at a maximum head loss of 2.5 m water gauge, and to have the manufacturer's guaranteed accuracy of +/-5% at the minimum flow rate. Dial registration to go up to 1,000,000 cubic meter. Meter to have a combination dial and roller totalizer in a hermetically sealed casing to preclude glass misting, moisture corrosion and tampering, a hot pressed brass body and a hinged cover, with male threaded ends for union connections into the line. Meter to be as approved by the local authority.

P2.20.7.15 Meter and Gage Applications

General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

P2.20.7.16 Meter and Gage Installation, General

Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.

P2.20.7.17 Thermometer Installation

Install thermometers and adjust vertical and tilted positions.

Install in the following locations and elsewhere as indicated:

At inlet and outlet of each hydroid zone.

Remote-Reading Dial Thermometers: Install in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tulen.

Thermometer: Install in vertical position in piping tees where thermometers are indicated.

Install wells with stem extending minimum of 50 mm into fluid. Install wells with stem extending to center of pipe.

Fill wells with oil or graphite and secure caps.

P2.20.7.18 Pressure Gage Installation

Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position.

Install in the following locations and elsewhere as indicated:

At suction and discharge of each pump.

At discharge of each pressure-reducing valve.

At building water service entrance.

Pressure Gage Needle Valves: Install in piping tee with snubber. Install syphon instead of snubber for steam pressure gages.

P2.20.7.19 Test Plug Installation

Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

P2.20.7.20 Flow-Measuring System, Flow Element and Meter

General: Install flow meters for piping systems located in accessible locations at most readable position.

Locations: Install flow measuring elements and meters at discharge of each pump, at inlet of each hydronic coil in built-up central systems, and elsewhere as indicated.

Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions. Install connection fittings for attachment to portable flow meters in readily accessible locations. Permanently Mounted Meters for Flow Elements: Install meters on walls or brackets in accessible locations.

Install connections, tubing, and accessories between flow elements and meters as prescribed by manufacturer's written instructions.

P2.20.7.21 Flow Meter Installation

Include 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 32 mm and smaller pipe. Include 20 pipe diameters upstream and 10 pipe diameters downstream for 40 mm and larger pipe.

P2.20.7.22 Connections

Piping installation requirements are specified in other Section 15 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.

Install meters and gages adjacent to machines and equipment to allow servicing and maintenance.

Connect flow-measuring-system elements to meters.

Connect flow-meter transmitters to meters.

Make electrical connections to power supply and electrically operated meters and devices.

P2.20.7.23 Adjusting and Cleaning

Calibrate meters according to manufacturer's written instructions, after installation.

Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint. That authority, the procedure described in either AWWA C651 or AWWA C652 or as described below:

Flush piping system with clean, potable water until dirty water does not appear at outlets.

Fill system or part thereof with water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) and allow to stand for 24 hours.

Drain system or part thereof of previous solution and refill with water/chlorine solution containing at least 200 parts per million of chlorine. Isolate and allow to stand for 3 hours.

Flush system with clean, potable water until chlorine does not remain in water coming from system following allowed standing time.

Submit water samples in sterile bottles to the Engineer or authority having jurisdiction. Repeat procedure if biological examination made by the authority shows evidence of contamination.

Prepare and submit reports for purging and disinfecting activities.

Clean interior of piping system. Remove dirt and debris as work progresses.

P2.20.7.24 Commissioning

Fill water systems. Check compression tanks to determine that they are not air bound and that system is completely full of water.

Before operating systems, perform these steps:

- Close drain valves, hydrants, and hose bibs.
- Open shutoff valves to full open position. Open throttling valves to proper setting.
- Remove plugs used during testing of piping systems and plugs used for temporary sealing of piping during installation.
- Remove and clean strainer screens. Close drain valves and replace drain plugs.
- Remove filter cartridges from housings and verify that cartridges are as specified for application where used, clean, and ready for use.
- Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- Check plumbing specialties and verify proper settings, adjustments, and operation.
- Energize pumps and verify proper operation.

P2.20.7.25 Protection

Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

Place plugs in ends of uncompleted pipes at the end of the day or when work stops.

Exposed PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of a water-based latex paint.

P2.20.7 Piping Line Class

Line Service Designation - 150 LB, Welded WB, LC, LS, DRN, PWW, SP, PO

Pressure/Temp Rating:

TEMPPSIG-max-F	-28520	100285	200260	300230	4020

PSIG-min F.VAC

Hydrostatic Test Pressure: 428 PSIG Corrosion Allowance: 1/8”

Code: ASME B31.3

- All piping fabrication will meet ASME code requirements.
- All pipe material, fittings, flanges and valves will meet ASME B31.3 code requirements.

Item:	Size Range	Description
Pipe:	2” and Smaller	ASTM A-106B, seamless, Std.Wt, plain end,
	2 ½” thru 16”	ASTM A-53B / A-106B, seamless or ERW, Std.Wt, beveled end,
Fittings:	2” and Smaller	Forged fittings ASTM A-105, 3000#, socketweld
	2 ½” thru 16"	Pipe fittings ASTM A234-WPB, seamless, Std.Wt, buttweld
Unions:	½” to 2"	Forged fittings ASTM A-105, 3000#, socketweld unions with metal to metal seats.
Flanges:	2” and Smaller	ASTM A-105, 150#, RFSW
	2 ½” to 16"	ASTM A-105, 150# RFWN flanges.
Bolting:	All Sizes	Alloy steel studs, ASTM A-193 Gr. B-7. with 2 carbon steel heavy hex head nuts ASTM A194 Gr. 2H
		Cap Screws, 150#, ASTM A-193 Gr. B-7, with ASTM A194 Gr. 2H heavy hex nuts for lug butterfly valve

Gasket:	All Sizes	Flexitallic graphite filled, 304 SS reinforced 1/8” thick with carbon steel soft center ring. (Union Carbide Grafoil Gr GHE or approved equal)
Miscellaneous		ASTM A105. sockolets, weldolets, threadolet, plugs etc. 3000# ASME B16.11

- All pipe material, fittings, flanges and valves will meet ASME B31.3 code requirements.

Nipples – Pipe:	½” to 2”	ASTM A53-B / A106-B, seamless, Sch. XS, minimum length 2”.

Notes:

- All piping 2” and less is preferred socketweld fabrication. Threaded is optional but not preferred.
- All substitute valves shall be better or equal to valves listed in the specification and require written prior approval.
- Use flat faced flanges against cast iron valves & equipment. Use weldneck flanges at Tbranches, reducer small ends, etc., where applicable.
- Use nipples listed at threaded joints. Use screwed fittings only at instruments, low point drains, & equipment connections where applicable

Branch Connection – See table below

Branch Size \ Header Size	16”	14”	12”	10”	8”	6”	4”	3”	2”	1½”	1”	¾”	½”
½”	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O
¾”	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	
1”	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O		
1½”	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O			
2”	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O	SWO /THD O				
3”	TrWO	TrWO	TrWO	TrWO	TrWO	BWTr	BWTr	BWT					
4”	TrWO	TrWO	TrWO	BWTr	BWTr	BWTr	BWT						
6”	TrWO	TrWO	BWTr	BWTr	BWTr	BWT							
8”	BWTr	BWTr	BWTr	BWTr	BWT								
10”	BWTr	BWTr	BWTr	BWT									
12”	BWTr	BWTr	BWT										

	14”	BWTr	BWT
	16”	BWT	

Legend:

SWT = Socketweld Tee per ASME B 16.11

SWO = Weldolet, Sockolet or approved equivalent.

TrWO = Tee reducing WeldOLet

BWT = Buttweld Tee

BWTr = ButtweldTee Reducing

BWT & Tr = ASME B31.3 & B16.9 WeldTee w~min crotch & rad. NOT Extruded.

P2.20.7.1 Applicable Valves

Angle Valve:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
½" to 2"	Vogt	socketweld 800#	SW1971	VAN-A2	Conventional Port
½" to 2"	Vogt	threaded	1971	VAN-A3	Conventional Port

Ball Valve:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
½" to 2"	Velan or Crane	threaded #800	S[size]G1302SSEA or CRANE [size] 9421S	VBA-A1	Forged, SS Trim,RFTE,NON SHOCK, WOG
½" to 2"	Velan or Crane	socketweld-800#	W[size]G1302SSEA or CRANE [size] 9423S	VBA-A2	RP, SS trim, RTF, A216-WCB to B16.10 / API 608, MSS-SP110, LG
2 ½" to 14"	Velan	150# flanged	F[size]01402SSEA FullPort SB600 - size limits	VBA-A3	RF, SS trim, RTF, A216-WCB to B16.10 / API 608, MSS-SP110, LG
Butterfly Valve:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
3"-6"	Durco BX20001	150# flanged	[size]BX2W1811T (Wafer) / [size]BX2L1811T (Lug)	VBU-A1	WOG, dim to API-609 /MSS- SP-67 Opt.Lugged for tight locations
8" to 24"	Durco BX20001	150# flanged	[size]BX2W1811T (Wafer) /	VBU-A2	WOG, dim to API-609 /MSS-

			[size]BX2L1811T (Lug)		SP-67 Opt.Lugged for tight locations

Check Valve:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
½” - 2”	Velan	socketweld 800#	W[size]2114B02TY	VCK-A1	Forged, Swing Chk, TR10, Horiz lift, API 602. Opt Vogt SWS701
½” - 2”	Velan	150# Flanged	F[size] 0114B02TY	VCK-A2	Forged, Swing Chk, TR10, Horiz lift, API 602. Opt Vogt S673
2” to 16"	Crane	150# Flanged	147XU	VCK-A3	150# CS
1/2” to 2"	Vogt	THD 800#	S701	VCK- AB4	
Gate Valve:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
½”-2”	Velan	socketweld 800#	W[size]2064B02T Y	VGA-A1	Forged, API 600 / 602
2” & Up	Crane	150# Flanged	47XUF	VGA-A2	A216-WCB API 600-603
Globe Valve:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description


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DP WORLD

½”- 2”	Velan or Vogt	socketweld-800#	[size]2074B02TY or Vogt SW12141	VGL-A1	Forged, Horiz lift,
2” to 14"	Crane	150# Flanged	143XU	VGL-A3	150# Cast Steel
Strainers:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
½” – 2”	Titan	socketweld	YS82-CS	STRNR- A1	600# SW CS
2 ½” & Up	Titan	150# Flanged	YS61-CS	STRNR- A2	150# CS

Ball Valves: TI, PI, Drains, Vents, Trap and Condensate assemblies					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
¼” – 2"	Velan	NPT	S[size]P1102SSEA for chemical and general use	VBA- A10	Trim for process, steam, condensate, PI, TI, drains, vents.
¼” - 2"	Velan	NPT	S[size]C1102SSEA corrosive environment. Eg. condensate	VBA- A11	Trim for process, steam, condensate, PI, TI, drains, vents
Sample Valves:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
¼” - 2"	Apollo	NPT	72-100	VSA- AB1	Veg. Oil Tanks
½” - 2"	Velan	NPT	S[size]C1102SSEA	VSA- AB2	Process Piping
Fill, Vent & Drain Valves:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description
½” - 2"	Vogt	SW	SW11103	VDR-A1	Geka 60% Fill,Vent,Dr

3-Way Full Port Ball Valves:					
Size	Manufacturer	End Conn.	Valve Fig. #	Valve Code	Description

2" - 6"	Flow Tek	150# RF Flange	MPF15-WCB- TPORT	VPBA-A1	Process
2" - 6"	KTM	150# RF Flg	EO3100 - Ball Valve	VPBA-A2	Process

P2.20.7.2 Trim Out Hardware

Pressure Indicators:					
Type	Manufacturer	End Conn.	Fig. #	Instr. Code	Description
	Ashcroft		45-1279SS-XLL-04L-"Range"W/5 0-200SS-	VPI -A1	Diaphragm Process
			04T-XCG		
	Ashcroft		45-1279SS-XLL-04L-"Range"	VPI -A2	Steam, N2, Air, Water, Additive
Vaccum	BOC Edwards		"Range"- CG16K (w /accessories	VPI -A3	ABS
Vaccum	Ashcroft		"PSI"-45-1279SS- XLL-04L-"Range"	VPI -A4	Vaccum Combination
Temperature Indicators:					
Type	Manufacturer	End Conn.	Fig. #	Instr. Code	Description
Every Angle	Ashcroft		30E160E "Stem Length"XN H	VTI -A1	w/316ss well stepped shank
Rear Conn.	Ashcroft		30E160R "Stem Length"XN H	VTI -A2	w/316ss well stepped shank

P2.20.8 As-built and Record Mechanical Drawing Requirements

P2.20.8.1 Work Scope

- This document outlines the minimum requirements for the completion of as-built mechanical facility drawings, to provide a safe operation and training to field operators.
- Specific objectives of change management are as follows:
    - Provide direction of minimum requirements for the completion of as-built mechanical facility drawings;
    - Provide an accurate inventory and location of facilities to meet the Engineers and Geoscientists of British Columbia (EGBC) regulatory requirements; ○

    Provide accurate information for safe operation of facilities; and
    - Ensure that all stakeholders are aware of the process to be followed.

P2.20.8.2 Responsibilities and Requirements

General Responsibilities

- As-Built drawings shall be completed for this project.
- All mechanical as-builts must be drafted and issued within 120 days post substantial completion date (TBC during Detailed Engineering).
- The cooperation of all parties involved in the construction process is required, to allow the contractors to gather information timely and accurately.
- A copy of all redline mark-ups shall be retained in the field until as-builts have been drafted and new updated drawing sets have been returned to the field.
- Per EGBC requirements, completed As-Built drawings must be sealed by the Engineer of Record (EOR) EGBC registered Professional Engineer.

Contractor

- The Contractor shall be responsible for all As-Built information and shall make it available for the Engineer to review as required.

- The Contractor shall prepare and maintain, in the site office, one full set of Red Line As-Built Construction Drawings in an “up-to-date” condition, updated daily throughout the duration of the project.
- The Contractor shall provide additional sketches as required, to clearly convey the As-Built information.
- The Contractor shall sign off on the Red Lined drawings when completed and prior to turnover.
- The Contractor shall provide a second set of As-Built Red Lined drawings completed with an electronic PDF drawing program such as “Blue Beam Revu” within 7 calendar days of the job completion/commissioning to the Employer.

Construction Coordinator

- The Contractor shall ensure that the contractor is maintaining Red Lined drawings that are being created and maintained as the project proceeds.
- The Contractor shall take pictures after construction is completed and before any underground assets are backfilled. These pictures will be turned over within 7 calendar days of the job completion/commissioning to Employer.


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P2.21 Electrical, Instrumentation and Controls Works

P2.21.1 Work Scope

P2.21.1.1 Introduction

Electrical works for canola oil transload facility include installing new equipment and connections within existing substations, switchgear.

Instrumentation and Control system works shall produce an entirely stand-alone system, not integrated with existing facilities, and not connected to the Internet, unless needed for remote troubleshooting, and needing explicit approval from the Engineer.

- It is the responsibility of the Contractor to carry out detailed design of the complete electrical, instrumentation and control systems, complete infrastructure, and complete containment routes required for canola oil transload facility. It is also the responsibility of the Contractor to obtain all relevant approvals from the electrical supply authority - B.C. Hydro (BCH) - as well as from all other Authorities.

The Contractor's proposed suppliers and manufacturers of electrical and instrumentation equipment shall be subject to approval by the Engineer. Site operation and diversity of equipment and processes shall be calculated, and all proposed and future loads shall be identified by the Contractor.

Selection of the DCS/PLC supplier shall require explicit approval of the Engineer.

The Contractor shall submit a plan for approval by the Engineer, indicating how sufficient electrical capacity and infrastructure shall be made available based on the electrical works to be added for the future Stages to final build out. This plan shall include how the electrical transitions will be affected and their impact on existing layouts. The electrical and control systems shall be designed to be easily extended without disruption to the existing infrastructure while also ensuring minimum operational downtime.

Leak detection system for the marine loading piping should be a single discrete input to the control system for monitoring.

P2.21.1.2 Environmental Ambient Conditions

Suitably robust and practicable design solutions shall be implemented to ensure that all environmental conditions are considered, and that all equipment remains operational and serviceable under the local conditions including a design flood event.

P2.21.1.3 System Overview

This Contract covers the following works for the canola oil transload facility, including the Contractors design development, manufacture, supply, installation, erection (where appropriate), testing, and

commissioning, whether detailed or not, as listed herein and on the drawings, as necessary to complete the installation:

a. Liaise with BC Hydro, complete preparation of terminal load study, equipment procurement, installation, and enabling works for the provision of electrical power for canola oil transload facility from the existing Substation #10

b. Lighting study required for safe use and operation of vehicles, equipment, and machinery to meet the minimum lighting standards

c. Load study to ensure the existing loads and canola oil transload facility additional loads can be safely provided from the existing BCH 12.5/25 kV supply and the existing transformation, protection and control works within Substation #10

d. Ductbank construction shall be undertaken in a manner to minimize daily operation disruptions.

e. Existing BCH 25 kV main incoming line review to ensure all loads (existing and new canola oil transload facility) can be supplied without overloading existing BCH main incoming cable.

f. Supply, install, and commission new transformer, prefabricated MCC building, Medium Voltage (MV) switchgear, 600V motor control centers, control and security systems network servers and hubs, protection and control relays and associated distribution apparatus to ensure all canola oil transload facility loads can be safely connected and operated

g. The new 25/12.5kV-600VAC transformer is recommended to include a high resistance ground (HRG) to limit the fault current to 5A

h. Protection and coordination study shall be completed prior to equipment procurement to ensure new transformer, switchgear, motor control centers, and associated distribution equipment are properly sized for short circuit fault currents and ampacities

i. All new cabling and wiring shall be insulated to minimum voltage level and sized for maximum load ampacities and minimum voltage drops per codes and regulations

j. New interior and exterior lighting system including panelboards as shown on drawings included in Volume 3

k. All equipment as shown in the MCC building layout drawing

l. Grounding and bonding study and site review for existing grounding installation. Provide, install, and commission grounding and bonding as per codes and regulations. Where the grounding and bonding study indicates inadequacies, provision of a grounding and bonding system for all new and existing HV and LV grounding systems, as required

m. Lightning protection study and provision of a lighting protection system for the canola oil transload facility.

n. Design, supply, install and commission new prefabricated Control and Security Building that will include all the control systems and security systems equipment as described in these specifications.

The following equipment, buildings, and areas shall be supplied electrically by the Contractor and shall include all required supplies, cabling, switchgear, transformers, and connections for a completed electrical installation:

Table 22: Facilities / Buildings to be Supplied

Facility/Building	Number
MCC building including all equipment	1
New 4.16kV Switchgear complete with a breaker to be coupled to the existing switchgear at substation#10	1
New 600V Motor Control Centers	2
New Transformer- Oil Natural Air Natural Cooling (ONAN), 25/12.47kV-600V.	1
Variable Frequency Drives for all pumps	6
New Lighting system at Jetty and Berth#10	N/A
New Lighting system at Rail car	N/A
New lighting system at pumping areas	N/A
New General areas lighting system	N/A
New lighting system at tank farm area	N/A
Parking lot lighting	N/A

P2.21.1.4 Medium Voltage Distribution System Overview

The main electrical power to the canola oil transload facility will continue to be supplied via BCH's 25/12.47kV power feed into Substation #10. Contractor shall liaise and obtain approval from BCH for canola oil transload facility electrical load additions and BCH acceptance of the design philosophy.

Refer to the Electrical Single Line Diagram for Substation-10.

P2.21.1.5 MCC Building Overview

MCC building shall be modular, insulated, pre-engineered, and prefabricated building (self-framing or light steel frame) with all specified electrical equipment pre-installed.

MCC Building will provide power throughout different areas and equipment of the site.

Refer to the Electrical Single Line Diagram for MCC-01 and equipment layout drawing for equipment details inside the building.

P2.21.1.6 Cabling

The scope of work concerning cabling consists of engineering, delivery, installation and connection of all cable circuits. Engineering shall be carried out and confirmed according to the cable routing indicated on the site layouts on the Indicative Drawings.

P2.21.1.7 Grounding and Bonding Installation

A complete grounding network, including instrument earth system, shall be supplied and installed around the MCC building and at different areas of the facility as shown on the drawings attached. Magnitude of the Substation-10 and MCC Building GPR (Ground Potential Rise) shall be calculated using the acceptable software program and shall comply with the standards identified in this document.

P2.21.1.8 Data and Communications

The ducting for this is indicated on the Indicative Drawings and is to be installed and coordinated as part of the Contract. The Contractor during the detailed design stage shall liaise with the Employer's IT department.

P2.21.1.9 CCTV, Terminal Security, Access Control & Fire Alarm Systems

The ducting for this is shown on the Indicative Drawings and is to be installed and coordinated as part of the Contract. The Contractor during the detailed design stage shall liaise with the Employer's Security Department.

All fire alarm systems shall be linked to the terminals Central Control Room as per the Employer's Requirements. It shall be the responsibility of the Contractor to have any proposed fire system designs approved by Engineer before procurement and installation. Cameras to be installed at Berth 10 to observe loading functions.

P2.21.1.10 Excavation On Site and Existing Services

Before any excavation is carried out, it is imperative that all available utility drawings are reviewed, and the ground is surveyed with a Cable Avoidance Tool (CAT) scanner to locate the buried services in the area. Any excavation near identified cables or other buried services shall be hand dig with caution. Regular CAT scanning of trenches being dug can reduce the possibility of damage to cables or other buried services. Drawings showing existing utilities that the Employer has within his records will be made available. The Contractor shall also make his own enquiries to utility companies to establish the arrangement of existing utilities.

Cable and pipe routes on layout drawings issued with this specification are assumed to be indicative routes only. A single cable identified on these drawings may indicate one or more cables at varying depths and spread over a varying area.

Any damages caused by the Contractor to existing underground services shall be made good by the Contractor and at the Contractor's expense.

P2.21.1.11 Continuity of Supplies

As part of this contract, it shall be the responsibility of the Contractor to determine, through investigation and survey all live services within the footprint of the site that may be affected by the construction or installation of canola oil transload facility electrical works. Liaison with the Engineer and BCH regarding shutdowns, temporary power or relocation of existing supplies and machines and equipment is essential.

Prior to carrying out any work the Contractor should confirm supply of all power and communication to existing facilities and equipment and investigate whether they are at risk of losing power or operation during construction of canola oil transload facility.

If the Employer determines the risk of loss of power will affect operations, the Contractor shall make provision for a temporary supply or local generator to power any essential supplies while the works are being carried out. This temporary supply may need to be coordinated with the Engineer.

P2.21.1.12 Marking, Warning Signs and Reference Designations

All electrical equipment shall be CSA approved and certified and marked as such in a visible and readable location on the equipment. All electrical equipment shall be marked with the supplier's name, trademark, or other identifying symbol.

Warning signs, nameplates, markings, and identification plates shall be of sufficient durability to withstand the physical environment involved.

Enclosures containing electrical devices shall be clearly and durably marked as such, including their voltage level and danger signage.

Control devices, visual indicators and displays (particularly those related to safety functions), used in the man-equipment interface shall be clearly and durably marked with regard to their functions either on or adjacent to the unit. Such markings shall be as agreed between the user and the supplier of the equipment.

A nameplate giving the following minimum information shall be fixed to the individual enclosures: a. CSA Certification mark;

b. Name or trade mark of supplier;
c. Rated voltage, number of phases and frequency;
d. Current rating;
e. Short-circuit interrupting capacity;
f. Serial number where applicable; and
g. The electrical diagram number(s).

P2.21.2 Equipment and Installation

P2.21.2.1 MV Switchgear

The substation 10 room it is housed in have been designed with space to add three (3) future vertical sections for feeder breakers. The Employer has confirmed one of these future spaces can be used for the feed to the new transformer. A new close coupled vertical section shall be added and configured for top entry. A shutdown of Sub10 will be required in order to add the new feeder breaker to the switchgear and terminate the new feed cables to the new transformer. Any shutdown of Sub 10 or other power interruption shall be planned to occur on a Union Meeting night and be approved in advance by the Engineer.

New MV switchgear shall as a minimum comply with the standards listed in this document. An overview of the general requirements is given below.

MV switchgear shall be located in Substation-10. The MV switchgear shall be used for protection of Transformer. Contractor shall coordinate with the existing switchgear vendor to obtain all relevant drawings required to close- couple new switchgear to the existing switchgear. The switchgear shall be designed and specified to accommodate all appropriate circuit protection devices, current transformers, voltage transformers, metering, control, and monitoring equipment and shall be purchased from the same manufacturer of existing switchgear to minimize the inventory and facilitate identical design.

The MV switchgear complete with metering, control, monitoring and instrumentation, special tools, accessories, test equipment, etc., shall be compliant with the latest standards. Full technical details of the MV switchgear together with a copy of all relevant standards shall be provided and made available for review and comment by the Engineer, prior to submission for approval.

Construction of New MV Switchgear

General requirements for construction:

a. Control voltage/tripping supply shall be compatible with the existing switchgear.
b. All cables (power and auxiliary) shall enter the switchboard from either the bottom or top side;
c. Switchboard/switchgear shall be of the extensible type for ease of future extension of either end; All control panel indication lamps shall be of the LED/LCD type;
d. The new switchgear shall incorporate a bus coupler device to interconnect with the existing switchgear.

Circuit Breaker

Circuit breaker shall be motor operated. The switchgear shall be completely equipped for local as well as remote operation. Circuit breakers shall be maintenance-free for at least 10,000 operating cycles without any limitation by time.

Degree of Protection

The degree of protection for the switchgear shall be NEMA 1

Grounding

Busbar sections for connections of incoming and outgoing cables shall be equipped with grounding bolts. A grounding cable set with connection clamps for the earthing bolts is included in the Contractor's scope of supply.

Switchgear shall be equipped with a grounding switch that can only be operated after the circuit breaker has been switched off. An interlock shall be included to prevent earthing of an energized cable.

The grounding switch shall be equipped with a padlock facility for the grounded position.

P2.21.2.2 Distribution Transformer

A new, 25/12.5kV-600VAC transformer will be required to power the canola export facility.

The transformer shall be fed from Substation #10 (Sub-10). Sub-10 has 25kV rated switchgear, currently operated at 12.5kV. The incoming disconnect and main vacuum breaker, are rated for 1200A, but the BC Hydro feed is limited to 3,000 kW.

The Contractors shall confirm transformer sizes as part of their detailed design, where equipment loads, and diversities should be identified.

The transformer shall generally comply with the requirements of CSA C88

P2.21.2.3 Cabling Installation

Underground (U/G) conduit shall be provided from the tank farm area to the Berth 10 area, as well as the 25/12.5kV power supply from Substation #10. Outside the substation, to a suitable location, cables shall transition to an underground pull box. From that point the underground conduit would run parallel with the piping to the canola oil transload facility. The conduits shall run adjacent to canola oil marine loading and recycle lines in a common trench with appropriate separation between piping and electrical conduits. The underground electrical ducting does not need to be concrete encased if in accordance with Codes and other aspects in regard to pavement loading is met..

Cabling shall as a minimum comply with the standards listed in this document. An overview of the general requirements is given below.

General Requirements for Low Voltage and Medium Voltage Cable

Specifications for cable:

a. Applicable standard: CSA
b. Conductor type: stranded copper;
c. Insulation: Cross linked polyethylene (XLPE); TECK 90
d. Sheath: PVC;
e. Resistant to water ingress;
f. Armour: Steel wire.

Low and medium voltage power cables to electrical equipment shall be XLPE multi-core armored cables (XLPE/SWA/PVC). Low and medium voltage power cable construction shall be 600/1000V and 35kV grade respectively, plain annealed stranded copper conductor, cross linked polyethylene (XLPE) insulated PVC extruded bedded, single galvanized steel wire armored and an overall black PVC sheath.

Cables which are to be installed inside buildings shall be of the low smoke and fume type (LSF).

All ground conductors shall be PVC covered single plain annealed core stranded copper cables. The PVC sheath shall be colored green/yellow.

The cables shall be of one length to eliminate the use of jointing wherever possible. Cable lengths shall be confirmed on site. Cables shall be routed to provide adequate segregation between it and other services. Cables shall not be bent with a radius of less than the manufacturers' recommendations.

XLPE insulated armored cables shall be terminated with a mechanical type of gland which shall have a seal over the inner sheath and an internal armor clamping cone. In addition, glands shall have a compression seal over the outer sheath. All glands shall be complete with PVC shrouds, earth tags and fiber washers and suitable for the environment in which they are installed. The Contractor shall provide all jointing materials, glands, encapsulations, crimping lugs and any other material required to terminate the specified cables.

All cables shall be terminated onto equipment using glands, cable boxes, heat shrinkable encapsulations or other approved terminations. Bolted connections shall be used wherever possible.

Cables shall be routed to provide adequate segregation between it and other services.

Protection against mechanical damage shall be provided as appropriate. Particular attention shall be given to:

a. Cables rising from ground or floor level;
b. Cables passing through elements of structures.

The use of plastic cable ties shall not be accepted as a method of securing the cables to cable trays. The support and fixing of the cable ways, support system and cabling shall be fixed at no less than the manufacturer recommended minimum spacing.

Cables should not be fixed directly to internal walls but should mounted on cable tray or be enclosed within trunking or conduit systems. Externally the preference is to run cables in the installed duct system.

P2.21.2.4 Below Ground Cabling

Trenches and ducts shall be run as straight as possible. When ground contours dictate changes in level of the trenches or ducts, the changes shall be gradual.

The underground electrical ducting does not need to be concrete encased if in accordance with Codes and other aspects in regard to pavement loading is met. Before backfilling commences the work shall be approved by the Engineer.

Concrete markers of the embedded surface visible type or other suitable markers shall be installed to indicate the position and route of all cables. Markers shall be installed at 30 meter intervals with

additional markers to indicate the changes of direction. The first marker post shall be not more than 3m from the building or from where the cable leaves a trench or duct.

Cables shall be drawn into conduits one at a time and where possible they shall be drawn directly from the drums.

The layout of electrical services is shown indicatively on the Indicative Drawings. The Contractor shall design the detailed layouts of all of the electrical services based upon the following criteria:

a. Spacing and depth of buried services shall comply with regulatory requirements and best practice;

b. Buried services shall be grouped together into "corridors" where reasonably practical;
c. Where reasonably practical buried services shall be routed in areas which are either unpaved or which are not generally trafficked;

d. The layout of buried services shall be designed to minimize the need for one service to cross another;

e. Where a service must cross another service, the crossings shall maintain minimum depth requirements and best practice minimum clearance heights;

f. Where reasonably practical the locations of pits shall be in areas that are generally not trafficked and outside of container stacking areas.

Unless otherwise specified where piped services and cables cross each other the cables shall pass under the piped services.

Generally, all power cables shall be installed in concrete encased ducts buried in the ground, unless stated otherwise here or on the Drawings. Ducts within the terminal are under roads and trafficked areas and hence shall be laid at minimum depth 900 mm to crown in minimum 100 mm surround of granular bedding.

Cable draw pits shall be installed at spacing/distances and changes in direction to facilitate the installation of the cable network appropriate to the construction and development program.

Where cable duct and trench systems are to be installed, all cable duct terminations into cable draw pits should incorporate suitable bell mouths to reduce the likelihood of cable damage when pulling in cables.

All spare ducts will incorporate cable draw ropes and a retaining system to alleviate any accidental removal of draw rope and to seal all used and unused ducts following the installation of cables.

The cable ducting will be sized by the Contractor to accommodate the cable requirements for the site complete with spare ducting and draw rope for future additions or modifications.

The Contractor is to ensure that each of the different cable systems to be used within the terminal are complete with adequate spacing and segregation between sensitive cables and all other services within the ground.

Ducts shall be made of rigid uPVC material. Ducts shall be sealed immediately after they are laid, the seals being broken only during the installation of cables. Ducts shall be resealed by an approved method after the cables have been pulled in. Cement shall not be used for sealing purposes.

Cables shall be drawn through ducts and buried in trenches or laid in concrete trenches. The current carrying capacity of the cable(s) shall be determined by the installation method.

Directly buried cables shall not be permitted, unless authorized by the Engineer. In such an event only, armored cabling shall be used, laid at 900 mm below the ground level and provided with a layer of at least 150 mm impervious soil around. Protective covers shall be carefully centered over the cables throughout their length. The covers shall be of adequate width to protect the cables, with a minimum overlap on each side of 50 mm. Colored PVC warning tapes shall be laid after filling, above the cable, up to 30 mm below the ground level.

The routes of the cables shall be clearly marked by cable route markers, at regular intervals not exceeding 10 meters along straight runs and 2 meters at deviations in the route. The route markers shall normally indicate the voltage level in English.

Cable ducts internal diameters for MV & LV cables shall be a minimum of 150 mm diameter and for communications and data ducts shall be a minimum of 100 mm diameter.

Each duct shall have a PVC draw ropes installed to aid cable installation and these ropes shall be suitably fastened at each end of the ducts. The ducts shall be capped at each end to deter water ingress and other obstructions. When a draw rope is utilized to draw a cable through the duct then a replacement draw rope shall be pulled in at the same time.

The ductwork shall incorporate a reasonable number of spare ducts and be designed for future expansion of the communications and IT system network. Two spare ducts or 20% of the installed cable ducts, whichever is the greater, shall be provided on all duct routes in addition to those required for future development phases.

P2.21.2.5 Surface Installed Cables

Cables run on the surface shall be supported and fixed by proprietary cable cleats, and accessories or cable straps. All cable cleats, straps and accessories shall be suitable for the environment and where appropriate resistant to sunlight and extremes of temperature. The spacing of supports shall satisfy the requirements of the relevant Standards and the cable manufacturer's recommendations.

P2.21.2.6 Cable Ladders, Trays and Other Cable Supports

Cable support systems shall as a minimum comply with the standards listed in this document. An overview of the general requirements is given below.

Cable trays and similar cable support systems shall be hot dip galvanized. These shall have adequate mechanical strength for the load to be carried and shall have provision for the addition of a minimum of 25% of the initial installed cable load. The deflections under design loading shall not exceed that recommended by the manufacturer of the support system.

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All runs of cable support systems shall be continuous and shall be constructed of bends, tees and other purpose made fittings. Fixings and connections of system components shall be made using purpose made devices or those recommended by the manufacturer of the support system. All fixings and connecting devices shall be of non-corrodible standards. Care shall be taken to ensure that fixing bolts, screws and similar do not introduce the possibility of damage to cable, either during or after their installation.

All cables, run on the surface, shall be supported and fixed by proprietary cable cleats, and accessories. The use of plastic or stainless-steel cable ties shall not be accepted as a method of securing the cables to cable trays. All cable cleats and accessories shall be suitable for the harsh marine environment and shall where appropriate be resistant to extreme temperature conditions expected on site. The spacing of supports shall satisfy the requirements of the relevant Standards and the cable manufacturer's recommendations.

Cable trays running along the ground shall be supported and held off the ground by hot dip galvanized 'unistrut' and shall have a lid fitted.

P2.21.2.7 Cable Labelling

The Contractor shall produce a cable schedule for all the cables to be installed on site. This shall contain as a minimum, where the two ends of the cable are terminated, the cables make up and size and a unique identifying number for the cable in accordance with the cable and cable core identification.

All cables shall be identified with a permanent numbering tag fitted at each end of every cable. This tag shall bear the cable reference number allocated to the cable on the cable schedule.

Each end of the cable shall be identified using a traffolyte label. Lettering shall be colored coded and character height shall be no less than 4 mm. These shall be attached to the cable using PVC/steel core tie wraps.

Cable labelling shall be fitted to the cable by means of 2 off PVC/Steel core tie wraps. Critchley labels are to be provided at twenty (20) meter intervals and either side of penetrations, cable chambers etc.

P2.21.2.8 Cable Glands And Terminations

All cables shall be terminated onto equipment by the use of glands, cable boxes, heat shrinkable encapsulations or other approved terminations. XLPE insulated and armored cables shall be glanded with a mechanical type of gland which shall have a seal over the inner sheath and an internal armor clamping cone. In addition, glands shall have a compression seal over the outer sheath. All glands shall be complete with PVC shrouds and earth tags and be suitable for the environment in which they are installed. Aluminum bodied glands shall not be used anywhere in the installation.

All cable glands shall be of the type used for external use whether the equipment is internal or external to a structure.

Cable conductors shall be terminated with crimped lugs or pins to suit the equipment connections.

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P2.21.2.9 Cable Joints

All cables shall be terminated onto equipment by the use of glands, cable boxes, heat shrinkable encapsulations or other approved terminations. Bolted connections shall be used wherever possible.

Cables shall be pressure tested on completion of installation. Phasing testing followed by further pressure testing shall be carried out prior to the final connection. All results shall be tabulated. All testing shall be attended by the Engineer.

The cable shall be insulation tested between phases and each phase to earth prior to and directly after each pressure test, once the cable is discharged.

P2.21.2.10 LV Motor Control Center (LV MCC)

LV MCC and equipment shall as a minimum comply with the standards land project drawings listed in this document. An overview of the general requirements is given below.

The MCC construction shall comply with NEMA 1 as a minimum.

Refer Drawings 7704-E-100, 101, 102, 103 for load and protection details

P2.21.2.11 Following MCC Design Options shall be considered during detailed design:

- Networked starter units (“Smart” MCC) that provide additional motor status and trip diagnostic information to the operators. Provides a safer remote access unit that doesn’t require additional hardwired I/O points.
- Auto-racking Unit to have bus isolation, stab indication, and lockout features that proactively prevent the initiation of an arc flash events.

Busbars

Busbars shall be copper and shall be sized to carry continuously the current specified on the drawing. Copper busbars shall have high pressure bolted joints. The main busbars shall be run either at the top or bottom of the control centre but ample access must be provided for top cable entry. Access to the busbars shall be by means of bolted cover plates or approved equal.

Ground Busbar

A copper ground bar of 50 mm x 6 mm minimum cross section shall be provided running the full length of the board. Each cubicle shall be securely bonded to the earth bar and provision shall be made for connecting units individually. A separate earth terminal shall be provided for each incoming and outgoing way.

The ground bar shall be provided with terminals for connections at both ends to the main earthing system by means of equal section copper tape or cable lugs suitable for up to 300 sq.mm cable.

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All non-current-carrying metalwork shall be bonded to the earth bar.

The fault rating of earth busbars, terminations and connections shall be not less than the corresponding symmetrical fault rating indicated on the relevant Indicative Drawings.

P2.21.2.12 LV Circuit Breakers

Circuit breakers, Fuses, Miniature Circuit Breakers (MCB), Molded Case Circuit Breakers (MCCB), Air Circuit Breakers (ACB) and the like shall comply with the requirements of ANSI/IEEE.

All circuit breakers shall be of the air break or moulded case type with the continuous current ratings and short circuit ratings to suit the system fault levels as calculated at detail design. Circuit breakers shall generally be of the horizontal draw out type, integral with their transport carriages and fully interlocked with provision for locking in the isolated position.

The circuit breakers shall be complete with primary and secondary isolating contacts, auxiliary switches, mechanical position indicator, control wiring and interlocks.

Moulded case circuit breakers shall be fitted with thermal and magnetic overload trips and shall have quick make quick break trip free mechanism and mechanical indication of ON/OFF/TRIPPED.

P2.21.2.13 LV Distribution Boards and Panels

The distribution boards shall be single phase and neutral or three phase and neutral. The distribution boards shall incorporate neutral busbars and ground bars with sufficient outgoing terminals for each outgoing circuit.

Each distribution board shall have a label to identify it. Every circuit in the distribution board shall be labelled and fully identified where it feeds. Incoming switches on boards shall identify where the board is fed from. Inside the front door of the distribution board shall be an accurate printed list of all the circuits.

Spare and unused ways in distribution boards shall be fitted with blanking plates.

Installed distribution boards shall be complete with all cabling, connections and terminations made, the earth bars installed and connected to the main earth system, metallic cases shall be earthed, all protective devices fitted or blanking plates covering spare ways and shall be fully labelled.

The LV distribution boards and panels shall incorporate spare circuit breakers of various ratings, such that at least one of each circuit breaker rating is provided and such that a switchboard cubicle section is a completed constructed section complete with circuit breakers.

All LV distribution boards and panels be provided with an additional 25% spare capacity to the initial requirements and the further requirements.

P2.21.2.14 Primary Protection

The equipment shall provide adequate safeguards against the effects of any fault occurring on the system or component parts. All protective devices, including relays and current transformers (CTs), etc. are to be adequately rated to withstand the prospective short circuit current which can flow or be induced.

The relay protection devices will be such that a clear indication is given of the fault which caused a trip.

P2.21.2.15 Overcurrent and Ground Fault Protection

LV incomer circuit breakers shall be complete with built in Micrologic trip units.

Protection shall be of the multi-function, microprocessor-controlled pattern incorporating trip circuit supervision and self-diagnostic functions. Protection relays shall be supplied complete with communications hardware and software to enable each protection relay to be connected to the Employer's LAN network for remote monitoring.

As a minimum, the following protection functions shall be available for selection on each relay:

- IDMT Inverse Definite Minimum Time - Standard Inverse, Very Inverse, Extremely Inverse
- LTI Long time inverse
- Inst Instantaneous
- DMT Definite Minimum Time

P2.21.2.16 Transformer Protection

The following protection will be provided for main transformers (Primary (M.V.) side):

a. Over-current with instantaneous high set;

b. Over temperature alarm and trip of upstream circuit breaker on transformer earth fault.

Inter-tripping will be provided between MV and LV breakers to ensure complete isolation of the transformer under fault conditions and inhibit close.

P2.21.2.17 Lightning Protection

All electrically conductive components of the canola oil transload facility shall be effectively connected to a ground electrode system with substantial low impedance connections to ensure, so far as is reasonably practicable, the safe discharge to ground of any lightning and/or fault and similar currents to which the installation may be subject.

P2.21.2.18 Lighting

Area Lighting Requirements

The following areas will need Lighting System Installations:

- Rail car unloading facilities
- Canola oil storage facilities
- Canola oil marine loading facilities
- MCC building
- Pumping areas

- General areas lighting system
- Service road and parking lot

The Contractor shall model and carry out a lighting design for these areas and achieve lighting levels to IESNA Standards.

Table 23: Lighting Levels as per Employer Standard

Area	Min. Maintained Horizontal Illuminance at Ground Level (Lux)
Canola oil marine loading facilities	50
Railcar Unloading Area	100
Pumping areas	100
General areas lighting system	50
Parking Area	20

The minimum maintained average lux levels that must be obtained for area lighting at the operational areas shall be:

Lighting levels must conform to the Employer's or Canadian Labour Code requirements, whichever is higher.

Cables running between buildings and lighting masts shall be protected at both sides against overvoltage.

P2.21.2.19 Control System Equipment

An automated control system with minimal operator involvement shall be provided consisting of a DCS or PLC-based system, whichever is considered most optimal for the application. The unloading and loading system will be operated via two double-tier HMI interfaces in the Control Room interlocked with local control stations.

The preferred solution is a true Peer-to-Peer DCS system, in which the failure of any individual node does not impede the communication or operation of any other node, and in which there are no intermediate servers for relaying real-time information from the process-connected devices to the Operator HMI's.

As an alternative, a SCADA-based system utilizing PLC-based process-connected devices may be considered, if the reliability of the proposed system can be shown to be equivalent to the Peerto-Peer DCS option.

Redundancy would be applicable to hot-swappable processors only, and will enhance the reliability and availability of the plant significantly. Hot-swappable I/O modules is not envisaged at this time, but could be included if the Employer prefers, or if safety review required particular loops to have higher level of integrity.

A network with ring topology meets the redundancy requirements for communications, provided it is a bi-directional ring.

A dual redundant automatic failover server setup is acceptable if a PLC system is selected.

In either case, a fully engineered and integrated system shall be provided, including all hardware, interconnecting cabling, communications systems, subsystem interfaces and cabling, marshalling panels, field wiring and field instrumentation.

Contractor shall also be responsible for providing all system software and application software, including sequence programs, complex loop programming, logic and control programming, Input/Output defintions, etc.

The control system will be expected to perform the following tasks:

- Operate actuated valves to select the systems flow path. The following operating conditions have been identified:
    - Railcar unloading pump -> CSD Storage tank ○ Railcar unloading pump -> Marine loading pump -> Ship loading ○ CSD Storage tank -> Marine loading pump -> Ship loading ○ Recycle mode for marine loading pipeline
- Once a railcar has been emptied this will be determined by activation of a low flow switch which serves to inform the operator that the valves for that railcar unloading station can be manually closed , and the unloading arm for that unloading station can be disconnected from the railcar. The low flow switch can also serve to indicate that a railcar has not been properly lined up for unloading if it remains active at the beginning of railcar unloading, prompting the operator to investigate to establish why there is no flow at that time.
- Control the railcar unloading pumps via a local Human Machine Interface (HMI) panel The pump will be required to ramp up and down to a setpoint given from 0-100% RPM. These pumps will be interlocked with the overfill protection system on each storage tank.
- Custody transfer metering of the incoming fluid from the railcars, via Coriolis mass flowmeter, due to the higher reliability and accuracy (mass flow accuracy of +/- 0.05%) compared with Volumetric flowmeters, which require pressure, temperature and density compensation (which is particularly challenging with Canola Oil, due to the fluctuation of viscosity over the operating temperature range).
- Provide overfill protection for the tank farm. Instrumentation on the tanks will provide operators details about each tank including liquid level, oil temperature, and tank pressure (future for RBD storage tanks). Readouts from these instruments will also be interlocked with

pump controls to ensure that the system will perform a controlled shutdown in case of an upset condition.

- Control the tank agitators via a local HMI panel. The agitators will be controlled via a basic on or off signal.
- Provide overpressure detection and protection for the system. This will be achieved by monitoring inlet and outlet pressures of the pumps to prevent dead-head and cavitation conditions.
- Control the ship loading pumps via the same local HMI panel as for the tank agitators. The pumps will be required to ramp up and down to a setpoint given from 0-100% RPM of the motor. These pumps will be interlocked with the tank overfill protection system, tank minimum level protection system, and with the ship loading system.
- Provide monitoring and control of ship loading activities at the marine terminal via a local HMI panel.
- Custody transfer metering of the outgoing fluids to the ship, also via Coriolis mass flowmeter, with an accuracy of +/- 0.05%, due to the higher reliability and accuracy compared with Volumetric flowmeters, which require pressure, temperature and density compensation. Some swaging up/down of the line may be required in order to enable the use of Coriolis mass flow meters in this application.
    - Both custody transfer meters are Coriolis flow meters.
- Monitoring all other instrumentation required from the system including the sump pits, drainage pumps, and water treatment system.
- Provide graphic-based interface for Operators with a hierarchical graphics package, accessible from all HMI's.
- Provide hierarchical interlocking for HMI's to enable Operator control of processes from Local or Control Room HMI's.
- Provide Historian and alarming capabilities for the system, with trends and alarming functionality also available at all HMI's.
- Miscellaneous Control System Requirements: ○ Full control system engineering software design and development including:
    - system, application, and graphics package ○ Factory Acceptance Testing ○ Site installation supervision, Site Acceptance Test, commissioning support ○ Site-wide CCTV system including system hub in MCC. ○ Building and site access security system, including system hub in MCC.
    - IT network to support interconnection of CCTV and Security system, as well as the Employer's IT business Local Area Network (LAN).

DCS/PLC Control System Architecture

The backbone of the control system shall be a Distributed Control System/Programmable Logic Controller (DCS/PLC) network, with all servers, routers, switches, communication hubs and drivers, located in a series of cabinets located in the MCC building.

Sufficient DCS/PLC cabinets will be required to provide a main controller, system hub, HMI package, and communications and historian servers along with three local HMI panels, each including remote I/O racks. The main controller cabinet(s) will be housed within the new MCC building, whilst one local HMI panel will be installed adjacent to the rail unloading arms to serve the local instruments, a second one located by the ship loading pump and tank area, and a third one at the marine loading area.

Processors for the core process-connected controllers shall be dual redundant. Other hot swappable dual redundant control systems can be considered, provided the reliability and availability can be shown to be equivalent.

Two double-tier HMI Operator workstations shall be located in the Security and Control building, as the primary Operator interface for the system.

The core DCS/PLC network shall be a dual redundant (other hot -swappable dual redundant control systems can be considered, provided the reliability and availability can be shown to be equivalent), bi-directional ring topology. The network will not be connected to a central data historizing system, such as PI, and at least initially, not to an Employer's IT network. Neither shall the system be connected to the internet, unless specifically required by the system supplier for remote maintenance, the specific architecture for which shall be subject to approval from the Engineer.

A system Historian shall be provided that will historize all process variable data and control system outputs, located in a cabinet in the MCC building.

An Inventory management package is included, and custom reports can be generated from DCS system, and most SCADA systems, as required, via a standard Reports Package. More extensive reporting would be part of an Enterprise Management System, which can be offered if required.

Subsystem communications, where they exist, shall be modbus TCP/IP or similar ethernet-based system, and wherever possible, each subsystem shall connect to the core DCS/PLC system via a dedicated interface. Where not possible, or where a subsystem requires external communication for remote troubleshooting, sufficient firewalls shall be provided to maintain cyber security of the core network.

The DCS/PLC communication network will consist of the following major items:

- The main controller(s) and system servers, Control Room and Local HMI's, and remote I/O rack(s).
- Power metering, motor control, and protection equipment housed within the new MCC unit.
- Other electrical equipment (UPS, HVAC) which may need to be networked within the MCC building. ○ A security/communication cabinet will be required in-order to consolidate all servers, recorders, and gateways to run the security system (cameras and FOB key entry).

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These systems will communicate using Ethernet/IP to a local workstation or panel PC which will be housed within the new Control and Security building.

An Radio-Frequency Identification (RFID) system will be specified for the railcar unloading system. A gateway/communication module for the RFID system will be linked back to the Ethernet/IP network.

RFID data would normally be displayed as part of the Business LAN system for the plant, and not in the DCS/SCADA. An HMI for the Business LAN system will be available in the control room for access by Operators, and will sit adjacent to the main DCS/SCADA HMI's.

A full suite of hierarchical graphics-based applications interfaces shall be provided within the DCS/PLC HMI. This shall include supervisory level overview graphics, process level operating graphics, detail level equipment graphics, alarming and trending packages, all provided and presented in such a way as to accomplish the operating requirements described in the Preliminary Process Control Narrative document and elsewhere in these specifications.

A system Historian shall be provided that will historize and provide trending packages for all the process variables in the facility, analog and discrete, including alarm handling.

Two control shelters containing HMI panels (as well as remote I/O racks) will be used as the secondary means of controlling the system in addition to the primary control in the MCC Building. Each shelter should be a covered area in which the Operator can access and operate the local HMI as required, with sunshades as necessary, but with a clear line of sight to the operating processes. The control shelters will be installed near the marine loading pumps and the marine loading area so that the operator can have a line of sight to the operation in each case.

Local push button stations, with Light-Emitting Diode (LED) indication, will be installed at each railcar unloading station to open the actuated valve for its corresponding arm.

Local push button stations, with LED indication, will be installed at each railcar vent connection station to open the actuated valve for its corresponding arm.

Connection requirements to the external site network, if required, will be determined during detailed design.

The following details the general design requirements for the DCS/PLC cabinets in the MCC building: ○ Free standing cabinets as appropriate to house the main DCS/PLC controllers and their associated modules, networking equipment, servers, and terminating points. ○ DCS/PLC controllers as appropriate Note: all DCS/PLC processors and communications modules shall be redundant, hot-swappable. ○ Core processing modules for remote HMI workstations and Remote I/O racks ○ Marshalling/terminating terminals and devices for the system. ○ One (1) Engineering Workstation dedicated to the core DCS/PLC system located in the

MCC building ○ All interconnecting wiring to their terminations

in the cabinet. ○ Designed for minimum 25% spare.

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Local Harsh Weather Workstations and Remote I/O Racks

The following areas shall require remote I/O racks and harsh weather HMI workstations:

- A location in close proximity to the Railcar unloading pumps.
- A location in close proximity to the Marine Loading pumps and storage tanks.
- At the marine loading dock.

The overriding principle for locating the remote I/O racks and harsh weather workstations shall be line of sight to the principal equipment being controlled by the Operator.

The local HMI's shall be harsh weather workstations, single tier operator HMI's, which shall provide access to the full suite of control room HMI graphics, alarms and trends. They will be installed with specific weather shelter cover to allow the Operator to be able to carry out his tasks in inclement weather, whilst still retaining line of sight to the operating process

Associated with each harsh weather HMI shall be a remote I/O rack from the core DCS/PLC system, installed in a weatherproof enclosure, NEMA 4X.

Processors for the workstations and Remote I/O racks shall be installed in the MCC building and connected via fibre optic to the remote devices.

Any and all outdoor runs for network or subsystem communications, including between buildings, shall be via fibre optic cabling, using diverse paths for redundant cabling where necessary.

The following details the general design requirements for the remote locations:

- Remote I/O Panel Layout: ○ One enclosure to house each remote I/O rack and its associated modules, networking equipment, and terminating points. It is anticipated that the enclosure will be mounted outdoors and NEMA 4X rated.
  - The local HMI in each case shall be designed for outdoor use in a harsh environment, appropriate for west coast British Columbia.
  - Marshalling/terminating terminals and devices for the system. ○ All interconnecting wiring to their terminations in the cabinet. ○ Designed for minimum 25% spare.
  - Remote I/O enclosures shall include air-conditioning if remote I/O electronics require it, but equipment rated for NEMA 4X is preferred.
- Loop, marshalling and I/O drawings
- Design and detail of network architecture drawings for DCS/PLC panels and equipment within the MCC building.

P2.21.2.20 Field Instrumentation

Control and On/Off Valves

Motor operated valves (MOV) shall be flanged body type, rotary actuation, and include the following signal capabilities:

- Remote and local Open
- Remote and local Close
- Remote and local Stop
- Valve position analog feedback
- Limit switch end of travel Open position
- Limit switch end of travel Closed position
- Motor Fault
- Local/Remote switch status

Note some MOV's may be required to work in "JOG" mode, which shall be determined during detail design phase.

Pneumatic piston-actuated rotary ON/OFF valves shall all be butterfly valves flanged body type, as identified on the P&IDs, (except where full bore ball valve is identified), and shall include the following signals:

- Open/Close command output
- Limit switch end of travel Open indication
- Limit switch end of travel Closed indication

Pneumatic piston-actuated rotary control valves shall all be butterfly valves flanged body type complete with positioner, as identified on the P&IDs, and shall include the following signals:

- 4-20mA output control signal
- Limit switch end of travel feedback for safety position of valve, as indicated on P&ID.
- Position feedback for some critical control valves, as indicated on the P&ID.

Field Sensory Instrumentation

Outdoor instrumentation shall be supplied with enclosure class IP-65 as a minimum, and shall be appropriately designed for local area classification.

Analog instrumentation shall be conventional 4-20mA with HART protocol where possible and loop powered where possible.

Contractor shall supply a minimum of two (2) HART protocol hand calibrators for exclusive use of the Employer's personnel.

Custody transfer meters shall require an individual accuracy +/-0.05% and Coriolis flowmeters shall be used in these applications. Two locations are identified on the P&ID's for custody transfer flowmeters; on the Railcar unloading header, and on the Marine Loading header. Both meters shall be 250 mm (10 inch) Coriolis mass-flow meter with swaging up/down of line-sizes as appropriate.

P2.21.2.21 Electrical Standards, Codes and Regulations

The electrical installation shall be carried out in accordance with the latest version of CSA C22.118 Canadian Electrical Code, Part 1.

P2.21.2.22 Power System Study of Electrical System

The following studies shall be provided for the Employer to review during the detailed design phase:

- Short circuit study
- Breaker coordination study
- Arc-flash study
- Harmonics Study

P2.21.2.23 Short Circuit Study (1/2 Cycle, 3 Phase and L-N Faults)

The short-circuit analysis will determine:

- If there is fault current contribution to specific locations in the network based on the system configuration,
- The amount of fault current contributing to specific locations in the network, and
- The device capabilities, to confirm they can withstand the fault current.

P2.21.2.24 Breaker Co-ordination Study

The breaker co-ordination study will analyze the effects of a 3-phase bolted fault on all major equipment within the project and will provide a list of settings for the project over-current devices to improve their selectivity.

P2.21.2.25 Arc-flash Study

The arc flash study will analyze the effects of an arc flash event per IEEE-1584-2018 standards on all major equipment within the project. The report will detail:

- The required personal protective equipment to be worn by electricians in order to conduct “live” work on the piece of equipment (as per CSA Z462-15 Workplace Electrical Safety).
- A list of recommendations on methodologies and technologies for reducing the incident energy that a Worker could be exposed to.
- Arc-flash labels per site standards.

P2.21.2.26 Voltage Drop

Voltage drop on cables shall be considered with respect to the allowable limits for equipment and motors. Cable size may be increased to reduce voltage drop. Cable voltage drop requirements shall be based on the requirements of the Canadian Electrical Code.

P2.21.2.27 Grounding, Bonding and Lightning Protection

For the purpose of grounding, bonding and lightning protection, the relevant sections of the following standards shall apply:

- CSA C22.1-18 Canadian Electrical Code, Part 1

bdc

- CSA-B72-20 Standard for Installation of Lightning Protection

P2.21.2.28 Lighting Study

The lighting design shall be carried out by the Contractor. The lighting study shall be submitted as part of the Contractors detailed design submission.

The lighting study shall be deemed to include the calculation of lux levels and uniformity as required to meet specified lighting levels.

P2.21.2.29 Cable Calculations

The cross-sectional areas of the cables shall be calculated and confirmed by the Contractor during his detail design regardless of whether it has been specified on the drawings or within this document.

P2.21.2.30 Electrical Installations in Hazardous Atmospheres

The Contractor shall ensure that the wiring installation, materials and equipment used or installed in any hazardous areas are entirely suitable for the anticipated hazard(s) and that they comply fully with the standards specified herein, all local statutory and similar requirements and the instructions and requirements of the manufacturers and certifying authorities.

P2.21.3 Workmanship

P2.21.3.1 Quality of Workmanship

All workmanship and materials used shall be of their best respective kinds and shall comply in all relevant respects with the most recent revisions of the appropriate regulations and standards. Under no circumstances will work or material of an inferior nature be tolerated in any part of the works.

P2.21.3.2 Defective Work or Equipment

Any faults in the work performed by the Contractor, or in the materials or equipment selected and supplied by the Contractor, shall be corrected or replaced by the Contractor, to the satisfaction of the Employer and the Engineer, at the Contractor's expense.

P2.21.3.3 'Equal' or Equivalent / Approved

The words or "equal" and/or "equivalent/approved" in the documentation means any material or workmanship proposed by the Contractor as an alternative to that specified which shall be of equal or better specification than that specified and is subject to the written approval of the Engineer before it may be used.

P2.21.4 Testing and Commissioning

P2.21.4.1 General

During the execution phase of the works, tests and inspections have to be carried out to verify compliance of the components, materials and works with the Employers requirements.

Tests will be carried out partially at the point of origin and partially on-site.

After the works are completed and the tests have been successful the commissioning phase starts during which the Employer and the Contractor will work in joint effort to achieve ready-foroperation status of the installations.

All Contractors' involvement during the test- and commissioning phase shall be included in the scope of work.

P2.21.4.2 Factory Acceptance Test (FAT)

Factory Acceptance Tests must be executed at the point of origin (factory where goods were produced) and include at least:

- Visual inspection;
- Check completeness (reference to drawings);
- Mechanical checks;
- Control circuits check;
- Signal and measurement check;
- High voltage test;
- Insulation measurement;
- Marking and signs;
- Check of presence of special tools, auxiliaries e.g.

A FAT is intended to confirm compliance of the component with the specifications on base of which the component has been ordered. The FAT is carried out by a third party, the costs of the FAT shall be included in the Contractors price.

In case of non-compliance the manufacturer will get the opportunity to rectify any incompliances and to repeat the test thereafter.

The Employer and/or the Engineer has the right to witness all tests and any costs associated with the same shall be deemed to be included in the Contract Price.

At least 4 weeks in advance of the test the Contractor must submit the test programme for approval to the Engineer.

P2.21.4.3 Site Acceptance Test (FAT)

A SAT is mandatory for (parts of) installations at the moment of completion of construction (Mechanical Complete).

Site Acceptance Tests include at least:

- Visual inspection;
- Control circuits check (including external connections);
- Signal and measurement check;
- High voltage test;
- Insulation measurement;
- Measurement of contact resistance at contact surfaces of bolted connections, such as busbar sections;
- Markings and signs;
- Check of special tools and auxiliaries;
- Interlock test;
- Phase sequence;
- Check of settings;
- Test of protective devices (by means of current injection in the primary circuit). The SAT is intended to confirm correct installation methods and quality of the on-site construction work.

For individual components the SAT must include also a test to demonstrate that the installed component meets the specification requirements.

P2.21.4.4 System Test

Components that are part of a system must be tested as (part of) an integral system. The system test must demonstrate that the complete system meets the specification requirements.

The Contractor shall notify the Engineer, in writing, when each area of canola oil transload facility is complete and when the whole of the work is completed. Each area and the whole of the work shall be tested in accordance with all relevant design and installation standards and codes of practice. The tests shall show that the whole installation complies with those standards and codes of practice unless any deviation there from shall have been authorized by this Specification. Any deviation from those standards and codes of practice shall be recorded on the test certificate(s).

The Contractor shall provide all personnel, equipment and apparatus necessary for carrying out the tests on site and all tests shall be carried out in the presence and to the satisfaction of the Engineer.

P2.21.4.5 Commissioning

Commissioning of installations is part of the Works and will be done by the Contractor after construction is completed and all required tests have been executed by the Contractor. The Contractor shall propose a Commissioning Specialist to the Engineer. After the Engineers' approval this Specialist will be responsible for the whole commissioning process.

In advance of the start of commissioning the Contractor shall provide commissioning manuals, comprising: (i) a set of commissioning procedures stating the tests that shall be performed; (ii) a

method statement detailing the testing procedure; (iii) sub-division between individual component tests and complete installation tests and (iv) commissioning record sheets showing: design data listed in or ascertained from the Employer's Requirements or otherwise provided by the Employer.

These tests shall prove the mechanical and electrical operation of the plant, including the correctness of the protective devices and auxiliary wiring and measure its insulation resistance. The inspection and commissioning results and the final test results have to be presented to and accepted by the Employer.

The commissioning procedure will be defined by the Employer and the Contractor must provide support and assistance to the Employers Commissioning team free of charge.

The Contractor shall provide all personnel, equipment, and apparatus necessary for carrying out the tests on site and all tests shall be carried out in the presence of and to the satisfaction of the Engineer.

P2.21.4.6 Operational and Maintenance Manuals

The Contractor shall supply a complete set of operational and maintenance manuals for every item of equipment supplied for the canola oil transload facility.

This documentation package shall contain at least the following items:

i. A description of the extent and manner of operation, including duration periods of standby systems;

ii. A description of the method used for compliance with Regulation related together with time/current characteristics for all protective devices for automatic disconnection of supply;

iii. A copy of any certificates of compliance with relevant standards or schemes as required; iv. Comprehensive instructions for the switching on, operation, switching off and isolation of circuits/systems and for dealing with emergency conditions;

v. Instructions for any precautionary measures necessary;

vi. Instructions for servicing, including frequency and materials to be used, to maintain the equipment in good and safe condition;

vii. Names and addresses of suppliers of all major components together with the type and model reference, serial number, duty rating and the order number and date.

Copies of manufacturer's data may be incorporated to supplement the descriptions and instructions required but shall not replace them. Only data relevant to the Works shall be included, and where non-relevant information appears on the same sheet it shall be clearly marked to show that it is not applicable. The information shall be cross-referenced within the text and included in the index, and, if possible, it shall be contained in the ring binders, covered in a plastic material with title and description. The format of the manuals shall be agreed with the Engineer. The manuals shall lie flat when open. Three (3 No.) hard copies of approved operating and maintenance manuals shall be submitted.

P2.21.4.7 Spare Parts

The Manufacturer shall supply spare parts sufficient for two years' continuous operation as recommended by the Manufacturer for each item of Plant. Such supply shall include lists of part numbers and unit prices.

The spare parts list for 2 years of operation shall be submitted before the FAT.

In addition to the above, the Manufacturer shall provide all spare parts required for installation and commissioning.

P2.21.4.8 Special Tools

The Manufacturer shall provide special tools and lifting bars/equipment necessary for maintenance, installation and commissioning.

The special tools list for maintenance, installation and commissioning shall be submitted before the FAT.

P2.21.4.9 Documentation

The SI system of units shall be used. English language shall be used for all drawings, texts and communications.

In general, the Manufacturer shall submit the following information:

- Shop Drawings: Indicate outline dimensions, Enclosure construction, shipping splits, lifting and supporting points, electrical single line diagram and equipment electrical ratings.
- Product data: Data-sheet for components and accessories.
- Test Report: Indicate procedures and results for specified factory and field testing and inspection

The Manufacturer shall submit for each supplied equipment (and components) the following documentation, but not limited to:

- General Arrangement drawings with typical sections and elevations;
- Foundation Plan; • Single Line Diagrams; • Schematic Diagrams:
  - Wiring diagram; ○ Control diagram;
  - Logic diagram.
- Component List (or Bill of Materials);
- Equipment's and Components Data-Sheets;
- Test Reports;
- Quality Assurance Books (or Manufacturer Data Book);
- Maintenance Manual;
- Installation/Erection field handling procedures;
- Detailed maintenance schedule;
- Programming Manual (where applicable);
- List of special tools or equipment;

- Manufacture authorization form/certificates for brought out sub-components/parts;
- Operation Spare Parts List for 2 years;
- Installation and Commissioning Spare Parts List.

Documentation shall be submitted in a digital/electronic copy in PDF format.

The documentation shall be well ordered and be easily accessible with an overall table of content.

P2.22 IT AND TERMINAL SECURITY

P2.22.1 Site Conduit Connections

In a manner consistent with the Employer's Requirements and Volume 3, the Contractor shall provide the following minimum concrete-encased Rigid Polyvinyl Chloride (RPVC) DB/2 conduit connections:

a) From Substation 10 to the SSF Vault in Yard 10:
   - Three 100mm (4") conduits for 12.5kV or 25kV Project power
   - Three 100mm (4") conduits for Project Low Voltage (LV) power
   - Three 100mm (4") conduits for Project controls and communications
   - One 100mm (4") conduit for future 12.5kV or 25kV power
   - Fifteen 100mm (4") conduits for future LV power and communications

b) From the SSF Vault to the MCC Building Building:
   - Three 100mm (4") conduits for 12.5kV or 25kV Project power
   - Three 100mm (4") conduits for Project Low Voltage (LV) power
   - Three 100mm (4") conduits for Project controls and communications
   - Three 100mm (4") conduits for future LV power and communications

c) From the SSF Vault to the pullbox nearest to the Marine Loading Pumps:
   - One 100mm (4") stubbed-up and capped conduit for future 12.5kV or 25kV power
   - Two 100mm (4") stubbed-up and capped conduits for future LV power and communications

d) From the MCC Building to the VFPA Vault on Timberland Road South:
   - One 50mm (2") conduit for communications

e) All other conduits as required to satisfy the Employer's Requirements and Volume 3
f) Fibre should be in separate ducts and not merged with LV/HV ducts and manholes.
g) Outdoor Fiber should be rodent protected.

P2.22.2 Site Fibre Optic System

The Contractor shall provide site fibre optic cables, including the following requirements:

- Provide single mode fibre and terminate in patch panels in the various control cabinets, collector cabinets, equipment racks, substation racks and, communications and server rooms;
- All new optical fibre cables shall be non-armoured, single-mode, undergroundrated, FT1-rated, no factory splices, all dielectric construction, 8.3/125 micron (core/clad),

suitable for outdoor use in conduit or indoor use (where required) nongel filled, single loose buffer tube design unless otherwise noted in the Electrical Design and shall be CSA approved.

- All fibre installed in raceways and conduits shall be non-armoured unless noted otherwise.
- The number of optical fibre strands shall be as required to meet the Employer's Requirements.
- Standard of Acceptance: Corning ALTOS Loose Tube, Gel-Free, Single-Mode.
- Terminate and test each fibre;
- Provide 24 duplex patch cords for each 48C fibre terminated at each patch panel location of the core fibre;
- Provide three duplex patch cords for each 12C fibre terminated at each patch panel location; and
- RJ 45 Ports/Face Plates for Indoor LAN are needed.
- Provide temporary fibre to suit the various stages of construction.

The Contractor shall prepare all design information and details necessary to complete the Design, including the following:

- Site wide fiber riser diagram including proposed and existing fiber.
- Connection diagram for each patch panel;
- Cable labelling.
- Installation of fiber optic system must be completed by a Corning Cable Systems LANscape NPI Certified Contractor.
- The Contractor shall supply and install all fibre optic cable, including the supply and installation of terminations and OTDR testing.
- All workmanship, material and/or installation practices and activity shall be equal to or better than the most recent version of the applicable standards established by the CSA and the Canadian Electrical Code.
- The Contractor's technician shall have a minimum of five (5) years of experience installing and testing single-mode cables of all types.
- Fibre optic cable shall be installed in a continuous run-in conduit and shall be spliced as noted in the Electrical Design. The fibre optic cable shall consist of 30m loops in each vault.
- When installing cable in conduits, concrete vaults, and junction boxes, the Contractor shall ensure the conduit does not exceed the minimum bend radius. Each cable shall be labelled within 10 centimeters of the terminated ends with a tag and text stating the fibre optic cable identifier and destination name. Cables shall be tagged every 5 m in the concrete vaults, junction boxes and all other access points with the fibre optic cable identifier and with "CAUTION, FIBRE OPTIC CABLE" tags.

- Enough cable slack shall be left at termination points to allow the cable to be routed through the termination hardware to a polishing/splicing table, plus a minimum of 3 m additional slack. Cable slack shall be coiled and secured with hook and pile fastener (e.g. Velcro™) ties for breakaway protection. Cable to termination panel shall be secured to cabinet with wire ties (e.g. Ty-wraps).
- Excess cable inside concrete vaults and junction boxes shall be coiled and mechanically secured in place with hook and pile fastener (e.g. Velcro™) ties such that the minimum bend radius is not exceeded and the cable is suspended above the concrete vault or junction box bottom. The hook and pile fastener straps are to provide "breakaway" protection in the event of an accidental dig up between pull boxes.
- Splice closures are to be installed with the cable jacket stripped and dressed; however, no splices in the cable are to be made, unless identified in the Electrical Design.
- All splice trays, patch panels, and patch cables shall be neatly organized and clearly labeled.

During construction the Contractor shall maintain power and communications infrastructure to all Local Area Network (LAN) and fibre optic equipment to ensure that existing LAN interconnectivity between devices and facilities is maintained at all times.

- Before and after installation, each segment of each fibre shall be tested using an Optical Time Domain Reflectometer (OTDR) and power meter equipment. Testing shall be completed in each direction on each fibre and at 1310 nm and 1550 nm wavelengths. Launch cable shall be used as per the OTDR manufacturer's specifications. The Contractor shall provide a typewritten report and digital test files detailing the results of each test, including OTDR test results

  in graphical format, cable length, any fibre breaks or anomalies, attenuation of the fibre's connectors, and fibre uniformity, complete with a concise summary of the results.
- The Contractor shall provide on-reel testing prior to cable installation. In the "Comments" section of the OTDR software the Contractor shall include: loss per km, helix factor, and length of cable. These form part of the cable specifications and usually attached to the reel. OTDR pulse width and acquisition time shall be adjusted until a clean trace is obtained. A clean trace is where the end of the fibre is significantly above the noise level. A 1.5 km launch box shall be used at the test point of the fibre. All anomalies shall be noted and included in the report. All test results shall be recorded onto a CD and submitted.
- The Contractor shall provide splice testing during fibre splicing. Loose tube, maximum loss of splice shall be less than 0.3 dB. OTDR wavelength shall be 1550 nm. Pulse width and acquisition time shall be adjusted so that the splice can be seen even though the splice is within specification. All anomalies shall be noted and reported to the Employer.

- The Contractor shall provide Final Acceptance Testing. Final Acceptance Testing shall consist of light source/power meter testing, and OTDR bi-directional testing following TIA FOTP8/59/60/61/78 test standard procedure.
- End to end testing shall consist of testing of the new fibre installed as part of this Contract.
- Light source/power meter testing shall be provided in either MS Excel or MS Word format and include: dates of tests, contractor, names of technicians, addresses of test locations, cable manufacturer, loose tube or ribbon, number of fibres, test instrument manufacturer and model numbers with last calibration date (equipment shall be calibrated within the last 12 months), length of launch reel (1500 m) or pigtails if used, and wavelengths. Light source/power meter testing shall be completed first to ensure that no fibres have been crossed. Wavelengths shall be 1310 nm and 1550 nm.
- OTDR bi-directional testing shall be provided. The fibre shall be tested from each end with the same OTDR parameters. OTDR wavelength shall be 1310 nm and 1550 nm. Pulse width and acquisition time shall be adjusted so that the end of the fibre is clearly seen. A 1.5 km fibre launch box shall be used at the test point of the fibre. Any anomalies shall be noted and reported to the Employer. All OTDR test results shall be either in "EXFO" trace format or a format acceptable by the Employer. All test results shall be recorded onto a CD and submitted.
- The Contractor shall document the following in the "Comments" section of the OTDR software: number of fibres in the cable, loose tube or ribbon, length of launch reel if one is being used, test location (street address), last calibration dates. All attenuation measurements shall be carried out using approved industry standard test equipment and materials. All measuring equipment shall be in good working condition and accompanied by current calibration certificates.
- Any cable found to be defective or below specified thresholds shall be replaced and retested at the Contractor's cost. The replacement of damaged cable requires the full replacement of the cable from end-to-end; splicing sections of cable to repair damage will not be permitted.

When construction activities require that existing LAN and fibre optic equipment be moved or their functionality or network interconnections otherwise impacted, the Contractor shall implement appropriate measures to provide LAN connectivity prior to impacting the existing interconnectivity in any way. Maintaining the existing LAN system may involve the following, as appropriate to the construction activity and as required to maintain operation that is equivalent to the existing system:

- Supply, installation, setup, configuration, and testing of temporary devices or fibre cable, and the provision of temporary power. Any temporary devices supplied shall be of at least equivalent functionality and quality to existing;
- Relocation of existing LAN and fibre equipment; and
- Installation of new LAN equipment supplied by the DP World, if the proposed location is applicable to the DP World's system upgrade plans; and

- Adjustments to the LAN and fibre system may require work to be performed by the DP World to configure, test, and confirm operation, as appropriate to each adjustment. The Contractor shall provide support to the DP World to address any identified issues and ensure that LAN interconnectivity is maintained. All adjustments to the camera system shall be coordinated with the Employer and submitted in advance of removal of any LAN or fibre equipment.

The Contractor shall provide a Fibre Optic Splice Enclosure inside the SSF Vault to allow future connections by the Employer.

The Contractor shall provide and splice into the VFPA fibre line a new fibre connection from the MCC Building to the VFPA Vault located along Timberland Road South.

P2.22.3 Site Wide Surveillance Camera System

The Contractor shall provide all equipment necessary to support the implementation of surveillance cameras as shown in Volume 3, including the following requirements:

- The Contractor shall provide security control cabinets at proposed security locations shown in Volume 3 to support the new camera system. The Contractor shall coordinate all work with the Employer who will supply, install, test and commission the cameras and LAN systems.

The Contractor shall provide provisions for the Employer to supply and install cameras as follows:

- Fixed IP Dome Camera
    i. All dome cameras shall be colour, five-megapixel, forensic WDR, Power over Ethernet (PoE) support, H.264 and Motion JPEG video multi-stream support, and IPv4/v6 protocol support.

ii. Standard of Acceptance for dome camera: AXIS Q3538-LVE Network Camera with appropriate mounting bracket for installation on wall, ceiling, or corner depending on placement of cameras as shown on the drawings.

- Multisensor/Multidirectional IP Camera
  i. All multisensor/multidirectional cameras shall be colour, 15 megapixel cameras with one IP address, 360° IR illumination, Power over Ethernet (PoE) support, remote zoom and focus, flexible positioning of four varifocal camera heads.

  ii. Standard of Acceptance: AXIS P3719-PLE Network Camera with appropriate mounting bracket for installation on wall, ceiling, or corner depending on placement of cameras as shown on the drawings.

- Outdoor PTZ IP Camera
  i. All PTZ cameras shall be colour, HDTV 1080p, two megapixel, 32x optical zoom, digital PTZ, with electronic iris control, Power over Ethernet (PoE) support, H.264 and Motion JPEG video multi-stream support, and IPv4/v6 protocol support.

  ii. All outdoor PTZ cameras shall be IP-66 and NEMA 4X rated.
  iii. Standard of Acceptance: Axis Q6075-E, complete with Axis T8124 High PoE Midspan 1-port Injector.

- Outdoor PTZ Rain Shroud:
  i. All outdoor PTZ cameras shall be equipped with custom rain shrouds.
  ii. Standard of Acceptance: Burrard Mechanical's PTZ Rain Shroud for Axis Cameras.

During construction the Contractor shall maintain power and communications infrastructure to all surveillance cameras to ensure that existing surveillance coverage is maintained at all times.

When construction activities require that existing cameras be moved or their functionality otherwise impacted, the Contractor shall implement appropriate measures to provide equivalent camera coverage prior to impacting the existing coverage in any way. Equivalent camera coverage refers to equivalent fields of view and area of coverage comparable to what is achieved by the existing cameras. Maintaining the existing camera system may involve the following, as appropriate to the construction activity and as required to maintain operation that is equivalent to the existing system:

- Supply, installation, setup, configuration in the existing video management system, and aiming of temporary cameras on new or temporary poles, network connection to adjacent poles or new or temporary poles, and the provision of temporary power. Any temporary devices supplied shall be of at least equivalent functionality (frame rate and resolution) and quality to existing;
- Relocation of existing camera equipment; and
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Installation of new camera equipment if the proposed location is applicable to the Employer's system upgrade plans; and

- Adjustments to the camera system may require work to be performed by the Employer to configure, test, and confirm operation, as appropriate to each adjustment. The Contractor shall provide support to the Employer to address any identified issues and ensure that camera coverage is maintained. All adjustments to the camera system shall be coordinated with the Employer and submitted in advance of removal of any light towers or other structures with camera equipment.

P2.22.4 Security Control Cabinets

The Contractor shall provide security control cabinets to support the security cameras as shown in Volume 3, including the following requirements:

- Provide control cabinets where noted for the future installation of minimum 4 cameras each;
- All security control cabinets shall be powder coated aluminum construction and painted grey. The cabinets shall be insulated and heated as well as designed with positive pressure ventilation in accordance with the British Columbia MoTI Electrical Material Standards Chapter 400;
- The cabinets shall be NEMA 3R rated and have thermostats to control weatherprotected exhaust fans and heaters;
- Provide surge arrestors and UPS in each cabinet along with status monitoring connectivity to the LAN;
- Provide door switches for all cabinets to control the cabinet lighting and provide input to the security system;
- Supply and install a 3kVA 600V primary to 120/240V secondary step down transformer inside the control cabinets;
- Provide door switches for all cabinets. Door switches shall be two pole, with 1 normally open contact for lighting control and 1 normally closed contact for remote monitoring;
- Provide fibre patch panels to terminate the fibre cables inside the control cabinets;
- Seal all duct entries after installation of wiring. Cap spare conduits.
- Use nylon slings for installation.
- Repair any scratches with touch up paint.
- Add label on the outside of the door for all power cabinets stating, "EXPOSED ELECTRICAL – ACCESS ONLY BY QUALIFIED PROFESSIONALS".
- All end of wire segments and all access points between source and destination shall be labeled. Wire labeling shall adhere to the labeling scheme provided in the Drawings. The
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Contractor shall provide a sample of the proposed labeling to the Consultant for approval prior to installation.

Provide a minimum of 4m of additional connected fibre coiled in each cabinet.

The Contractor shall provide the following additional details on the Design:

- Equipment layout, single line diagram and wiring diagram for each cabinet. Unique drawings shall be produced for each cabinet location; and
- Detailed mechanical shop drawings for the cabinets including heating and ventilation.

P2.22.5 Perimeter Security

The following requirements shall be met relating to the perimeter security infrastructure during construction:

- The Contractor shall maintain perimeter security at all times during construction. This may involve the installation of temporary fencing and the relocation of gates including controls and card access, as required. Adjustments to the system will require work to be performed by the Employer to re-configure and confirm operation, as appropriate to each adjustment. All adjustments to the perimeter security infrastructure shall be coordinated with the Employer and submitted for consent in advance of removal of any equipment or impact to any functionality.
- Provide all required works and material including, cables, conduits, vaults and equipment for any temporary works.

P2.22.6 MCC Building Card Access and Video Surveillance Coverage

Provide card access equipment including card readers, door contacts, request to exit sensors, electric strikes, access reader modules, and access network controllers at all exterior doors of the MCC Building along with interior doors to the Control Room, and PLC/Electrical Room.

Provide provisions for the future installation of video surveillance equipment within the MCC and building. The cameras shall be Axis cameras, minimum 4MP resolution to match existing camera types that are currently installed on site as per the record drawings.

Provide Access Network Controller (ANC) within each of the MCC Building server room complete with cables and connectors.

- Standard of acceptance shall be the Lenel, LNL-X3300.

Provide Access Reader Module (ARM) at each of the door locations that require card access in both the MCC Building:

- Standard of acceptance shall be the Lenel, LNL-1300-S3 Single Reader Interface Modules.

Provide Access Control Power Supply as follows:

- Access Control Power Supplies shall have 2 auxiliary outputs rated for 12VDC and 24VDC applications with backup battery capabilities.
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bdc

- Standard of Acceptance: Lenel AL1012ULXBL Power Supply Board.

Backup batteries shall be installed and connected to the Access Control Power Supply.

- Standard of Acceptance: Lenel ABT-12 12VDC, 12 AH Battery Kit.

Provide Standard Card Readers at each location shown on the drawings:

- Standard of acceptance shall be the HID, Signo Reader 40, Contactless MultiTechnology Smartcard Reader.

Provide Door Contacts shall consist of, but not be limited to, the following:

- Shall be recessed in-door magnetic contacts
- Shall be double-pole-double-throw for connection to both the card access and building intrusion systems
- Contacts shall be installed in the top corner of the door frame, furthest away from the door hinge as to provide indication when door is propped open slightly.
- Contractor shall confirm suitability of door contact for each door prior to ordering.
- Standard of Acceptance: GE Security Recessed Door Contacts or approved alternate. Provide passive infrared sensors for request to exit door alarm shunting functionality.
- Detection zone shall be configured to cover entire width of door, while reducing detection of personnel not using the doorway.
- Standard of Acceptance: Kantech T.Rex Exit Detector or approved alternate.

Electronic door strikes shall be installed in door frames for new card access locations, or as shown on the Drawings.

- Contractor shall confirm suitability of door strike for each door prior to ordering.
- Standard of Acceptance: Assa Abloy Electronic Door Strikes suitable for industrial locations.

Building Conduits for Future Security Cameras

- The Contractor shall provide appropriately sized conduits within the MCC building for the future installations of the video surveillance equipment. The cameras and cabling in the new building will be supplied and installed by the Employer as part of a future project. However, as part of this project, the Contractor shall provide empty conduits from each camera location to the equipment rack for future use by the Employer to install cabling within these conduits to the cameras.

Racks for Network Equipment

- Provide an equipment rack inside the electrical room at the new MCC building for all the communication and security components. A minimum of 1 equipment rack shall be provided. The equipment rack shall offer 42 units of rack space and be of dimensions of 600mm x 1200mm, have included removable side panels and top panel, have rear-mounted PDU cable tray, and be equipped with earth bonding kit. Provide power conduits from the rack to the nearest power panel. Provide communication conduits from the rack to where the conduits transition for communication equipment in the field.
- Provide one Uninterruptible Power Supply (UPS) within the electrical room of the MCC building. The UPS unit shall be rated for 5kVA, mounted on the proposed racks, and include appropriate step-down transformer to step down the voltage to 120V from higher voltages

such as 208V. Conduits shall be provided for connection of the UPS unit to the closest electrical panel within the room for each building.

- Provide one Power Distribution Unit (PDU) in the rack: Standard of acceptance:
- Schneider Electric AP8965, or approved alternate. Fibre Cables
- The Contractor shall provide a 12 Conductor (12C) single mode fibre cable for each proposed cabinet location and routed to the nearest building that includes fibre cable communication infrastructure. All the proposed cabinets by the Tank Area shall be provided with 12C single mode fibre cable and connected to the MCC Building fibre patch panel in the proposed equipment racks of the electrical room. Furthermore, the cabinet shown at the new structure by the berth shall be provided with 12C single mode fibre cable and connected to the existing Substation #10 fibre infrastructure at this location. Fibre cables shall be outdoor rated.
- The Contractor shall provide a main 48 Conductor (48C) single mode fibre cable within the proposed communication conduits from the existing Substation #10 to the new MCC Building. Fibre cable shall be outdoor rated. This will allow for network connectivity from the existing substation to the new MCC Building.

APPENDIX 1:

Dolphin & Trestle Structural Condition Assessment for Berth 10

APPENDIX 2:

DP World list of Preferred Supplier

APPENDIX 3:

FIRE AND LOSS PREVENTION BEST PRACTICE RECOMMENDATIONS

APPENDIX 4

CANOLA SAMPLE VESSELS

APPENDIX 5

HCBI Tank Clarification Log