

2006 DESIGN BUILD STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION

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INTERPRETATION DESIGN BUILD STANDARD SPECIFICATIONS

Any reference to the “Design Build Minor Specifications”, “Standard Design/Construct Specifications”, “Design/Construct Specifications”, “D/C Specifications” and similar terms will be a reference to these specifications.

Generally, standard drawings of the “SP” series (such as SP635-2.3.6) are not included within this document. Unless otherwise stated in the Request for Proposals/Tender Document Package, any reference to an “SP” drawing which is not present herein (or otherwise included with the Request for Proposals/Tender Document Package) will be a reference to the like-numbered drawing in the edition of the Ministry’s ***Standard Specifications for Highway Construction*** in effect at the time of issuance of the Request for Proposals or the Tender, as the case may be.

Notwithstanding any provision of these specifications, the Contractor will supply all materials necessary for the

completion of the Work (unless supply of those materials is explicitly specified in the “Ministry Supplied Materials and Services” schedule to the Request for Proposals or the “Ministry Supplied Materials” Special Provisions clause in the Tender Document Package) and will be responsible for all quality control and quality assurance testing of the materials.

Any reference to “as shown by the Design”, “in the opinion of the Designer”, “as approved by the Engineer”, or similar language will mean as shown by the Design or as field adjusted to the suit the conditions at the Site and to achieve the intent of the Project. Any field or designer decisions will be made by a professional engineer or other such professional, as appropriate to the nature of the Work, registered to practice in the Province of British Columbia, in a manner to ensure the safety of, and minimize the impact upon, the public and to minimize the lifecycle cost to the Province, including construction, maintenance, and rehabilitation over the life of the Work.

SECTION 101

QUALITY MANAGEMENT

101.01 General All work on Ministry projects shall be undertaken through a total quality management process, utilizing Ministry, Contractor and third-party resources, as necessary.

The Ministry accepts the following definitions associated with Quality Management:

- **Quality Control (QC):** The process of checking specific product or service results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory product or service performance.
- **Quality Assurance (QA):** The process of evaluating overall product or service, by persons or companies independent of those doing the Work, on a regular basis to provide confidence that the product or service satisfies the relevant quality standards.
- **Quality Audit (QAudit):** Review by a party independent of QC and QA, to provide confidence that QC and QA processes and resulting products satisfy the contractual requirements.
- **Quality Management (QM):** The compendium of quality control, assurance and audit provided by a party.

The quality management program on a Design Build project has three key components as follows:

- Quality Control – the Contractor’s responsibility
- Quality Assurance – the Contractor’s responsibility
- Quality Audit – the Ministry’s responsibility

Each component of the program must address design, materials, processes, products, and documentation.

The Contractor shall provide unrestricted access to all its Quality Management operations and documentation produced by or on behalf of the Contractor and shall allow the Ministry full access at any time during working hours.

The Ministry Representative will review the Contractor’s performance of the Work and determine the acceptability of the Work based on the Ministry’s Quality Audit results and, where deemed appropriate

by the Ministry Representative, supplemented by the Contractor’s Quality Management results.

Work failing to meet the conditions of the Contract shall be considered Unacceptable Work.

The Ministry Representative may consider all Work from the last acceptable Quality Audit testing as Unacceptable Work. The Contractor shall not be entitled to payment for Work that lacks the appropriate Quality Management documentation, verified by the Quality Manager, as required by the Contract.

The Contractor shall implement a well-coordinated approach to all operations related to the Work and will organize its team and operations in keeping with the goal of doing things right the first time.

101.02 Quality Control Plan (QC Plan)

101.02.01 QC Plan General Requirements The Contractor shall be responsible for all Quality Control during the performance of the Work. QC work includes monitoring, inspecting and testing the means, methods, materials, workmanship, processes and products of all aspects of the Work, including design, construction and management, as necessary to ensure conformance with the Contract.

The Contractor shall prepare a Quality Control Plan (QC Plan) in accordance with the Contract provisions and shall submit the complete QC Plan to the Ministry Representative a minimum of two weeks in advance of commencement of any element of Work covered by the plan.

The QC Plan shall be structured around the ISO 9001:2000 program (although ISO registration is not required), and clearly demonstrate the Contractor’s understanding and commitment to ISO’s eight principles of quality management:

- Customer focused organization
- Leadership
- Involvement of people
- Process approach
- System approach to management
- Continual improvement

- Factual approach to decision-making
- Mutually beneficial supplier relationships.

The QC Plan must also include sections detailing the Contractor's methodology associated with each of the relevant sections of ISO 9001:2000 as listed in Table 101-A.

No work shall be undertaken on any element of Work (including payment Items and incidental Work_or submittals for review) for which there are QC Plan submission requirements until the Quality Manager and the Ministry have accepted the base portion of the QC Plan and the specific details for that element of Work.

Subject to the submission requirements outlined in DBSS 101.02.03, the QC Plan is required to cover the Work in its entirety, including without limitation all materials the Contractor and Subcontractors are supplying, and all items and phases of the design and construction on the Project.

The plan may be operated wholly or in part by a qualified Subcontractor or an independent agency/organization. However, the plan's administration (including conformance with the plan and its modifications) and the quality of the Work remain the responsibility of the Contractor.

Table 101-A: ISO Section Headings

§	ISO 9001:2000 Section Heading
4	Quality Management System
4.1	General Requirements
4.2	Documentation Requirements
5	Management Responsibility
5.1	Management commitment
5.2	Customer focus
5.3	Quality policy
5.4	Planning
5.5	Administration:
5.6	Management review:

§	ISO 9001:2000 Section Heading
6	Resource Management
6.1	Provision of resources
6.2	Human resources
6.3	Facilities
6.4	Work environment
7	Product Realization
7.1	Planning of realization processes
7.2	Customer-related processes
7.3	Design and/or development:
7.4	Purchasing
7.5	Production and service operations
7.6	Control of measuring and monitoring devices
8	Measurement, Analysis and Improvement
8.1	Planning
8.2	Measurement and monitoring
8.3	Control of nonconformity
8.4	Analysis of data
8.5	Improvement

The Contractor's QC program and the Work shall be undertaken in accordance with the QC Plan. Testing results must represent actual operations. Results will be reported accurately and in a timely manner.

The Contractor shall also ensure that all workers are familiar with the Quality Management Plans, its goals, and their role under it, as well as with the Contract specifications associated with the Work they are to undertake.

101.02.02 QC Plan Quality Control Staff and Equipment Submission Requirements The

Contractor shall provide all resources and take all actions necessary to ensure:

- Provision of sufficient review, inspection and testing staff, with adequate equipment and technical support to perform all Quality Control functions in an accurate and timely manner.
- That QC staff perform only reviews, inspections and tests for which they are qualified.
- All testing equipment is calibrated, properly maintained, and in good operating condition.
- All testing and inspection is performed in accordance with applicable industry standards and the appropriate standards of the Contract.
- Submission to the Ministry Representative, within twenty-four (24) hours, of daily reports for all tests and inspections that indicate non-conformance of the material being tested.
- Production, within forty-eight (48) hours, of daily reports for all tests and inspections that indicate conformance of the material being tested and the availability of back-up documentation to substantiate test results when required.
- Organization, compilation and submission of all project QC documentation within 14 days of issuance of the Completion Certificate.

The Contractor shall designate one person as the Quality Manager (Quality Manager) who shall be responsible for the implementation of the QC Plan. The Quality Manager shall be a qualified Professional Engineer, Certified Engineering Technician, or Applied Science Technologist, or other person subject to professional liability for their certifications and with knowledge, skills and abilities acceptable to the Ministry Representative. The Quality Manager shall be at arms length from the productivity part of the Contractor's organization and specifically shall not be the Project Manager or the Project Superintendent. On Minor Works contracts, this requirement will, upon request by the Contractor and where the candidate is deemed acceptable under the foregoing paragraph, generally be waived by the Ministry Representative.

The Ministry recognizes the Contractor's Project Manager, Superintendent and Designer as the personnel responsible for making the product meet the contractual requirements, but the Quality Manager's duties include being responsible to measure

conformance and to ensure that quality is not compromised by production pressures.

The Quality Manager, or a designated replacement acceptable to the Ministry Representative empowered and able to perform all of the Quality Manager's relevant duties, shall remain on Site at all times the Contractor is performing Work which must be tested or inspected in-process, and must be readily accessible and able to return when off-Site.

The QC Plan will include the following information:

- the name of the Quality Manager and qualifications establishing a proven capability to provide the specific services required for the Project;
- the name of QC testing agencies and their proven capability to provide the specific services required for the Project;
- a listing of QC staff (including names, qualifications and relevant experience) and their assigned roles and work scheduling in performing QC duties;
- a list of testing equipment to be used for the Work.

The QC Plan must include an organizational chart showing details of the flow of information, "hold" points, rectification of deficiencies and other relationships and responsibilities necessary to assure Project quality requirements are met.

The QC Plan should describe how the QC staff are allocated to Project requirements, the tasks assigned to each, and how their work will be coordinated.

Without limitation, the Contractor's Quality Manager shall:

- implement the Contractor's QC Plan;
- be responsible for measuring conformance with all aspects of the contract quality;
- stop work when materials, product, processes or submittals are deficient;
- develop inspection and testing plans for each element of Work;
- develop acceptance/non-acceptance reports and quality control checklists for each element of Work

in sufficient detail to gauge conformance with all contractual requirements;

- ensure the requirements for quality management (including an overview of how the QC Plan operates, the worker's role in it, contractual specifications for the Work, and work procedures) are known to, understood by, and adhered to by all workers on the Site;
- ensure that all QC checklists are signed-off by competent and responsible parties as close to the actual work as appropriate to the nature of the Work (e.g. by the Designer for engineering drawings; by the actual worker or a foreman for most work; by a Professional Engineer for falsework erection; etc.)
- review, sign, and be responsible for all reports (materials and testing results);
- consult with field inspectors regarding materials and testing issues;
- receive notification by inspectors re deficiencies and ensure re-testing or rejection;
- provide weekly and monthly summary reports on testing and inspection results;
- initiate the non-conformance process when materials or product do not meet the required specifications and, inform the Ministry Representative of such non-conformance;
- consult with the Contractor Representative and initiate corrective action on non-conformance;
- respond to each Non-Conformance Report (NCR) issued by the Contractor or the Ministry Representative, within the time specified in the NCR;
- schedule testing and inspection services in coordination with the Contractor's superintendent and foremen;
- include and monitor QC testing and inspection procedures including those of the Subcontractors;
- work directly with the Ministry Representative on matters related to QC;

- ensure required approvals and permits from the Ministry Representative and others are obtained as and when required;
- verify that all testing equipment is properly maintained and kept in good working order;
- keep an organized filing system to ensure that quality records are easily accessible so that auditors can obtain necessary information;
- review issued for construction drawings, calculations, and shop drawings and ensure that all concerned Contractor staff have current versions of documents applicable to their part of the Work;
- notify the Ministry Representative of any changes in survey layout, location, line, grade, etc., for approval; notify the company principles of any issues that compromise the integrity or function of the Quality Management System, and
- provide an auditable trail for survey computations to the Ministry Representative.

101.02.03 QC Plan Submission Requirements (Contract-Specific)

(i) Full Submission

Unless otherwise specified in the Contract, the Contractor's QC plan shall provide details of the means, methods, and frequencies of Quality Control measures for all elements of Work (whether payment Items or incidental or being performed by Subcontractors or Suppliers, including design, construction and management) in the Contract.

(ii) Partial Submission

On projects considered by the Ministry to be of low complexity and/or risk, and only where explicitly invoked by the Contract, the Ministry will accept a partial QC Plan submission.

Notwithstanding any such reduced submission requirements, the Contractor remains responsible for QC for all aspects of the Work.

The Contractor's partial QC Plan submission to the Ministry Representative is only required to address the details of the following types of Work:

- Traffic Control

- Survey/layout
- Design
- Materials incorporated into the Work (concrete barrier, culverts, filter cloth, lock-blocks, etc.)
- Compaction (subgrade, embankments, granular aggregates, culvert backfill, etc.)
- Aggregate gradation
- Plus any other elements identified in the Contract as a submission requirement.

The Contractor shall initiate such other Quality Control procedures as are necessary for ensuring the production of a quality product and may include them in the Quality Control Plan submission.

(iii) For Both Full and Partial Submissions

The initial QC Plan shall be submitted to the Ministry Representative a minimum of seven (7) days in advance of the Project pre-construction meeting and must provide details of all elements of Work anticipated to be undertaken within the Contractor's first thirty (30) days on Site.

The portion of the QC Plan dealing with the design shall be submitted to the Ministry Representative on the earlier of:

- thirty (30) days after Award; and
- a minimum of seven (7) days in advance of the first design submission.

Detailed submissions for the balance of the Work must be received a minimum of seven (7) days prior to the anticipated first day of Work on each element covered by the submission.

The initial submission, as well as any subsequent submission or revision, must be accompanied by the Contractor's QC checklist for Quality Management, verifying that the submission meets all relevant contractual requirements.

Improved procedures may be introduced after the start of work as necessary as amendments to the Quality Control Plan. All amendments require the written acceptance of the Ministry Representative.

The type and frequency of QC tests shall be established by the Contractor and shall be in conformance with the requirements of the Contract, including the minimum frequencies specified in the Contract and/or DB Standard Specifications (for those listed items applicable to the Work), and the current acceptable practice of the industry.

When materials or equipment are specified by standard or performance specifications, the Contractor shall obtain from suppliers or manufacturers independent test reports, or test certificates stating that the materials or equipment meet or exceed specified requirements. The Contractor shall provide documentation of actual testing results upon request by the Ministry Representative.

101.03 Quality Assurance Plan (QA Plan) The Contractor will prepare and the Quality Manager shall implement a Quality Assurance Plan, based in part on the effectiveness and reliability of the Contractor's Quality Control Plan, to assess the effectiveness of that QC Plan. The Contractor shall also undertake random and systematic inspections of the Work and Contractor's QC documentation.

The purpose of the QA Plan and inspectional activities is to ensure that QC procedures are available, are being followed, and that the Contractor will have confidence that the resulting products (transitory or permanent) conform to Contract requirements.

The operation of the QA Plan shall be fully independent of those performing the QC tasks, except for the Quality Manager.

Any instances of Unacceptable Work discovered will result in a Non-Conformance Report being issued by the Contractor to the Contractor.

The QA program activities will not relieve the Contractor of Quality Control responsibilities under the terms of the Contract.

The frequency of QA inspection and testing will generally be approximately five to ten percent (5 – 10%) of the frequencies undertaken by the Contractor in its QC Plan and will initially be set at a level commensurate with the risk that an element will have on final product quality. Elements that have higher risks shall be checked at higher frequencies; lower risk elements may be checked at lower frequencies.

The Contractor may, with the prior approval of the Ministry Representative, decrease the frequency of QA

inspection and testing during the course of the Work, based upon the proven effectiveness of the Contractor's QC Plan.

101.04 Quality Audit The Ministry will have one or more auditors on the Project. The Ministry Audit will provide a systematic and independent assessment of whether or not the design, construction and management comply with the Contract and the Contractor's QC and QA Plans. . The auditors may or may not be Ministry employees but will be from resources which have not otherwise been involved with the Work.

The objective of Quality Auditing is to have an independent opinion on both QC and QA activities and be proactive in avoiding or reducing quality related issues by requiring the process of conformance verification to be systematic.

The auditor(s) will be allowed unrestricted access to the Site and all activities therein, to all testing and documentation of the work done by the Ministry, Contractor and their agents and suppliers.

The Ministry Representative will monitor the Contractor's operations and the Quality Control program to assure that standards and the terms of the contract regarding quality of materials and processes are being met, and to assess what payments have been earned under the terms of the Contract.

101.05 Non-Conformance Reports (NCRs) The Contractor shall and the Ministry may review the Work to determine conformance with the contractual requirements.

Non-conformances found shall be dealt with as follows.

101.05.01 Contractor's Internal NCR Should the Contractor's QC or QA reporting indicate that the Work is not in conformance, the Quality Manager shall issue an internal Non-Conformance Report (NCR) to the Contractor, with a copy to the Ministry, including a response time.

The Contractor shall then respond to the Quality Manager, with a copy to the Ministry Representative, with respect to the NCR, within the specified time, with proposed resolutions and corrective actions. The Contractor and/or the Quality Manager may consult with the Ministry Representative on the proposed resolutions.

Payment for Quality Management (where specified in the Contract) will not be affected by internal NCRs, as long as the issue is diligently pursued and resolved.

Payment for the Work itself may be withheld until the NCR issue is resolved.

101.05.02 Ministry-Issued NCR Should the Ministry's QAudit reporting indicate that the Work is not in conformance, the Ministry Representative will issue to the Contractor a NCR, including a response time.

The Contractor shall then respond to that NCR, within the specified time, with proposed resolutions and corrective actions.

The Ministry Representative will accept or reject the proposed resolution and corrective action proposal.

Assurance testing and inspection will be performed to determine if the corrective action has provided an acceptable product. Acceptance and rejection will continue until the Ministry Representative determines that a quality product has been achieved.

A portion of the payment for Quality Management (where specified in the Contract) may be withheld until the NCR issue is resolved or, in accordance with DBSS 101.07, may be withheld permanently.

Payment for the Work itself may be withheld until the NCR issue is resolved.

101.05.03 Opportunity for Improvement Should the QAudit review indicate that the Work is not in conformance, but the variance is deemed minor by the Ministry Representative, the Ministry Representative may issue an Opportunity for Improvement (OFI) report.

The Contractor is encouraged to review the findings and undertake such modifications to the QC and/or QA Plan and the work procedures as necessary to address the issue.

An OFI will not affect payment for Quality Management (where included in the Contract) or for the Work itself.

101.06 Appeal If the Contractor disputes the validity of a finding in an NCR, the Contractor may file an appeal with the Ministry Representative. The Ministry Representative and the Contractor Representative will use all reasonable efforts to refine the area of dispute

and to resolve the dispute in conformance with the Contract.

If the Ministry Representative and the Contractor Representative cannot come to a mutually agreeable resolution, the Work that is the subject of the Non-Conformance Report shall be re-evaluated by an independent third-party, selected by the Ministry Representative in consultation with the Contractor, at a test frequency equivalent to twice that specified in the Contract or to such other frequencies as may be mutually agreed between the Ministry Representative and the Contractor.

If the appeal testing confirms the non-conformance determination, all appeal testing costs will be borne by the Contractor. If the appeal testing shows that the Work did in fact meet the requirements of the Contract, all appeal testing costs will be borne by the Ministry.

101.07 Payment [Applicable only where a payment Item is explicitly included in the Contract] The Lump Sum Price bid for Quality Management shall be full compensation for all costs resulting from the Quality Management requirements set out in the Contract.

Payment will be made on a monthly basis prorated for the percentage of the total Work completed as determined by the Ministry Representative, subject to

the Contractor being totally compliant with the requirements of this Section and with its own Quality Control Plan.

The Ministry Representative may deduct an amount from any monthly payment so computed, for any quality management work required but not satisfactorily undertaken during that month. The Ministry Representative may also reduce the total Lump Sum payable by the value of any quality management work required but not satisfactorily undertaken during the Term of the Contract. The foregoing determinations will be made in the sole discretion of the Ministry Representative.

Inspection or testing by the Ministry Representative will be at the Ministry's cost. However, re-inspection or re-testing by the Ministry for repaired deficient details shall be at the Contractor's cost.

Work that is deemed unacceptable in accordance with DBSS 101.01 will not be eligible for payment from the applicable Item for that Work.

The Completion Certificate will not be issued if there are any unresolved Non-Conformance Reports.

SECTION 108

SAMPLE FORMS

PART A – GENERAL

108.01 General -This Section provides sample copies of forms which the Contractor may be required to execute and submit to the Ministry in accordance with the Contract. Blank copies of these forms are available from the Ministry Representative or Ministry Manager.

PART B – STATUTORY DECLARATIONS

108.11 Not Used

108.12 Not Used

108.13 Design Build and Design Build Minor – The forms attached as “Appendix C” (Ministry forms H1112 and H1113) are used to meet the Statutory Declaration requirements of the Design Build Agreement or the Design Build Minor General Conditions. The forms relate to Total Completion and Progress Payments/Holdback Release respectively.

APPENDIX C – DESIGN BUILD MINOR



**BRITISH
COLUMBIA**

**Ministry of
Transportation**

**STATUTORY DECLARATION
(Design Build Minor and Design Build)
Total Completion**

IN THE MATTER OF THE EVIDENCE ACT, 1996 RSBC c.124 AND IN THE MATTER OF CERTAIN DISBURSEMENTS TO BE MADE IN CONNECTION WITH THE CONTRACT

dated the _____ day of _____, _____ between:

**HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA,
AS REPRESENTED BY THE MINISTER OF TRANSPORTATION
(the Province)**

and:

(the Contractor)

pertaining to Project Number _____ Contract ID _____

I, _____, being a
(PRINT OR TYPE FULL NAME AND POSITION OR TITLE)

duly authorized representative of and agent for the Contractor on the above-referenced Project do solemnly declare and attest that:

- (i) the Contractor has performed all of its obligations to date under the Contract;
- (ii) that the Work has been designed in substantial accordance with the Contract;
- (iii) the Work has been constructed in substantial accordance with the Design, the Standards and all codes, by-laws and regulations applicable to the Work; and
- (iv) a suitably qualified representative of the Designer has been to the Site to inspect the Work on a sufficient number of occasions, reviewed the Quality Management Plan and is satisfied that, based on the foregoing, the Work has been constructed in accordance with the Design, the Standards and all codes, by-laws and regulations applicable to the Work.

I MAKE THESE SOLEMN DECLARATIONS, conscientiously believing them to be true and knowing that they are of the same legal force and effect as if made under Oath.

DECLARED BEFORE ME AT THE _____)

of _____, in the _____)

Province of British Columbia, on this _____)

_____ day of _____, _____)

A Commissioner for taking Affidavits for British Columbia)

Signature of Contractor's Authorized Representative



**BRITISH
COLUMBIA**

**Ministry of
Transportation**

**STATUTORY DECLARATION
(Design Build Minor and Design Build)
Progress Estimate & Holdback Release**

IN THE MATTER OF THE EVIDENCE ACT, 1996 RSBC c.124 AND IN THE MATTER OF CERTAIN DISBURSEMENTS TO BE MADE IN CONNECTION WITH THE CONTRACT dated the _____ day of _____, _____ between:

**HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA,
AS REPRESENTED BY THE MINISTER OF TRANSPORTATION
(the Province)**

and:

(the Contractor)

pertaining to Project Number _____ Contract ID _____

I, _____, being a
(PRINT OR TYPE FULL NAME AND POSITION OR TITLE)

duly authorized representative of and agent for the Contractor on the above-referenced Project do solemnly declare and attest that:

- (i) the Work covered by this invoice has been completed in accordance with the Design and Standards and all other requirements of the Contract and is fit for the purpose intended by the Contract;
- (ii) the Contractor has paid in full on all accounts for labour, subcontracts, products, materials, construction machinery, equipment and all other indebtedness or obligation incurred by the Contractor in the performance of the Work as incurred up to the date of the previous invoice; and
- (iii) the Contractor has provided written notice to their financial institution and their surety of all payment disputes with respect to any accounts for labour, subcontracts, products, materials, construction machinery, equipment and any other indebtedness or obligation incurred by the Contractor in the performance of the Work.

I MAKE THESE SOLEMN DECLARATIONS, conscientiously believing them to be true and knowing that they are of the same legal force and effect as if made under Oath.

DECLARED BEFORE ME AT THE

of _____, in the

Province of British Columbia, on this

_____ day of _____, _____

A Commissioner for taking Affidavits for British Columbia

Signature of Contractor's Authorized Representative

STATUTORY DECLARATION

H1113 (2005/12/07)

Design Build Minor - Progress Estimate (GC 49.03) & Holdback Release (GC 55 & GC 56)
Design Build - Progress Estimate & Holdback Release

SECTION 125

VALUE ENGINEERING - PROPOSAL GUIDELINES

125.01 Definitions

125.01.01 VEP means a value engineering proposal which has been set out in writing by the Contractor to the Ministry in accordance with these guidelines.

125.01.02 Summary VEP means a brief summary of a VEP, including the anticipated cost and timing of developing the VEP, submitted by the Contractor to the Ministry.

125.01.03 Implemented VEP means a value engineering proposal which has been accepted and implemented by means of a Supplemental Agreement or Work Order.

125.01.04 Net Cost Savings means an amount determined by the Ministry on the basis of the Contract Price before implementation of the VEP minus the adjusted Contract Price determined after the implementation of the VEP less the following costs, which are subject to negotiation:

- the Contractor's costs of developing the VEP.
- the Ministry's costs of evaluating the VEP.
- the anticipated additional administration and project management costs to the Ministry resulting from the implementation of the VEP.

125.01.05 Value Engineering Incentive means an amount calculated pursuant to written agreement between the Ministry and the Contractor, which will generally be equal to 50 percent of the Net Cost Savings realized by the Ministry due to the implementation of the VEP.

125.02 Guiding Principles for VEP Evaluation

125.02.01 To be considered, a VEP must be perceived by the Ministry to provide a tangible benefit to the Ministry, such as:

- a) a reduction in the total cost of the Project; or
- b) an improvement to the product which the Ministry expects will reduce the life cycle costs; or
- c) a change in the Construction Schedule which will be beneficial to the Ministry; or
- d) a reduction or transfer of risk which will benefit the Ministry;

and should result in a product which is functionally equal

or superior to that which would result in the absence of the VEP.

125.02.02 A VEP should not:

- a) impair the functionality and characteristics of the Project, including, but not limited to, the service life, economy of operation, ease of maintenance, aesthetic considerations, preliminary engineering commitments, or design and safety standards.
- b) be similar to a change in the Drawings or specifications under consideration by the Ministry for the Work at the time the VEP is submitted to the Ministry.
- c) increase the anticipated life cycle costs of the Project.

125.02.03 To be eligible for a Value Engineering Incentive, a VEP must propose a change to the Work which meets the same constraints, assumptions and considerations as those which governed the original design of the Work, as it is defined in the Contract.

125.02.04 A VEP may involve:

- a) a material or product substitution.
- b) a change to the Work method.
- c) a Work sequencing change, including changes to traffic routing or detour sequences, changes to structure or roadway construction sequences.
- d) a change to the design or engineering of the Project which provides a marked departure from the product as defined in the Contract.

125.03 Value Engineering Proposal Submissions

125.03.01 Prior to presenting a VEP, the Contractor will prepare a Summary VEP and submit it to the Ministry for consideration.

125.03.02 The Ministry will evaluate the Summary VEP and will advise the Contractor whether or not the Ministry would be willing to consider, without obligation, the VEP described in the Summary VEP.

125.03.03 A VEP should contain the following information:

- a) a statement that the proposal is submitted as a VEP.

- b) a detailed description of the VEP and the manner in which the VEP should be implemented (by Supplemental Agreement or Work Order).
- c) a detailed description of the Items and quantities, Drawings, specifications, designs, Completion Date, Milestone Dates or other elements under the Contract which would be changed, altered, modified or replaced by the implementation of the VEP.
- d) plans and working drawings needed to analyze the VEP and determine the impact of the VEP on the Project.
- e) an itemized cost analysis of the Net Cost Savings.
- f) the date, which must be not less than two weeks after the date of the VEP, by which the VEP must be implemented in order to maximize the cost reduction during the remainder of the Agreement.

125.03.04 Any request by the Contractor for substitution of material or method will only be considered if submitted as a VEP.

125.04 Implementation of a VEP

125.04.01 To implement a VEP, the Ministry Representative will prepare a Supplemental Agreement or a Work Order which will set out the Net Cost Savings, the change to Work required to realize the Net Cost Savings, and the adjustment to the Contract Price(s) and payment terms resulting from the VEP, in accordance with these guidelines.

125.04.02 The Ministry will retain the right to utilize a VEP, or part thereof that has been accepted for the Project, on any other or subsequent projects without any obligation to the Contractor, unless the Contractor has provided written notice in the Summary VEP and the VEP regarding patented materials or processes involved in the VEP.

SECTION 135

CONSTRUCTION SITE SAFETY

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

135.01 Definitions - In this Section, except as otherwise expressly provided herein:

a) Base Safety Program means the occupational health and safety program that the Contractor will initiate and maintain, as described in this Section.

b) Designated Prime Contractor means the Contractor, or another contractor, designated by the Ministry pursuant to DBSS 135.04.01 to discharge the responsibilities of the Prime Contractor for the Specified Area.

c) Designated Qualified Coordinator means the person designated by the Designated Prime Contractor to discharge the responsibilities of the Qualified Coordinator for the Specified Area.

d) Designated Qualified Person means the person designated by the Designated Prime Contractor to discharge the responsibilities of the Qualified Person for the Specified Area.

e) Designated Supervisor means the person who is designated by an Employer at a Multiple-Employer Workplace to discharge the responsibilities of a supervisor as described in the Workers Compensation Act and the Regulation.

f) Employer means an employer as defined in the Workers Compensation Act, and includes the Contractor.

g) Joint Committee means the joint health and safety committee established and maintained by the Contractor in compliance with the Workers Compensation Act and the Regulation, and

Joint Committees means additional committees that may be established by the Contractor in compliance with the Workers Compensation Act and the Regulation.

h) Multiple Employer Workplace means a workplace where workers of 2 (two) or more employers are working at the same time, and includes the Site and the Specified Area.

i) Notice of Project means the notice of project described in the Regulation.

j) Notice of Unsafe or Harmful Condition or Act means the written notice that the Contractor will deliver to any Employer pursuant to DBSS 135.05, in the form set out in DBSS 135 - Appendix A.

k) Other Persons means any person or persons, other than Workers working on the Project, who, for whatever reason or purpose, are on the Site or the Specified Area.

l) Prime Contractor means a prime contractor as defined in the Workers Compensation Act.

m) Qualified Coordinator means the person, who meets the qualifications of a qualified coordinator described in the Regulation, and who is appointed by the Prime Contractor to discharge for the Site, the responsibilities of a qualified coordinator as described in the Workers Compensation Act and the Regulation.

n) Qualified Person means the person who meets the qualifications of a qualified person described in the Workers Compensation Act and the Regulation, and who is designated by the Prime Contractor to discharge for the Site the responsibilities of a qualified person as described in the Workers Compensation Act and the Regulation.

o) Regulation means the British Columbia Regulation 296/97 entitled *Occupational Health and Safety Regulation* prescribed under the Workers Compensation Act, as amended from time to time.

p) Safety Officer means the person so designated by the Ministry pursuant to this Contract.

q) Specified Area means that part or those parts of the Site and any lands adjoining or overlapping the Site that are designated as the Specified Area in the Contract or in a written notice that may be issued by the Ministry Manager from time to time pursuant to DBSS 135.04.01.

r) Workers means the employees, workers, servants, agents or invitees of Employers, including of the Contractor, at the Site or at the Specified Area.

s) Workers Compensation Act means the Workers Compensation Act, R.S.B.C. 1996, c.492 as amended from time to time.

t) Workers' Compensation Board means the Workers' Compensation Board constituted under the Workers Compensation Act and Regulation.

135.02 Base Safety Program

135.02.01 Notwithstanding the limitation relating to the requirement for initiating and maintaining an occupational health and safety program set out in the Regulation, the Contractor will initiate and at all times maintain at the Site, and if the Contractor has agreed to be the Designated Prime Contractor, at the Specified Area, the Base Safety Program which will be designed to prevent injuries and occupational diseases within the contemplation of the Workers Compensation Act and the Regulation and, without limiting the generality of the foregoing, will describe how the Contractor will ensure that:

- a) (not used)
- b) the requirements of an occupational health and safety program stipulated in the Regulation will be satisfied, including the establishment and maintenance of a Joint Committee.
- c) the activities of all Employers, Workers and Other Persons at the Site and, if applicable, at the Specified Area, relating to occupational health and safety will be coordinated.
- d) reasonably practicable measures are taken to establish and maintain a system or process to ensure compliance with the Workers Compensation Act and the Regulation in respect of the Site, and if applicable, the Specified Area.
- e) all Workers, Employers, and Other Persons are made aware of all known or reasonably foreseeable health and safety hazards to which they may be exposed on the Site, and if applicable, the Specified Area, and are instructed in the terms of the Workers Compensation Act and the Regulation.
- f) complete and accurate reports, records and documents relating to occupational health and safety activities at the Site and, if applicable, at the Specified Area, or related to the Work, will be established, maintained, reviewed and assessed on an ongoing basis.
- g) safety equipment and apparel are properly used and worn by Workers and Other Persons, as required pursuant to the Regulation and the Base Safety Program.
- h) a first aid program in compliance with the Regulation is established, implemented and maintained at all times on the Site and, if applicable, on the Specified Area.

135.02.02 The Contractor will determine and control the manner in which the Base Safety Program is established, initiated, and maintained and the manner in which the

instructions, directions, rules, policies and procedures contained therein are carried out.

135.03 Prime Contractor - The Site

135.03.01 The Contractor, by entering into the Contract, agrees to be the Prime Contractor in connection with the Site for the purposes of the Workers Compensation Act and the Regulation.

135.03.02 The Contractor will, prior to commencement of the Work, deliver to the Ministry Representative, in writing:

- a) the name of each of the Qualified Coordinator and the Qualified Person in connection with the Site.
- b) a copy of the Notice of Project.
- c) confirmation that the Base Safety Program has been initiated and is readily available on the Site.

135.03.03 The Contractor will, in connection with the Work and the Site:

- a) observe, abide by and comply with the Workers Compensation Act and the Regulation.
- b) deliver the Notice of Project to the Workers' Compensation Board in accordance with the Workers Compensation Act and the Regulation.
- c) prominently post and at all times maintain on the Site the Notice of Project in accordance with the Workers Compensation Act and the Regulation.
- d) ensure that the person or persons to be appointed as the Qualified Coordinator and Qualified Person meet the qualifications of a "qualified coordinator" and "qualified person" as described in the Workers Compensation Act and the Regulation.
- e) appoint and at all times maintain a Qualified Coordinator to perform the functions of the "qualified coordinator" on the Site as described in the Workers Compensation Act and the Regulation, and as set out in this Section, and designate and at all times maintain not less than one Qualified Person to be responsible for health and safety activities of the Contractor in connection with the Work, including, without limiting the generality of the foregoing, administering the Base Safety Program.
- f) deliver written notice to the Ministry Representative of any change in the appointed Qualified Coordinator or the Qualified Person referenced in DBSS 135.03.03 (e).

g) establish and at all times maintain one or more Joint Committees.

h) where conditions or activities affect the Workers of more than one Employer, or where there are overlapping or adjoining work activities of 2 (two) or more Employers at the Site, ensure

i) that the Qualified Coordinator coordinates the occupational health and safety activities at the Site,

ii) that:

- Employers, Workers, Suppliers and Subcontractors of the Contractor, and Other Persons,
- the work activities of Workers, Employers, Suppliers and Subcontractors of the Contractor and Other Persons, and
- the conditions of the Site

comply with the Workers Compensation Act and the Regulation;

i) make the Base Safety Program and a copy of the Workers Compensation Act and the Regulation readily available at the Site.

j) provide and maintain the Site in a manner that ensures the health and safety of persons at or near the Site.

k) ensure that every Employer at the Site is given the information known to the Contractor that is necessary to identify and eliminate or control hazards to the health or safety of Workers and Other Persons at the Site.

l) ensure that Workers, Employers and Other Persons are made aware of all known or reasonably foreseeable health and safety hazards to which they are likely to be exposed by the Work on the Site.

m) do everything that is reasonably practicable to establish and maintain a system or process that will ensure compliance with the Workers Compensation Act and the Regulation with respect to the Site.

n) immediately notify Employers, Workers, Suppliers and Subcontractors of the Contractor, and Other Persons of any hazard created by virtue of overlapping or adjoining work activities of 2 (two) or more Employers and ensure that the hazards are addressed throughout the duration of such activities.

o) at the sole cost of the Contractor, provide, post and maintain 2 (two) signs, in accordance with the specifications, which contain the informational messaging stipulated in Drawing SS SP135-01 of this Section, at locations satisfactory to the Ministry Representative.

p) immediately give written notice to the Ministry Representative of any event which is reportable or is subject to notification requirements under the Workers Compensation Act or the Regulation.

q) where the execution of the Work involves overlapping or adjoining work activities of 2 (two) or more Employers that create a hazard to Workers, cause the Qualified Coordinator to:

i) coordinate health and safety activities of all Employers at the Site in accordance with the Regulation.

ii) publish and post at the Site and otherwise make readily available on the Site, information relating to health and safety activities at the Site, including without limiting the generality of the foregoing:

- the name of the Qualified Coordinator,
- a drawing of the Site showing the project layout, first aid locations, emergency transportation provisions and the evacuation marshalling station, and
- a set of construction procedures designed to protect the health and safety of Workers at the Site

all in compliance with the requirements of the Workers Compensation Act and the Regulation.

135.04 Designated Prime Contractor - The Specified Area

135.04.01 The Ministry may, in its sole discretion, designate in writing the Specified Area, and

a) appoint in writing the Contractor to be the Designated Prime Contractor in connection with the Specified Area, and upon notification of such appointment the Contractor will deliver written confirmation to the Ministry of its agreement to be the Designated Prime Contractor, or

b) appoint in writing a contractor other than the Contractor as the Designated Prime Contractor in connection with the Specified Area, and will notify the Contractor in writing of the designation.

135.04.02 The Designated Prime Contractor, in connection with the Specified Area, will:

- a) deliver written confirmation to the Workers' Compensation Board, with a copy to the Ministry Representative, of its agreement to be the Designated Prime Contractor for the Specified Area.
- b) appoint a Designated Qualified Coordinator to perform the functions of the "qualified coordinator" as described in the Workers Compensation Act and the Regulation, and as set out in this Section for the Specified Area.
- c) where conditions or activities affect the Workers of more than one Employer, or where there are overlapping or adjoining work activities at the Specified Area, ensure that
 - i) the Employers, Workers, Suppliers and Subcontractors of the Designated Prime Contractor, and Other Persons,
 - ii) the work activities of all Employers, Workers, Suppliers and Subcontractors of the Designated Prime Contractor and Other Persons, and
 - iii) the conditions of the Specified Area,
 comply with the Workers Compensation Act and the Regulation;
- d) provide and maintain the Specified Area in a manner that ensures the health and safety of persons at or near the Specified Area.
- e) ensure that every Employer at the Specified Area is given the information known to the Designated Prime Contractor that is necessary to identify and eliminate or control hazards to the health or safety of Workers and Other Persons at the Specified Area.
- f) make a copy of the Workers Compensation Act and the Regulation readily available at the Specified Area.
- g) cause the Designated Qualified Coordinator to:
 - i) coordinate health and safety activities of all Employers on the Specified Area in accordance with the Workers Compensation Act and the Regulation.
 - ii) publish and post on the Specified Area and otherwise make information relating to overlapping or adjacent health and safety activities on the Specified Area readily available, including without limiting the generality of the foregoing:
 - the name of the Designated Qualified Coordinator,
 - a drawing of the Specified Area showing the project layout, first aid locations, emergency transportation

provisions and the evacuation marshalling station, and

- a set of construction procedures designed to protect the health and safety of Workers in the case of overlapping or adjacent work activities on the Specified Area,

all in compliance with the requirements of the Workers Compensation Act and the Regulation.

135.05 Site and Specified Area Notice Process

135.05.01 If the Prime Contractor, in connection with the Site, or the Designated Prime Contractor, in connection with the Specified Area determines, in its reasonable discretion, that:

- a) any Employer or its Workers has failed to comply with the Workers Compensation Act or the Regulation, or to act in accordance with the requirements of the Base Safety Program for coordinating health and safety activities,
- b) the failure creates or may create an unsafe or harmful condition on the Site or Specified Area that poses a danger of injury or death to Workers,

the Prime Contractor, or the Designated Prime Contractor, as applicable, may issue a Notice of Unsafe or Harmful Condition or Act to the applicable Employer, stipulating in reasonable detail the basis for the issuance of the Notice of Unsafe or Harmful Condition or Act, and the Contractor, or the Designated Prime Contractor, as applicable, will deliver a copy of the Notice of Unsafe or Harmful Condition or Act to the Ministry Representative.

135.05.02 The terms "Employer" and "Workers" referenced in DBSS 135.05, do not include the Prime Contractor's or the Designated Prime Contractor's Subcontractors or Suppliers, or their respective employees, workers, servants, agents or invitees.

135.05.03 Upon receipt of the Notice of Unsafe or Harmful Condition or Act, the Ministry Manager will issue to the applicable Employer a Stop Work Order at the location on the Site, or on the Specified Area, as applicable, that is specified in the Notice of Unsafe or Harmful Condition or Act.

135.05.04 The Ministry will be deemed to have relied on the terms of and reasons for the issuance of the Notice of Unsafe or Harmful Condition or Act, notwithstanding any subsequent investigation or inquiry of the matter by the Ministry, which the Ministry may but will not be obligated to undertake.

135.05.05 If the Prime Contractor, or the Designated Prime Contractor, as applicable, and the Employer referenced in DBSS 135.05.01 fail to agree on the reasons for the issuance of the Notice of Unsafe or Harmful Condition or Act, then within one day of the issuance of the Notice of Unsafe or Harmful Condition or Act, the directive of the Prime Contractor, or the Designated Prime Contractor, to rectify the failure to comply with the Regulation or to act in accordance with the Base Safety Program, as the case may be, will be immediately implemented.

135.05.06 When the failure to comply with the Workers Compensation Act or the Regulation in accordance with the Base Safety Program stipulated in the Notice of Unsafe or Harmful Condition or Act has been rectified by the Employer to whom it was given to the reasonable satisfaction of the Prime Contractor, or the Designated Prime Contractor, as applicable, the Prime Contractor, or the Designated Prime Contractor, as applicable, will immediately:

- a) withdraw the Notice of Unsafe or Harmful Condition or Act by endorsing on a copy thereof confirmation that the failure to comply with the Workers Compensation Act or the Regulation in accordance with the Base Safety Program has been rectified.
- b) deliver the endorsed copy of the Notice of Unsafe or Harmful Condition or Act confirming the cancellation thereof to the applicable Employer and to the Ministry Representative.

135.05.07 The Ministry Manager will issue an Resume Work Order on receipt of the endorsed copy cancelling the Notice of Unsafe or Harmful Condition or Act.

135.05.08 If the Prime Contractor or the Designated Prime Contractor, as applicable, is delayed in performing the Work as a result of being required to issue the Notice of Unsafe or Harmful Condition or Act and the Work is stopped pursuant to an Stop Work Order under this Article, then the Completion Date will be extended by the number of days equal to the delay, as determined in the sole discretion of the Ministry Manager, and the Prime Contractor or the Designated Prime Contractor, as applicable, will not be entitled to any compensation, in damages or otherwise, including without limiting the generality of the foregoing, any claim for lost profits or other consequential loss, including business loss, as a result of or in connection with the issuance and operation of any Notice of Unsafe or Harmful Condition or Act or the issuance and operation of any Stop Work Order pursuant to this Section.

135.06 Contractor Obligations to Coordinate with the Designated Prime Contractor - The Specified Area

135.06.01 Notwithstanding the Contractor's agreement to be the Designated Prime Contractor for the Specified Area pursuant to DBSS 135.04.01, the Contractor will continue to undertake and perform the obligations of a Prime Contractor at the Site at all times in accordance with the Workers Compensation Act, the Regulation and this Section.

135.06.02 If another contractor is appointed as the Designated Prime Contractor in connection with the Specified Area pursuant to DBSS 135.04.01, the Contractor will:

- a) continue to undertake and perform the obligations of a Prime Contractor at the Site at all times in accordance with the terms of the Workers Compensation Act, the Regulation and this Section.
- b) schedule and perform the Work and, in good faith, co-operate with the Designated Prime Contractor so as to comply with any directives that may be issued by the Designated Prime Contractor to coordinate the health and safety activities on the Specified Area.
- c) ensure that at all times all Employers, Workers, Subcontractors and Suppliers of the Contractor, and Other Persons comply with the Designated Prime Contractor's directions on coordinating occupational health and safety activities on the Specified Area.
- d) upon the request of the Designated Prime Contractor, deliver occupational health and safety records and documentation to the Designated Prime Contractor as necessary for the Designated Prime Contractor to meet its obligations under the Regulation and under this Section.
- e) advise the Designated Prime Contractor in writing and in advance of any work activities to be undertaken in the Specified Area that are likely to create a hazard for Workers of another Employer, and of the work activities.
- f) on receipt of notification from the Designated Prime Contractor of any unsafe or harmful condition or act by its Workers, Subcontractors, or Suppliers, or the Workers of its Subcontractors or Suppliers, investigate the reported situation and take immediate action to correct the condition or act, and report back to the Designated Prime Contractor, as may be required by the Designated Prime Contractor.
- g) upon receipt of a Notice of Unsafe or Harmful Condition or Act from the Designated Prime Contractor and of an Stop Work Order from the Ministry

Representative, take all steps to rectify, or cause to be rectified, the failure to comply with the Workers Compensation Act and the Regulation or to act in accordance with the Base Safety Program to the satisfaction of the Designated Prime Contractor.

h) if the Contractor and the Designated Prime Contractor fail to agree on the reasons for the issuance of the Notice of Unsafe or Harmful Condition or Act within 1 (one) day of the issuance of the Notice of Unsafe or Harmful Condition or Act, immediately implement the directive of the Designated Prime Contractor to rectify the failure to comply with the Regulation or to act in accordance with the Base Safety Program, as the case may be.

i) advise the Designated Prime Contractor in writing of the name of the Qualified Person, and of any change in the Qualified Person, designated to be responsible for the Contractor's health and safety activities on or in connection with the Site, including the Specified Area.

135.06.03 The Ministry will be deemed to have relied on the terms of and reasons for the issuance of the Notice of Unsafe or Harmful Condition or Act notwithstanding any subsequent investigation or inquiry of the matter by the Ministry, which the Ministry may but will not be obligated to undertake.

135.06.04 Notwithstanding any other term of this Section or of the Contract, the Ministry may withhold payment of any progress payment due to the Contractor under the Contract. If the Designated Prime Contractor has issued, in connection with the Site or the Specified Area, as applicable, a Notice of Unsafe or Harmful Condition or Act in accordance with this Section, and the Ministry may continue to withhold payment of such progress payment or payments, as the case may be, until such time as the Notice of Unsafe or Harmful Condition or Act has been cancelled and the Resume Work Order has been issued.

135.07 Contractor's Health and Safety Records

135.07.01 The Contractor will:

a) establish and maintain at a location on the Site, or at a location off the Site that is satisfactory to the Ministry, accurate records, including supporting documents, relating to the implementation, operation, and maintenance of the Base Safety Program, and to any other occupational health and safety matters relating to the Work.

b) notify the Ministry of the location referred to in DBSS 135.07.01 (a) not later than 5 (five) days after the Commencement Date.

c) permit the Ministry, its servants, employees and agents, at any time or times during normal business hours, to copy or audit, or both, any or all of the records, including supporting documents, referred to DBSS 135.07.01 (a).

135.07.02 The records and documentation referred to in DBSS 135.07.01 (a) include, but are not limited to the following in relation to the Work, the Site and the Specified Area:

a) the Base Safety Program.

b) any and all notices, directives and inspection reports which have been delivered to the Workers' Compensation Board by the Contractor or which the Contractor has received from the Workers' Compensation Board.

c) any and all written summaries of the particulars of any and all remedial actions taken by the Contractor to prevent the development or continuance of any risks, unsafe or harmful conditions or acts or hazards and to prevent the recurrence of such events.

d) minutes of and other documentation prepared in connection with or relating to safety meetings held between the Contractor and its Workers demonstrating that all Workers have and are receiving ongoing and adequate direction and instruction in the performance of their duties and the Work is being performed safely and without undue risk, and demonstrating the performance of regular inspections in accordance with and for the purposes stipulated in the Workers Compensation Act and the Regulation.

135.07.03 The entitlement to any payments by the Ministry to the Contractor under the Contract is conditional on the prior submission to the Ministry Representative by the Contractor, on a monthly basis, of a written summary of the documents recorded and collected under DBSS 135.07.02 and, if the Contractor is designated to act as the Designated Prime Contractor, a written summary of the actions taken by the Contractor to coordinate the occupational health and safety activities of the Employers, the Workers, and the Other Persons within the Specified Area.

135.07.04 The Contractor will cause the Qualified Coordinator to obtain and will ensure that the Qualified Coordinator:

a) obtains the records prepared with respect to the Joint Committee meetings held in connection with the Site.

b) distributes such records to the qualified persons, appointed in accordance with the Workers Compensation Act and the Regulation, of other Employers on the Site,

and as may be otherwise required by the Workers Compensation Act and the Regulation.

135.07.05 At all times during the Term, the Contractor will deliver to the Ministry Representative a copy of any accident or incident reports prepared by the Contractor in compliance with the Workers Compensation Act and the Regulation, when such reports have been completed.

135.07.06 The Contractor will provide the Ministry Representative with a statistical summary of all health and safety records applicable to the Site during the Term which summary entitled "Contractor's Accident Statistics Summary Report" attached as in Appendix B to this Section, will provide particulars of the following information:

a) the total number of hours worked by the Workers of the Contractor and the Workers of Subcontractors of the Contractor.

b) the total number of occurrences or events which occurred on the Site that were reportable to or subject to the notification requirements of the Workers Compensation Act or the Regulation.

c) the total number person-days lost due to accidents, injuries or incidents.

d) the total actual cost of damage to equipment and materials due to accidents, injuries, or incidents.

135.07.07 Receipt and retention by the Ministry of the information and documentation listed above in this Section in no way constitutes approval of or authorization of the form, content or adequacy of such information and documentation on the part of the Ministry.

APPENDIX "A"

**PRIME CONTRACTOR'S NOTICE OF UNSAFE OR HARMFUL
CONDITION OR ACT (the "Notice")**

This Notice has been issued by the Prime Contractor to:

Name of Contractor: _____

Address: _____

The following unsafe or harmful condition or act was observed at the following location and time:

Description of unsafe or harmful condition or act: _____

Location: _____ Date: _____ Time: _____ AM/PM

The Contractor named in this Notice is required to correct the above referenced unsafe or harmful condition or act prior to performing any more work activity at the location identified above.

Prime Contractor: _____

Signature: _____ Date: _____ Time: _____ AM/PM

Receipt acknowledged by the Contractor:

Signature: _____ Date: _____ Time: _____ AM/PM

The Ministry Manager received a copy of this Notice on: Date: _____ Time: _____ AM/PM

On the basis of this Notice, the Ministry Manager will issue an "Stop Work Order" in connection with the unsafe or harmful condition or act as identified on this Notice.

The Prime Contractor will, if satisfied that the unsafe or harmful condition or act has been rectified cancel and withdraw this Notice.

Date of cancellation/withdrawal: _____ Time: _____ AM/PM

Prime Contractor - Signature: _____

The Ministry Manager will issue an "Resume Work Order" when in receipt from the Prime Contractor of this Notice endorsed to indicate that the unsafe or harmful condition or act has been rectified.

DISTRIBUTION:

Original: Contractor

Copy: Ministry Manager

File Copy: Prime Contractor

APPENDIX "B"


**BRITISH
COLUMBIA**

 Ministry of
Transportation

**CONTRACTOR'S ACCIDENT
STATISTICS SUMMARY REPORT**

Project Number _____

Date (yyyy/mm/dd) _____

Description _____

Award Date (yyyy/mm/dd) _____

Completion Date (yyyy/mm/dd) _____

Name of Contractor _____

Month	Total Number of All Hours Worked by All Contractor's & Sub-contractor's Workers	Number of Reportable Accidents & Incidents	Number of Days Lost Due to Lost Time Accidents	Total Cost for Damage to Equipment or Material
Jan				
Feb				
Mar				
Apr				
May				
Jun				
Jul				
Aug				
Sep				
Oct				
Nov				
Dec				
Totals				

Contractor's designated authority - Signature _____

Print name of Contractor's designated authority _____

Attach additional copies of this form as necessary and submit to Ministry Representative upon contract completion.

SECTION 145

GENERAL REQUIREMENTS FOR HIGHWAY, BRIDGE AND MARINE CONSTRUCTION

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

145.01 General Requirements - This Section covers the general Work requirements for highway, bridge, and marine construction.

The standards and materials specifications contained in the Design Build Standard Specifications govern the specific requirements for the Work. The Contract may provide additional specific requirements for the Work and supersede the Design Build Standard Specifications where there is conflict.

Specifications, standards, regulations and codes of other authorities named in full or by acknowledged abbreviations in the Glossary of Terms, the Design Build Standard Specifications or the Contract Document Package shall be adopted by reference.

Such reference in whole or in part by the necessary alphanumerical designation from the latest edition or revision is intended to fully detail the requirements of the Work.

145.02 Reference Information - Reference information for the Work identified in the Contract is made available for the Contractor to use for its own purpose. The Contractor shall be solely responsible for any interpretation placed thereon and for all impacts resulting from such interpretation.

145.03 Value Engineering Proposals - The Ministry wishes to encourage the development of value engineering proposals (VEP's) during the Term of the Contract. The Ministry will provide a process, as outlined in DBSS 125 to encourage the introduction, consideration, and possible implementation of VEP's. The Contractor may submit any number of VEP's during the Term.

The Ministry will be the sole judge of the acceptability of a VEP and of the cost savings, which will be realized by the Ministry due to the implementation of the VEP. The decision of the Ministry will be final.

The Ministry will not be liable to the Contractor for the Ministry's failure to accept or implement a VEP submitted by the Contractor nor for any delays to the Work that may be attributable to the VEP. A VEP or Summary VEP cannot, under any circumstances, be the

basis for a claim by the Contractor.

145.04 Scope of Work - The scope of Work is described in the Contract. No warranty is given or implied that any or all of this Work will be required or supplied.

145.05 Not Used

145.06 Not Used

145.07 Pre-construction (Post-Award) Meeting - The Ministry Representative will determine the pre-construction (post-Award) meeting's location and time and notify the Contractor. The meeting shall be held reasonably soon after Award. And afford both parties an opportunity to establish relationships and to gain an enhanced understanding of the project, the design, and each parties expectations.

145.08 Mobilization - Mobilization consists of the necessary Work and operations including, but not limited to, the movement of personnel, equipment, supplies, and incidentals to the Site, the establishment of offices, camps, and other facilities necessary to undertake the Work and all other Work Items and operations which must be initiated and finished as part of completion of the Work.

145.09 Authority of the Ministry Representative - The Ministry Representative and Ministry Manager have the authority to accept or reject the Contractor's Work in accordance with the conditions set out in the Contract. Until the Work meets the requirements of the Contract and has been accepted by the Ministry Representative, the Ministry is not obligated to make payment for Work done by the Contractor.

145.10 Power, Telegraph, Telephone Lines and Other Utilities - Moving of existing power, telegraph and telephone lines, poles and other utilities from their current to their final design locations is part of the Work.

If the Contractor's operations require the temporary removal or relocation of lines or poles, such removal or relocation shall be entirely the responsibility of the Contractor and costs of any interim utility relocations shall be to the Contractor's account. Utility owner(s) must be contacted prior to doing any utility work.

The Contractor shall be responsible for any damage to poles, lines or utilities caused by the Contractor's

construction operations, and shall repair and make good the same or bear the expense of making good and repairing the same.

The Contractor shall take the necessary precautions to protect existing utility services during the performance of the Work and shall be responsible for any losses or damages caused by the Contractor.

Locations of the utilities shown on the Drawings are approximate and may not be complete. The Contractor shall be responsible to ensure the locations of the utilities are complete and shall notify the Designer and the Ministry Representative of any discrepancies between the Drawings and the Contractor's findings.

145.11 Permits - The Contractor shall give all requisite notices in connection with the Work to the proper authorities and shall procure at the Contractor's expense all permits, licences, etc., of every description necessary for the construction and completion of the Work.

The Contractor shall deliver or make available all original certificates to the Ministry Representative for all or any part of the Work for which such certificates may be required in connection with performing the Work.

145.12 Inspection of Work - All materials and each part or detail of the Work shall be subject to inspection by the Ministry Representative.

The Contractor shall be held strictly to the true intent of the Contract in regard to quality of materials, work practice and the diligent execution of the Contract.

The Ministry Representative shall be given access to all or any part of the Work, and to the preparation, fabrication or manufacture of the materials to be used. The Contractor shall furnish all information and assistance as is required to make a complete, true and detailed inspection.

The Ministry Representative or Ministry Manager may reject any part or parts of the Work which do not comply with the requirements of the Contract.

Inspection may extend to all or any part of the Work and to the preparation, fabrication or manufacture of the materials to be used. The Ministry may station others on the Site to report on the progress of the Work and the manner in which it is being performed.

Where detected through Ministry Quality Audits, the Ministry Representative will report to the Contractor

on materials furnished or Work performed that fails to fulfill the requirements of the Contract.

Inspection or its lack shall not relieve the Contractor from any obligations to furnish acceptable materials or to provide completed construction Work that complies with the Contract.

The Contractor shall furnish for the approval of the Ministry Representative, at proper times, all shop and installation drawings as requested by the Contract or which the Ministry Representative may deem necessary.

In accepting the Contractor's drawings, the Ministry Representative will assume no responsibility as to the correctness of such drawings and the Ministry Representative's examination is only to ensure general compliance with the Contract.

145.13 "Ministry's Instruction" and "Contractor's Declaration"

145.13.01 "Ministry's Instruction" - "Ministry's Instruction" form (H0202) may be issued by the Ministry to the Contractor in order to:

- a) describe a portion of the Work which may not be covered specifically in the Contract.
- b) confirm instructions which may affect the method of carrying out the Work or payment.
- c) confirm verbal agreements made with the Contractor's representative.
- d) respond to the Contractor's representation on "Contractor's Declaration" form (H0203).

145.13.02 "Contractor's Declaration" - The Contractor is to issue the "Contractor's Declaration" form (H0203) to the Ministry Representative in order to:

- a) make a declaration of acceptance or objection to contents of the "Ministry's Instruction".
- b) formally present the Contractor's opinions, problems or requirements for clarification.

145.14 Protection and Restoration of the Work - The Contractor shall protect all Work and surrounding infrastructure from injury or damage until the issuance of the Completion Certificate.

If the Contractor fails to prevent any injury or damage

to the Work, the Contractor shall rebuild, repair, and restore at its expense any portion of the Work so injured or damaged.

145.15 Materials Supplied by the Contractor - The Contractor shall provide all materials necessary for the orderly completion of the Work with the exception of the materials supplied by the Ministry as listed in the Contract.

Material supplied by the Contractor shall not have been previously used and shall be in new condition.

All materials incorporated into the Work shall conform to the requirements of the Contract unless previously approved otherwise by the Ministry Manager.

Materials supplied by the Contractor must be approved prior to incorporation in the work.

145.15.01 Inspection of Materials - The Contractor must provide manufacturer certification or milling slips for the Ministry's use, and allow 2 weeks for the Ministry Representative to test the materials. Such certificates or mill slips must demonstrate the material properties of the specific batch of materials provided to the Project and must demonstrate that the material complies with the requirements of the Contract.

The Ministry may also perform random inspection of the materials.

The Contractor shall notify the Ministry Representative of the sources of materials supplied by the Contractor, and such notification shall be given sufficiently far in advance of delivery to enable the Ministry Representative to make inspection of the material at the source. Insufficient notice will be cause for the Ministry to reject the materials without compensation.

The Contractor will be charged for all travel time, board and lodging costs incurred by the Ministry or its designate, required to inspect materials components if the source of the material is outside the Province and incorporated into the Work.

The Ministry will offset any costs for inspecting the materials from any payments made to the Contractor.

145.15.02 Samples and Testing - The Contractor shall, as required, submit to the Ministry Representative, for approval, samples of the materials proposed for use in the work. The approval or acceptance of samples of material shall not preclude the rejection of any material upon discovery of defects or weaknesses previous to acceptance of the complete

work.

Any testing done on samples of materials provided to the Ministry Representative will be performed at the Ministry's expense, except where such testing establishes that the material does not comply with the Contract. In such cases, the Ministry may offset the cost of testing from any payments due the Contractor.

145.15.03 Alternative Materials - Brands, species and manufacturer's names specified are approved for use in the performance of the Work. No alternative materials will be considered unless approved in advance by the Ministry Manager in writing.

Savings as a result of using alternate materials will be evaluated using DBSS 125 Value Engineering.

145.16 Materials Supplied by the Ministry - Ministry supplied materials will be arranged by purchase orders for delivery by the Purchasing Commission on instructions from the Contractor notifying the Ministry Representative.

Separate purchase orders will be issued for each class of material.

Materials ordered for a specific Site shall not be transferred to any other Site without the written consent of the Ministry Manager.

Ministry supplied and owned materials will be used only for Ministry Work.

145.16.01 Delivery Points - Each purchase order will specify points of delivery. The Contractor shall be responsible for all costs that may arise such as unloading from truck or rail car, hauling to the Site, stockpiling, dunnage, and reloading.

The costs to transport all materials to the Site will be incurred by the Contractor at its own cost and will be considered incidental and no separate payment will be made for this portion of the Works.

Should the Contractor request delivery be made to an alternative point other than the nearest specified point of delivery or in any manner of delivery other than specified by the Purchasing Commission, the additional cost for this delivery shall be charged to the Contractor's account.

145.16.02 Delivery of Materials - When the Ministry Representative advises the Contractor of the name of the supplier(s), the Contractor shall be responsible for:

- a) determining requirements and ordering far enough in advance that work is not delayed.
- b) acceptance of all materials; careful unloading and handling; hauling and delivery from delivery point to job site; storage and security; prompt turn around of tank or shipping cars, trucks or delivery containers.
- c) prompt payment of all demurrage or rental charges on cars, freight, handling, delivery, storage or any other charges arising after the initial receipt of material at the delivery point.
- d) ensuring that proper accounting is kept of all materials received.

The Contractor will obtain approval from the Ministry Representative prior to removing any materials from a Ministry storage site.

The Contractor shall not during normal working hours unload or take delivery of any material unless the Ministry Representative is present.

Where the Contractor takes delivery of materials during non-working hours, the Contractor shall immediately notify the Ministry Representative at the beginning of the next shift and allow sufficient time for the Ministry Representative to check quantity and quality before any materials are used.

After taking delivery of any materials supplied to the Contractor by the Ministry under the Contract, the Contractor shall be solely responsible for same and shall make good at the Contractor's expense any loss of or damage to such materials.

The Contractor will provide a secure yard or storage area for materials supplied by the Ministry. The Contractor will replace at its own cost any material, which cannot be accounted for in the storage yard inventory.

145.16.03 Distribution of Materials - To control distribution of Ministry supplied materials and to facilitate accounting:

- a) the Contractor shall arrange for delivery of the materials only after applying for and receiving authority to do so on "Authority to Arrange for Delivery of Construction Materials" form (H0313). The requirements of the Contractor shall be indicated on Part "A" of the form. Approval from the Ministry Representative shall be indicated on Part "B" of the form. The Contractor may then arrange for delivery from the supplier. As delivery will be made only on

receipt of the purchase order number and the serial number of the "Authority" form, the Contractor shall arrange with the Ministry Representative to immediately distribute appropriate copies of the "Authority" form.

Material suppliers will be required to notify both the Ministry Representative and the Contractor when materials are shipped, giving sufficient information to identify each and every shipment against an appropriate "Authority" form serial number and purchase order number.

- b) The use of "Authority" form shall not in any way relieve the Contractor of any responsibility imposed under DBSS 145.16.02.

- c) If the Ministry Representative refuses to authorize the delivery of materials to the job, the Ministry Representative will send the refusal, with reasons in writing, to the Contractor.

- d) The Ministry may, at the completion of the Work, if materials are delivered in excess of job requirements through conditions beyond the control of the Contractor, take over the surplus material or grant the Contractor the option of purchasing the material on Site. The transaction will be completed only after the Contractor obtains for the Ministry Manager, a supplier's credit note for the total cost to the Ministry of the excess material purchased f.o.b. at the delivery point.

Upon completion of the Work, the Contractor will deliver all unused materials, which have been purchased by the Ministry, to a location as specified by the Ministry Representative.

145.17 Operation of Pavement Brooms on Highway - No mechanical pavement broom shall be operated on any highway without a rotating amber flashing light in operation. The light shall be mounted on self-propelled brooms and upon the towing vehicle of trailer type brooms.

Traffic Control is to be in accordance with the Traffic Control Manual for Work on Roadways. In addition, on extremely winding narrow roads an additional shadow vehicle shall be used ahead of the broom with a C-37 on the front of the vehicle and a flashing arrow in bar mode.

145.18 Supply and Maintain Facilities

145.18.01 Working Office – When specifically required under the Contract, the Contractor shall

provide a suitable working office with lock-up for the sole use of the Ministry. The office shall meet the requirements of Appendix A and be weatherproof, reasonably soundproof, and have ample window area and ventilation. Location of the office shall be determined by the Ministry Representative.

The Contractor shall regularly collect refuse and keep the office clean and properly maintained with heat and light. .

The office and contents shall be for the use of the Ministry for the duration of the Work and may if necessary be used concurrently with the other inspection agencies.

The Contractor shall supply a private telephone line for the sole use of the Ministry Representative. Ministry's long distance calls will be paid for by the Ministry.

The Work will include the provision of the office, furnishings, maintenance through out the Term, and removal in its entirety.

145.18.02 Testing Facility – When specifically required by the Contract, the Contractor shall provide the Ministry with a material testing facility with a minimum of 12 m² floor space either in the form of a small trailer or the portion of a large trailer. The testing facility shall include power, light, heat, ventilation, plus basic furniture to permit testing and preparation of test records. The facility shall be stable, reasonably quiet and lockable.

The Work will include the provision of the facility, furnishings, maintenance through out the Term, and removal in its entirety.

145.18.03 Not Used

145.18.04 Weigh Scale - The Contractor shall provide a truck weigh scale wherever measurement of materials by mass is required.

The weigh scale shall be an approved electronic weigh scale or platform type with remote balancing beam. The scale shall be of sufficient size and capacity to weigh, at a single pass, the largest, rigid-framed haulage vehicle to be used on the job and in any case shall be of not less than 13 t (tonne) capacity. The scale shall be capable of weighing all loads to within 20 kg of the true mass.

At the start of the Work, and as frequently as the Ministry Representative may deem necessary in order to ensure the accuracy, the scale shall be calibrated and

checked at the Contractor's expense by an Inspector of Weights and Measures.

The remote balancing beam shall be enclosed in a sound, watertight, dust-free scale house, properly ventilated and insulated. Adequate heating must be provided when the shade temperature is below 16°C.

The scale house shall be provided with full length windows facing the scale platform, and windows shall also be provided at either end, so that those in the scalehouse can at all times see vehicles to be weighed, not only on the scale but also approaching and leaving.

The front window shall be sufficiently large and low that the whole scale platform is readily visible from the scale house. Immediately behind the balancing beam, a bench or table of sufficient length shall be provided to permit both scaleperson and checker to sit abreast in a position in which they can both write on the table and view the electronic scale or weigh beam and scale platform. Drawing SS SP145-01 shows these requirements.

The Contractor shall supply and maintain portable washroom facilities at the weigh scale site.

145.19 Weighing Materials - The Contractor shall supply a qualified scaleperson to carry out the necessary weighing.

A weighing certificate prepared in triplicate, certified by the scaleperson, will be issued for each load.

The delivery receipts will bear the signature, initials or other approved marking of the issuing scaleperson and receiving checker.

If the Contractor has an automated scale and the following conditions are being met, the Contractor shall not be required to supply a scaleperson:

- a) All weighed material is being delivered to a single job site. If the Contractor is delivering to two or more job sites at the same time, the Contractor shall supply a scaleperson as detailed in the first paragraph.
- b) Truck operators do not require instruction.
- c) There are no overloads, tarp covering, spillage difficulties, or any safety problems.
- d) The scale platform is maintained by the Contractor to be clean and free from loose material at all times.

All weighed vehicles must be tared at least once a day.

145.20 Weather - No work shall be undertaken by the Contractor when, in the opinion of the Quality Manager, the weather is unsuitable or unfavourable for that particular class of work.

145.21 Layout of Work and Calculation of Quantities- A number of key reference points of control line (primary) for the establishment of the design control line may be provided by the Ministry to aid the Contractor to lay out the Work. The Contractor shall assume full responsibility for the alignment, dimensions and elevations of each and every part of the work and their mutual agreement.

145.21.01 Not Used

145.21.02 Contractor's Responsibilities - The Contractor shall perform all layout of the work and all other survey work required to execute the Contract and construct the works in accordance with the Contract.

The Contractor shall be responsible for establishing all control points and/or lines, all slope stakes, the establishment of line and grades for subgrade and the various granular aggregate layers, layout by line and grade of all structures, culverts, and underground utilities, and shall perform all other layout and measurement necessary for the proper execution of the Contract.

The staking of all works shall be of a sufficient accuracy and frequency for the Ministry to carry out its quality management program.

On request of the Ministry Representative, the Contractor shall submit documentation to verify the accuracy of the layout work.

The Contractor shall be satisfied, before commencing any Work, as to the meaning, intent and accuracy of any control points, control lines and benchmarks established by the Ministry.

Should the Contractor discover or suspect any errors in any control points, control lines, benchmarks, and data provided by the Ministry, the Contractor shall at once discontinue the affected work until such errors are investigated by the Ministry Representative and, if necessary, rectified.

Unless the Design requires a tighter tolerance, all Work shall be laid out and constructed to within ± 50 mm of its Design location.

Unless the Design requires a tighter tolerance, the Work shall be so laid out and constructed that the

location of substructure elements and anchor bolt groups shall not differ from the true positions by more than the following amounts:

- a) Substructure elements - 12 mm
- b) Anchor bolt groups - 6 mm.
- c) The elevation of bridge seats shall not differ from true elevations by more than 3 mm.

Any deviation beyond the above mentioned tolerances shall be satisfactorily corrected by the Contractor at the Contractor's expense.

145.22 Access to Site - The Contractor shall provide access to the Site as may be necessary.

The Contractor shall make arrangements with the property owners adjacent to and around the terminal site for the use of access and for the use of any storage areas the Contractor may require. The Contractor shall acquire such access and storage rights at the Contractor's expense.

In the event of roads being temporarily closed to the travelling public, the Contractor shall, at the Contractor's expense, provide, erect and maintain all requisite barriers, fences or other proper protection and must provide, keep and maintain such patrollers, lights and danger signals as may be necessary, or as may be required by the Designer or Ministry Representative to ensure safety to the public and to the workers.

The Contractor, during the Contractor's operations, must also provide and maintain reasonable road access and egress to property fronting along or in the vicinity of the work under contract, unless other means of road access exists. The Ministry Representative will be the sole judge as to what may be deemed reasonable road access.

145.23 Accommodation of Traffic - The Contractor shall cause as little inconvenience as possible to the travelling public during the Contractor's operations and shall erect and maintain proper and adequate barricades, traffic signs, lights and other traffic control devices as may be considered necessary, in the opinion of the Designer or Ministry Representative, for the safety of both workers and public traffic.

All barricades, traffic signs, lights and other control devices shall be provided at the Contractor's expense, and shall be erected in accordance with, and otherwise conform to the standards as set out in the Ministry's "Traffic Control Manual for Work on Roadways",

Contract and DB Standard Specifications.

145.23.01 Maintenance of Traffic - The Contractor shall comply with the requirements of the Transportation Act and amendments thereto and such other Acts, By-Laws or Regulations as are in force for the governing and regulating of traffic or use of any road upon or over which it is necessary to do work or transport materials. The Contractor must arrange to keep roads open to traffic at all times and must cause as little inconvenience as possible to the travelling public, except as permitted under the Contract.

145.23.02 Road Closure Notification - Road closures shall not be permitted until the Contractor requests and receives written permission from the appropriate authority in the Ministry. This request shall be submitted in writing not less than seven days in advance of the closure.

Upon receiving written permission for closure, the Contractor shall notify the local police, fire, ambulance, municipality, school board, and public transit at least 72 hours in advance of the closure.

The Contractor shall notify the public by local radio and newspaper at least 24 hours in advance of the closure.

145.24 Not Used

145.24.01 Not Used

145.25 Use of Explosives - In using explosives the Contractor shall exercise the utmost care so as not to endanger life or property and, whenever directed, the number and size of the charges shall be reduced. Before doing any blasting the Contractor shall ascertain if there are in the neighbourhood any railway, power or other lines, water or other pipes, etc., which are likely to be in danger of being damaged. The Contractor shall give to the owner of such lines, pipes or other works timely notice of the intention to blast.

Whenever possible electric batteries shall be employed for simultaneous blasting.

The storage of explosives shall be in accordance with the regulations of the Canada Explosives Act and with any requirements of the representative of the Explosives Regulatory Division within the Mineral Technology Branch of the Minerals and Metals Sector of the Federal Department of the Natural Resources Canada.

145.26 Work in Ministry Pits or Quarries - When

operating in a Ministry pit or quarry where the Ministry retains the role of Pit Manager, the Contractor shall comply with all provisions of the Mines Act, the Health, Safety and Reclamation Code for Mines in British Columbia, and/or the WCB Occupational Health & Safety Regulation, as applicable to the work undertaken.

The Contractor shall appoint a properly qualified supervisor or shift boss in any Ministry pit or quarry where work is undertaken, in compliance with Section 26 of the Mines Act, and ensure that the supervisor or shift boss is duly qualified certified in accordance with Section 1.13 of the Health, Safety and Reclamation Code for Mines in British Columbia.

When the Contractor is operating in a Ministry pit or quarry, the Contractor shall utilize the pit or quarry in accordance with the Ministry Pit Development Plan or obtain written approval from the Ministry Project Manager prior to deviating from the plan.

When investigating private aggregate sources, the Contractor shall ensure that all permits are in place allowing the Contractor to purchase and remove the aggregate from the property of the Owner.

Availability and use of the listed reserves or any other private aggregate source must be arranged by the Contractor. Prior to the removal of any aggregate material from an aggregate source, the Contractor shall provide a written notice from the owner authorizing the Contractor to remove aggregate material for use in the work.

Ministry pits or quarries may be used without charge, provided they are utilized, worked and maintained in accordance with the DB Standard Specifications and the Ministry's development plans. Prior to the removal of any aggregate material, the Contractor shall obtain written approval from the local District Manager Transportation. No warranty is given or implied that the source of aggregate material from the Ministry pits or quarries will meet requirements or requisite quantities.

The Contractor shall contact the Road and Bridge Maintenance Contractor a minimum of two (2) weeks before the date the Contractor anticipates the use of any Ministry pits or quarries.

The Contractor and the Road and Bridge Maintenance Contractor shall co-ordinate their activities and schedule usage of the pit among themselves and any other affected parties.

The following listed Variances to the Health, Safety and Reclamation code for Mines in British Columbia will apply only to pits and quarry operations which fall under Ministry ownership.

The Chief Inspector of Mines has provided the following clarifications to the Ministry in a letter dated August 9, 1999:

Application for Continuation of Variance to Mine Code Section 1.5.1 - Hours of Employment

"Pursuant to section 13 of the Mines Act, R.S.B.C. 1996. c293, the assigned Ministry of Transportation (MoT) Pit Manager may permit the employment of persons in a sand and gravel pit or quarry (Mine) for up to 12 hours in a 24 hour period.

This variance applies only to pits managed by the MoT (Ministry of Transportation).

The Pit Manager shall communicate this variance to all affected workers, whether employees of the Ministry of Transportation, its contractors or sub-contractors.

This variance is subject to review within five years as provided by section 13(4) of the Mines Act.

A copy of this variance is available to any MoT regional or district Occupational Health and Safety Committees which may be involved in sand and gravel pit or quarry operations."

Section 4.9.1 – Health, Safety and Reclamation Code for Mines in British Columbia (Code)

"Due to the short period of time that some haul trucks spend at your various pits and quarries, i.e. for loading purposes only, I am hereby enabling a Health and Safety Inspector of the Mines Branch to vary the requirement for automatic back-up alarms on transient haul trucks at the discretion of the Inspector. If, in the opinion of the Inspector, the time spent by the truck at the pit or quarry is of short duration, and the required routing of the truck for loading purposes is such that no hazards are created by such a routing, then an automatic back-up alarm need not be required and the use of any audio warning device will be accepted while in reverse."

"You are reminded that the above refers only to transient haul trucks and not to trucks used for production purposes; neither does it apply to any other vehicle in excess of 7,000 kg gross vehicle weight."

Section 4.9.5 - Health, Safety and Reclamation Code

for Mines in British Columbia (Code)

As a haul truck driver's visibility of the area surrounding the truck tends to improve as the size of the truck decreases, I am prepared to allow a variance to the above section of the Code as follows:

"Provided that any haul truck used for production purposes at a gravel pit or quarry does not exceed 45 tonnes gross vehicle weight, there will be no requirement for the attachment of a whip antenna fitted with a flag and lamp, or a flashing light mounted on the cab of non-production vehicles."

145.26.01 Available Ministry Sources - The Contractor, by entering an available source, will be deemed to have accepted all obligations, risks and costs for the production of aggregate meeting the contract requirements, just as if the pit or quarry was private. No warranty is given that the source will meet the quality and quantity requirements. The Contractor, without any additional compensation, shall provide whatever selection, screening, crushing, mixing, blending or other processing of any kind may be required to produce aggregate meeting all requirements for its intended use, including but not limited to:

- specified aggregate gradation,
- fracture count,
- aggregate quality requirements such as but not limited to those set out in DBSS 202.04 and Table 501-D of DBSS 501 as applicable, and
- the specified properties of any products into which the aggregate is to be incorporated.

The Contractor shall comply with the Ministry pit development plan and the Ministry Representative's directions regarding the location of material extraction within the pit by the Contractor.

The Contractor's use of Ministry pits is limited to the extraction of previously unexcavated material from the bank, for the supply of materials for use on this Contract.

The Ministry's Road and Bridge Maintenance Contractor has certain rights and obligations with respect to some Ministry pits, and the Contractor shall coordinate its activities with those of that contractor, where applicable, and with any other users, to the satisfaction of the Ministry Representative and the Ministry's District Manager, Transportation.

145.27 Highway Right-of-Way - The Contractor shall confine its operations to the highway right-of-way and Licences to Construct as shown on the Ministry's Drawings. Any land, property or water lot outside these boundaries required for construction yards, access roads, disposal or storage areas, or other operations of the Contractor, shall be acquired by the Contractor at no additional expense to the Ministry. The Contractor shall make arrangements for the use and compensation of such land with the titled land owner.

Work within the Site shall be confined to that necessary to construct the Project to the lines and grades specified. Excavation outside the design lines and grades to extract aggregates or for other purposes is prohibited unless authorized in advance by the Ministry Representative.

145.27.02 Disposal Site Outside the Right-of-Way - Waste, or other materials specified or designated by the Ministry's Representative to be disposed of, such as, but not limited to clearing and grubbing materials, fences, old culverts, old concrete and asphalt, etc., shall be removed from the Site to a disposal site provided by the Contractor. All disposal sites shall be the responsibility of the Contractor.

The Contractor shall ensure that the disposal site complies with all Federal, Provincial, Municipal and Regional by-laws and regulations prior to disposing of the material. Any fees incurred shall be paid by the Contractor. The Contractor must provide documented proof to the Ministry Representative for the use of the selected disposal site.

In addition, the Contractor shall ensure that the disposal site complies with all municipal and regional government by-laws and regulations and, when relying upon any exemption permitted under section 2(d) of the *Agricultural Land Reserve Permit Regulation*, shall provide a written confirmation from the Regional District of their agreement that no permit is required.

145.27.03 Access Roads to Private and Public Lands - The Contractor shall not block or impede the use of any private access roads or driveways during the Work of this Contract without the consent of the Ministry Representative.

The Contractor shall schedule any anticipated closure of an access with the property owner to minimize impact on the owner.

145.27.04 Private Land Reserves Borrow material shall not be obtained from land outside the right-of-

way, without prior approval from the titled land owner. In addition, excavation or deposition on lands located within an Agriculture Land Reserve require the approval from the B.C. Agricultural Land Commission and issuance of a valid permit under the Soil Conservation Act.

145.28 Protection of Land Subdivision Monuments, Roads and Property

145.28.01 Protection of Subdivision Monuments - The Contractor shall protect, preserve, and keep uncovered all land subdivision monuments or property marks during its construction activities which may cause disturbance to them. At points where construction activities will cover or destroy any land subdivision monuments or property marks, the Contractor shall restore them afterwards.

145.28.02 Protection of Survey Monuments - The Contractor shall be responsible for the preservation during construction of all geodetic benchmarks, survey monuments and property markers on the right-of-way. The Contractor shall use, at no additional expense to the Ministry, a British Columbia Land Surveyor to replace any survey monuments destroyed or damaged as a result of the Contractor's negligence.

145.28.03 Protection of Roads - The Contractor shall ensure all equipment working on or hauling material on to and from the Site does not damage or deposit material onto any part of an existing roadway. Materials spilled onto the public roadways or driveways opened to public traffic shall be cleaned up immediately. The Contractor has the full responsibility to repair any damage to existing highways, local roads and driveways caused by its construction equipment and/or operations.

145.28.04 Protection of Railway Property - The Contractor shall be wholly responsible for any damage to railway trackage or property on the railway company's right-of-way resulting from highway construction operations. It shall be the Contractor's responsibility that all workers and persons employed by the Contractor or the Contractor's agents, or under the Contractor's control, shall use due care that no person or property is injured, and that no rights are infringed in performing the work. The Contractor shall compensate injured parties.

The Contractor shall be responsible for:

- traffic control persons or other personnel required for the protection of the railway trackage

- re-routing or repairing any telegraph or telephone lines during the course of operations.

The Contractor shall, to the satisfaction of the Ministry Representative, restore and clean all slopes between the highway and the railway track together with any fences, ditches and drains disturbed by the work.

The Contractor shall give advance notice to the railway company prior to carrying out any work on the railway right-of-way and shall not proceed without specific coordination with the railway company and its schedule, and notice to the Ministry Representative.

145.28.05 Not Used

145.28.06 Protection and Restoration of Property and Environment - The Contractor shall not enter upon private property for any purpose without first obtaining permission of the owner of that property and shall be responsible for the preservation of public property along and adjacent to the Work, and shall use every reasonable precaution necessary to prevent damage or injury thereto.

The Contractor shall be liable for all damages caused by fire started by the Contractor and shall, under no circumstances start fires without first securing the required permits and approval of authorities having jurisdiction even though it may be ordered or required to do such burning.

The Contractor shall take special care when burning brush, stumps or rubbish not to damages any standing trees, shrubs or other property and to use when practicable smokeless burning methods.

145.29 Haul Routes and Overloads - The Contractor shall be responsible for ascertaining that the Contractor's haul routes are acceptable to the authority having jurisdiction for highway loading.

Overweight or oversize vehicles are not permitted to use existing highway as a haul road for the hauling of construction materials, notwithstanding Section 7.01 of the Commercial Transport Regulation 1980 Consolidation, as amended from time to time.

Off-highway equipment may be permitted to cross the existing highway only at specific locations as approved by the Ministry Representative.

Once the crushed granular base, surfacing or pavement work has commenced on any portion of the new, reconstructed or relocated highway, no overloads will be permitted on that portion unless written approval is

given by the Ministry Representative.

145.30 Health and Safety

145.30.01 Occupational Health and Safety Program

- The Contractor shall provide an Occupational Health and Safety Program and have it in place prior to the commencement of any Work on Site.

Any delays in commencement of the Work related to acceptance of the Contract and site specifics of the Contractor's Occupational Health and Safety Program or interruptions of the Work related to the implementation of the Occupational Health and Safety Program are not Reimbursable Delays unless otherwise agreed to in writing by the Ministry Representative.

145.30.02 Worksite Hazards - The Contractor has the responsibility to identify worksite hazards and shall develop operational occupational safety policies and procedures and plans which are specific to the Work to ensure the safety of all persons at the Site and the travelling public passing through the Site.

When requested by the Ministry Representative, the Contractor shall provide copies of any safety policies, procedures or plans verifying steps have been taken to make all concerned fully aware of all hazards or unsafe conditions in accordance to DBSS 135 - Construction Site Safety.

The Contractor shall provide for the safety, protection and convenience of the general public and residents along the highway.

The Contractor shall erect and maintain signs, fences and barricades at the ends of the bridges before they are opened to traffic and at other dangerous areas of the Project, as necessary to prevent access of vehicles and pedestrians to the unfinished bridge and other dangerous areas.

145.30.03 Equipment - All trucks and other equipment used by the Contractor whether owned or rented for use on the Project shall meet manufacture's specifications for its purpose.

All trucks and other equipment rented by the Contractor for use on the Project shall when practicable be qualified local trucks obtained from local residents.

For the purposes of this Section, qualified local truck means a truck that meets all the following:

- a) a truck that has Motor Carrier approval.

- b) where the Contractor has a collective agreement with its employees the truck operator is a member of, or has the permission of the appropriate bargaining unit.
- c) the truck fulfils, in the opinion of the Ministry Representative, the specialized needs of the Contractor.
- d) a truck registered on the Ministry's Hired Equipment list for the geographic area encompassing the Site to in adjacent areas.

Hire of trucks and other equipment paid on a production rate basis constitutes a Subcontract.

145.30.04 Audible Back Up Warning Device - All haul vehicles shall be equipped with an automatic audible warning device which will activate whenever the vehicle is backing up. The warning device shall be clearly audible above the ambient noise level at a minimum distance of 6 m from the back of the vehicle

145.31 Faulty Work - If there is evidence of any fault, defect, or injury from any cause whatever, which may adversely affect the strength, durability, safety, maintenance, or appearance of any section of the work, the Contractor shall, at the Contractor's expense, satisfactorily correct such faults or, if required, shall replace as much of said section as the Ministry Representative may deem necessary, even to the extent of replacing the entire section. The fact that the inspector in charge may have previously overlooked such defective work shall not constitute an acceptance of any part of it.

145.32 Temporary Excavation - Where temporary excavations are undertaken in the course of the Work, the Contractor shall be responsible for maintaining the stability of adjacent ground and all structures and other works thereon.

145.33 General Sign Requirements

145.33.01 Contractor Identification Signs - The Contractor may supply and install contractor identification signs for the Term. The Contractor shall maintain and remove such signs and all costs of supply, installation, maintenance and removal shall be the responsibility of the Contractor.

The contractor identification sign shall display only the Contractor's company name and beneath it the word

"Information" followed by a telephone number which directly connects any caller to the Contractor's personnel who are familiar with, and are currently active on the Project.

The sign will not be reflectorized, and the background colour will not be either red, yellow or orange. The sign dimensions will not exceed 2,400 mm horizontal and 1,200 mm vertical, and the text size (height) will not be less than 150 mm.

The contractor identification sign will be erected only in conjunction with the C-35 project identification sign, and will not be in advance of or at the same location as the C-35 sign. Where there is no C-35 sign, no contractor identification sign will be permitted.

No contractor identification sign may be installed without prior approval of both the sign and the intended installation and location by the Ministry Representative who, in determining whether or not to grant such approval, will not necessarily be limited to the requirements set out above.

145.33.02 Prime Contractor Sign - When designated as the Prime Contractor, the Contractor shall provide "Prime Contractor" sign as specified in DBSS 135 Construction Site Safety.

145.33.03 Safety Apparel and Traffic Control Signs - All traffic control signs shall meet current Ministry specifications. The Ministry *Specifications for Standard Highway Sign Materials, Fabrication and Supply* are located on our Ministry web page at:

www.th.gov.bc.ca/publications/eng_publications/geometsigns.htm

The safety apparel and traffic control retro-reflectivity signs and devices referenced in the Traffic Control Manual for Work on Roadways (TCM) are being revised as per Technical Circular T-09/05.

http://www.th.gov.bc.ca/publications/Circulars/Current/T_Circ/2005/t09-05.pdf

Notwithstanding the 3-year phase-in period described in the circular, the new standards shall apply to all Work under this Contract.

APPENDIX A

Ministry Office Requirements

REQUIREMENTS FOR OFFICE TYPES			
Office Type	A	B	C
Lockable desk/chair	1	2	3
Typist desk/chair	-	-	1
Drafting table 1.2 m x 2.4 m /stool	1	1	1
Reference table 1.2 m ²	-	1	3
Conference table 1.2 m x 2.4 m	-	-	1
Additional chairs	2	2	9
Plan case or drawing storage unit	1	1	2
Filing cabinet (# drawers)	1 - 2 drawers	1 - 4 drawers	3 - 4 drawers
Shelving bookcase m ²	2	5	20
Fire Extinguisher for Class A, B and C fires	1 - 5 kg	1 - 5 kg	2 - 5 kg
Supply Activated Telephones and Lines	One (1)	One (1)	Three (3) on two (2) lines with external bell and switch
Toilet	On site	On site	In washroom, hot and cold running potable water and wash basin
First Aid Kit	On site	#1 Unit Kit	#1 Unit Kit
Floor Areas - m²			
a) Entrance	-	-	5
b) Ministry Representative's office	12	12	12
c) Additional Staff office	-	8	20
d) Wash room	-	-	As required
e) Store room	-	-	5

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PROTECTION OF THE ENVIRONMENT

165.01 General - This Section covers the general and specific provisions for the protection of the environment, in cooperation with any Federal and/or Provincial Environment officers or an Environmental Monitor, as designated in the Contract.

165.01.01 Intent of Specifications - These Specifications give the Ministry the right to exercise control over environmental aspects of the work. The Contractor shall adhere to specific instructions if the work may result in an adverse impact on the environment.

The Ministry will determine the significance of environmental impacts in consultation with Environmental Agencies. The Ministry reserves the right of approval over the general methods employed by the Contractor in the performance of the work, but only insofar as they may affect relations with Environmental Agencies and the protection of aquatic and terrestrial resources, the health and safety of public, and protection of socio-community resources and features.

These specifications are for the protection of the environment, and shall be given such interpretation as will secure this intent.

165.01.02 Definitions - For the purposes of this Section, the following general terms are defined as follows:

“Compensation” refers to monetary payment or replacement in kind for environmental losses resulting from a development project, as well as the construction activities for the re-creation of lost or damaged habitat.

“Deleterious Substance or Material” is defined as a substance harmful to fish or fish habitat (Canada Fisheries Act, Section 34.1).

“Designated” shall mean designated in the Contract or by the Ministry Representative.

“Environment” refers to the physical, biological, social, spiritual and cultural components that are interrelated and affect the growth and development of living organisms. The term “environment” in these specifications shall include socio-community issues and resources.

“Environmental Agencies” shall mean the appropriate regulating branches of the Federal and Provincial agencies responsible for the management and protection of the Environment and human resources. A partial listing of these Environmental Agencies and their areas of concern is given in the joint publication “Land Development Guidelines for the Protection of Aquatic Habitat”,

Fisheries and Oceans Canada and Ministry of Environment, Lands and Parks (1992), hereafter referred to as the “Land Development Guidelines”.

The “Environmental Monitor” shall mean an agent hired by the Contractor's in compliance with the environmental protection aspects of Standard Specifications, the Contract, permits and approvals, and to advise the Contractor and Ministry Representative on environmental problems. An Environmental Monitor will be used when and where required, and will report to the Contractor.

“Environmental Approval” is defined as the written authority issued to a person or company by a government agency that allows the person or company to do something that otherwise may not be permitted by law or which is not defined in law. An environmental approval is a broad, generic term referring to informal or formal authorization for actions that may have an adverse effect on the environment, such as (i) undertaking an activity (e.g., authorization from fishery agencies to proceed with work within the wetted perimeter of a fish-bearing stream); or (ii) discharging some form of material (e.g., approval under the British Columbia Waste Management Act to introduce waste into the environment or the storage of special waste for a period of 12 months or less). The term “approval” can include related forms of authorization such as permits and licenses.

“Environmentally Sensitive Areas” shall mean areas requiring special management and attention to protect resources, habitat or species (which includes and is not limited to water quality, identified sensitive areas, fish and fish habitat, vegetation, rare and endangered flora/fauna, landscaping and visual aesthetics, soil conservation (including dust control), air quality and archaeological, heritage and cultural resources).

“Environmental Timing Window” shall mean any period suitable for environmentally sensitive construction work as designated by an Environmental Agency or other federal, provincial, municipal or local agency. This window represents the period that the natural or human environment is likely less susceptible to adverse impacts. A common example of an Environmental Timing Window on highway construction projects is a Fishery Timing Window. Timing windows may also be imposed for the protection of breeding birds, retention of significant recreational activities, maintenance of critical traffic patterns, etc.

“Fishery Timing Window” refers to the time period(s) of reduced risk for important commercial, sport, and resident fish species, based on their life histories. The Fishery

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Timing Window is the time of year during which there are no fish eggs or alevins present in the substrates of local watercourses, and the period when fish migration (juvenile out-migration and adult spawning in-migration) is not occurring. This is generally the preferred period for (i) instream work or (ii) work adjacent to or over top of fish-bearing streams with the potential to create adverse impacts on fish or fish habitat.

"Habitats" are defined as those parts of the environment on which terrestrial and/or aquatic species depend, directly or indirectly, in order to carry out their life processes.

"Fisheries Sensitive Zone" is defined as the instream aquatic habitats, as well as out-of-stream supporting habitat features such as side channels, wetlands, and vegetated riparian areas adjacent to these features.

"Impact" is defined as an alteration, either positive or negative, to the environment brought about as a direct or indirect result of a highway project, including construction, operation and maintenance work (e.g., the consequence of a highway-related activity interacting with its surroundings).

"Mitigation" refers to a procedure or an action designed to avoid, reduce or control the severity, magnitude, duration and/or frequency of environmental impacts of a project through design alternatives, scheduling or other means.

"Permit" refers to a formal authorization, typically granted to proponents by an Environmental Agency, for discharging agreed upon quantities and types of regulated substances such as pollutants or waste. For example, under Section 8 of the British Columbia Waste Management Act, a permit may be issued to introduce waste into the environment or to store special waste subject to environmental protection requirements which are deemed advisable. The permit can specify the procedures or requirements respecting the handling, treatment, transportation, discharge or storage of waste that the holder of the permit must fulfill. The term "permit" can be defined by applicable legislation. The term "permit" is synonymous with the term "license", and the two terms are often used interchangeably.

"Riparian Area" is defined as the land adjacent to the normal high water level in a stream, river, lake or pond and extending to the portion of land that is directly influenced by the presence of adjacent ponded or channeled water, or a groundwater zone fed by surface water bodies (e.g., zone in which rooted vegetation is influenced). Riparian areas typically contain important vegetation resources which provide several critical functions for the survival of fish (e.g., protection from predators, shade for temperature regulation of the watercourse, and sources of food).

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"Sedimentation" is defined as the deposition of material carried in water, usually as a result of a reduction in water velocity below the point at which material can be transported.

"Watercourses" shall apply to all bodies of water including streams, rivers, canals, ditches, lakes, ponds, and wetlands.

"Wetted Perimeter" is defined by Station number and/or as highlighted on the plan drawings.

165.01.03 General Restraints for Watercourses and Groundwater - The following general restraints in regard to the protection of any watercourse shall apply:

- a) The Contractor shall place and/or dispose of all organic material, refuse, ash, petroleum products and other deleterious materials so as not to directly or indirectly pollute any watercourse or groundwater. The placement and disposal of all such products and materials shall be done in an environmentally acceptable manner.
- b) Except as required by the Contract, all inorganic material shall be placed and/or disposed of in a manner that does not obstruct or unduly disturb any permanent or seasonal watercourse. Any such obstruction or disturbance shall be restored to the original drainage pattern. Any removal of inorganic material from a watercourse shall be done in a manner that minimizes adverse impacts.
- c) All activities within the wetted perimeter of any watercourse shall be kept to an absolute minimum. Machinery and equipment shall not be operated within the wetted perimeter of any watercourse other than under the terms of the Authorization and permits issued by the Environmental Agencies. An Environmental Monitor shall be present during any work within the wetted perimeter of any watercourse on the Project.

The preceding requirements, a) through c), are considered incidental to the price bid for work under Contract and no other compensation will be made.

165.01.04 Designated Streams and Designated Environmentally Sensitive Areas - Any watercourse or environmentally sensitive area designated in the Contract is subject to all of the restraints of this Section.

165.02 Planning and Scheduling - The Contractor shall carefully plan and schedule construction activities in a manner that ensures the avoidance or absolute minimization of environmental damage. The Contractor shall be familiar with and be able to identify those areas and times which present environmental problems and shall

prepare schedules and work methods accordingly. The Contractor shall forward a copy of each of the schedules to the Ministry Representative at least one week in advance of commencement of each of these operations, unless otherwise specified in the contract.

The Contractor, shall provide an **Environmental Management Plan (EMP)** which describes in detail the approach to be taken in addressing environmental issues associated with the Project and the correlation of the EMP to the project schedule. The EMP will be structured according to the following format and will include, but not be limited to, the following:

- demonstrate understanding of the specific environmental issues involved with the Project,
- indicate an understanding of Ministry/Contractor responsibilities,
- include a sediment and drainage management plan,
- identify all the tasks required and clearly identify the duration and sequence of each task leading to the receipt of agency approvals, and
- indicate its linkage to the project schedule.

The EMP will clearly indicate how the Project will be undertaken to avoid negative impacts pertaining to, but not limited to, the following resources:

- water quality (including all surface and sub-surface sources),
- identified sensitive areas,
- fish and fish habitat,
- wildlife,
- vegetation (including riparian plant communities),
- rare and endangered flora/fauna,
- landscaping and visual aesthetics,
- soil conservation (including site stability, dust control),
- air quality, and
- archaeological, heritage, and cultural resources.

The Contractor, in consultation with the Ministry Representative, Environmental Monitor and the Environmental Agencies, shall be responsible for determining the conditions under which the work must be carried out in Environmentally Sensitive Areas, and for making all required on-site examinations and examinations of documents supplied and referenced by the Ministry in order to fully comprehend the environmental aspects of the work required.

165.02.01 Environmental Legislation and Regulatory Requirements - The Contractor shall observe and comply with all federal, provincial, municipal and local laws and regulations which seek to ensure that construction work does not adversely affect the environment or social-community resources.

In the event of conflict between the requirements set out in these Specifications and quality control laws, statutes, regulations and ordinances of federal, provincial, municipal or local agencies, the more restrictive requirements or regulations shall apply. A violation of the environmental laws and regulations reported to the Ministry by the responsible agencies may result in the issuance of a non-conformance report. Should the situation warrant more stringent measures, it may also result in the issuance of a stop-work order until the violation is corrected. The Contractor shall have no recourse for reimbursement due to delays or alterations to construction activities arising from such violations or the correction of such violations.

165.02.02 Environmental Procedures - The Environmental Agencies or the Ministry Representative may require one or more detailed sets of environmental procedures for any work in and around Environmentally Sensitive Areas, such as critical fish habitat. When a set of environmental procedures is required, the Contractor shall prepare and submit the procedures to the Ministry Representative and the Environmental Agencies prior to undertaking work in these areas. These detailed procedures shall supplement the EMP. The Contractor shall forward a copy of the approved set of procedures to the Environmental Agencies and the Ministry Representative, prior to undertaking the work. The environmental procedures shall contain the following items:

- a) Existing environmental conditions. Identification of the environmental resources (e.g. fish species and habitat) in the area of the proposed work.
- b) Description of work proposed in the Environmentally Sensitive Area. Summary of the proposed work, equipment to be used, schedule of activities, and location.
- c) Environmental protection measures. Statement concerning the protective measures that will be used to protect environmental resources (e.g., species and habitat) from each anticipated adverse impact.
- d) Contingency plan. Description of alternative or backup plan in the event of an environmental emergency or failure of any of the protective measures.
- e) Environmental monitoring requirements. Indication of any specific or unique environmental monitoring requirements to ensure compliance with environmental specifications and proper implementation of the environmental procedures.

The Contractor's Environmental Monitor shall contact the Fisheries and Oceans Canada (F&OC) and the Ministry of

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Environment for specific recommendations about the preparation of the environmental procedures. The environmental procedures must be approved by the Ministry Representative and the Environmental Agencies prior to commencement of work in Environmentally Sensitive Areas.

165.02.03 Project Orientation - The Contractor and their the Environmental Monitor shall arrange regular meetings with the Ministry Representative,. Other interested parties may be asked to attend (e.g., Agency Representatives), whose representation is necessary because of the specific type or location of work being undertaken. The purpose of such regular meetings will be to outline the schedule of upcoming construction and proposed activities, and to review the activities of the previous week. Such regular meetings do not relieve the Contractor from attending or arranging other types of meetings as required due to the nature or extent of the work being done.

The Contractor shall arrange and conduct such regular meetings during construction, subject to the following conditions:

- a) Meetings shall be held on a weekly basis when construction activities are to proceed during an Environmental Timing Window, during a period when work is to proceed in an Environmentally Sensitive Area, or during a period when the proposed construction activity elsewhere on a project is to proceed for a duration greater than two weeks and has the potential to cause adverse environmental impacts.
- b) During periods other than that specified above, regular environmental meetings shall be held every two weeks, or as otherwise agreed to by the Ministry Representative.
- c) In the event that the Environmental Monitor or the Ministry Representative deem the Contractor's compliance regarding environmental requirements to be inadequate at any time during the Project, the frequency of the weekly or biweekly regular meetings shall be increased accordingly until the Contractor's Environmental Monitor and the Ministry Representative are satisfied with the compliance rate.
- d) The Contractor's Environmental Monitor will record highlights from the meetings (e.g., summary of major discussion items and key action items) and forward a copy to the Contractor, as well as include this material in the Project Environmental Progress Reports.
- e) During the maintenance phase of the Project, the Contractor shall conduct regular environmental meetings on a quarterly basis, unless operations are to be conducted within Environmentally Sensitive Areas

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that pose potential environmental concerns. In the event that operations are to be conducted within such areas, the Contractor and Environmental Monitor shall conduct weekly environmental meetings for the duration of the maintenance work in such areas.

The Contractor is responsible for ensuring that the foreman, operators, and work crews (including any subcontractors) understand the specific environmental issues on the work site and their responsibilities under this Section. The Contractor's Environmental Monitor will give all construction personnel a brief environmental orientation prior to such personnel commencing work in any Environmentally Sensitive Area on the Project. The Contractor's Environmental Monitor will ensure that construction personnel are familiar with the environmental requirements and acceptable construction practices on the Project. The Contractor shall support the Contractor's Environmental Monitor's role in this regard.

165.02.04 Activity Within Designated Watercourses and Environmentally Sensitive Areas - All activities that are conducted within the wetted perimeter of any designated watercourse or within other designated Environmentally Sensitive Areas must conform to the timing restrictions stated in the Contract, and to the Environmental Timing Windows given in the authorizations/approvals of the Environmental Agencies. Construction work must be scheduled so that all operations affecting the Fisheries Sensitive Zone or other designated Environmentally Sensitive Areas can be completed within these time periods. Prior to the commencement of any construction activities, all work in these areas must be approved by the Environmental Agencies.

The Contractor must advise the Ministry Representative in advance of any construction-related activity in designated areas. Construction activities within designated watercourses or other Environmentally Sensitive Areas shall not commence without the attendance and support of the Environmental Monitor.

165.02.05 Inclement Weather - The Contractor shall cease operations, modify construction methods, or relocate to an alternative site within the project area during periods of inclement weather to avoid siltation of designated watercourses

165.02.06 Work Stoppage - Prior to initiating work stoppages, the Contractor shall initiate and complete any mitigative and environmental protection measures required to safeguard the environment and the Project during work stoppages.

The Contractor shall consult with the Ministry Representative of impending shutdowns to enable the Ministry Representative, Contractor, and the

Environmental Monitor to examine the project. This notice shall be sufficient to permit the Contractor adequate time to install all necessary additional environmental mitigation measures.

The Contractor shall ensure that the Environmental Monitor and construction personnel inspect Environmentally Sensitive Areas on the Project on a regular basis during any extended work stoppages (e.g., weekends, statutory holidays, Christmas vacation periods) to prevent environmental problems. If potential adverse environmental impacts are observed during work stoppage periods, the Contractor shall initiate and undertake any required environmental measures to avoid or minimize impacts.

165.03 Compliance, Enforcement and Payment

165.03.01 Temporary Pollution Control - The Contractor shall be responsible for implementation of any temporary environmental protection measures, such as pollution control measures. If the Contractor fails to respond, the Ministry may take whatever action is necessary to provide the proper corrective measures. In the event the Contractor fails to take reasonable action to implement temporary environmental control measures, the Ministry Representative or the Environmental Agencies shall determine the need for additional corrective action. The Ministry Representative may deduct incurred costs from any money due or to become due to the Contractor for any corrective action taken in this regard.

165.03.02 Responsibility for Damage to Environment - The Contractor shall bear sole responsibility for any direct or indirect damage to the environment which occurs as a result of failure to comply with these Specifications, the Contract and the directions of the Ministry Representative or recommendations of the Environmental Monitor.

165.03.03 Stop Work Orders - In the event that the Ministry Representative determines that some aspect of the construction is creating or will result in a substantial adverse effect on environmental values or resources on or adjacent to the project site, the Ministry Representative may issue a "stop work order". The Contractor shall subsequently be responsible for advising the Ministry Representative of the intended remedial action. The Ministry Representative may direct the Contractor to cease construction work on an unaffected portion of the site so that any necessary equipment can be immediately diverted to address the environmental emergency. In such an event the Contractor will not be entitled to any claim for compensation from the Ministry.

The Contractor shall be required to modify or halt any aspect of construction or maintenance that the Environmental Agencies determine poses or will pose an

environmental concern. The Environmental Agencies may verbally direct the Contractor to modify or halt any such activity or submit formal written instructions to that effect. In either case, the Contractor's immediate compliance with their instructions will be mandatory. The Contractor shall document any such requests by the Environmental Agencies and forward a copy of this documentation to the Ministry Representative within five working days of the initial notification by the Environmental Agencies.

165.03.04 Compliance with Specifications - The Contractor is responsible for ensuring that all subcontractors and employees are in compliance with these Specifications and all applicable environmental legislation and regulatory requirements at all times, and shall take immediate action to rectify problems in this regard. The Contractor shall initiate action to rectify environmental problems. The Contractor shall have available such additional safeguards, safety devices and protective equipment as are necessary to protect the environment. The Contractor shall be responsible for ensuring sufficient safety devices and protective equipment (e.g., pumps, silt fence, armoring, tarps, fuel spill cleanup kits, etc.) are readily available at all times during construction of the Project. The location and inventory of safety devices and protective equipment shall be documented and placed in a prominent location in the Contractor's field office. A copy of this information shall be updated as necessary and provided to the Ministry Representative.

The Environmental Monitor will inspect and monitor conditions at, and in the vicinity of, the project to ensure acceptable levels of pollution and disturbance are not exceeded, and to ensure compliance with the environmental specifications contained herein and in the Contract.

The frequency of such inspection and monitoring efforts shall correspond to the sensitivity and location of construction activities, as well as to the environmental conditions (e.g., increased monitoring and inspection will be conducted during periods of inclement weather). In the event that the Ministry Representative is not satisfied with the frequency and duration of such inspection and monitoring, the Contractor's Environmental Monitor will be required to increase their efforts in this regard to a level satisfactory to the Ministry Representative.

165.03.05 Payment - All the requirements for compliance with these environmental specifications shall be considered incidental to the price bid for the Project under contract and no other compensation shall be made to the Contractor. However, the Contractor may be eligible for reimbursement for the installation of any additional environmental works (e.g., enhancement measures) where directed and approved in writing and not covered in this

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Section or elsewhere in the Contract or Schedule of Quantities and Unit Prices. Any eligible reimbursement will be paid for by an Order for Extra Work. The Ministry Manager, in consultation with the Ministry's Environmental Quality staff and the Environmental Agencies, will be responsible for determining the Contractor's eligibility in this regard and for identifying what environmental work is beyond the scope of the Contract and these specifications.

165.04 Erosion, Sediment, and Drainage Control - All works shall be undertaken in a manner that avoids or absolutely minimizes erosion problems and the discharge of siltation or other deleterious substances into any watercourse. The Contractor shall not disturb designated watercourses, unless the express written consent of the Environmental Agencies is obtained prior to initiating construction activities in such areas. No obstruction or debris shall be placed in any watercourse during any operations, unless specified in the Contract or by the Ministry Representative, or for designated watercourses approved by the Environmental Agencies. Should any material be inadvertently placed within the normal high water wetted perimeter of a watercourse, the Ministry Representative shall be notified immediately and the Contractor shall remove the material immediately, using environmentally acceptable construction procedures and under the direction of the Environmental Monitor.

165.04.01 Sediment and Erosion Control - The Contractor shall incorporate all permanent soil erosion control features into the project at the earliest practicable time, as outlined in the accepted work schedule, and shall be responsible for temporary erosion and sediment control measures, including daily inspection of the integrity of such measures during adverse weather conditions or when construction operations are proceeding in Environmentally Sensitive Areas. Control measures shall be capable of continuous operation during working and non-working hours. Any deficiencies which are observed in erosion control measures shall be immediately corrected.

The Environmental Agencies and the Ministry Representative have the authority to define environmentally sensitive areas or conditions, such as areas of erodible soil, and to direct the Contractor to provide temporary erosion and sediment control measures. These measures may include, but may not be limited to:

- interceptor ditches or berms to direct runoff away from erodible areas;
- slope protection measures such as mulches, hydroseeding, erosion mats, geotextiles, filter fabric, polyethylene covers, or riprap;
- silt fences;
- ditch blocks to reduce flow velocities, and;
- sediment control measures, such as settling ponds.

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The Contractor shall have sufficient materials, such as clean rock, granular material, and filter fabric available on-site for emergency protection measures when required.

The Contractor shall regularly maintain sediment and drainage control measures, such that they function as designed. Immediate action shall be taken by the Contractor to correct any deficiency observed in the operation of sediment and erosion control measures. In the event that a deficiency in any sediment or drainage control measures is directly or indirectly creating an adverse environmental impact, the Contractor shall initiate the necessary action to correct the problem within one hour of observing or being informed of the situation. In the event that a deficiency in any sediment or drainage control measures poses the potential to create an adverse environmental impact, the Contractor shall take action within two days of observing or being informed of the situation. In the event that environmental conditions or the status of the situation change in regards to a potential deficiency, the Contractor shall accelerate any proposed correction measure(s) by taking immediate action (i.e., within one hour). The judgment of the need and timing for corrective action in regard to sediment or drainage control measures shall be at the discretion of the Contractor and the Environmental Monitor, and shall be to the satisfaction of the Ministry Representative and the Environmental Agencies.

Sediment and debris accumulations which compromise the functioning of the erosion and sediment control measures shall be removed by the Contractor and disposed of in an environmentally acceptable location and manner. At a minimum, silt fence structures shall be cleaned when sediment accumulation heights exceed 30 cm along any portion of the structure.

In the absence of site-specific requirements from the Fisheries and Oceans Canada or the British Columbia Ministry of Environment, the Contractor shall comply with criteria for suspended solids in runoff water from the site as agreed upon prior to construction by the Environmental Agencies.

Sediment and drainage control methods are detailed in the "Land Development Guidelines" and the MoT publication "Control of Erosion and Shallow Slope Movement". Compliance with the spirit and intent of these guidelines is mandatory.

165.04.02 Sediment and Drainage Management Plans - The Contractor, in consultation with the Contractor's Environmental Monitor, shall be responsible for the preparation and implementation of any Sediment and Drainage Management Plan(s) required for the Project. Such plans will form an essential component of the Contractor's environmental protection program, in terms

of identifying environmentally acceptable construction practices for sediment and erosion controls at specific sites. The Sediment and Drainage Management Plan(s) will be subject to, but not limited to the following requirements:

- Prior to commencement of construction activities on the Project and thereafter when deemed necessary, the Contractor and the Environmental Monitor will identify areas and major construction activities for which the Contractor will be required to prepare one or more Sediment and Drainage Management Plans. Designation of these areas and activities will be done in consultation with the Environmental Agencies and the Ministry's Environmental Quality staff.
- In addition to activities within the Project area, a Sediment and Drainage Management Plan shall be submitted for activities related to the Contractor's work in areas away from the project that have the potential to create adverse environmental impacts, which will be determined by the Contractor in consultation with the Environmental Monitor, the Environmental Agencies and the Ministry Representative. These activities are not confined to the areas immediately adjacent to the right-of-way, but also in other locations in which the work or associated activities will be conducted, including but not limited to haul or access roads, temporary structures, borrow and granular excavations, staging/laydown areas, material storage sites and disposal sites.
- The Contractor shall not commence work in any area so identified until a Sediment and Drainage Management Plan has been submitted and accepted by the Ministry Representative and involved Environmental Agencies.
- The acceptance and approval of the Contractor's Sediment and Drainage Management Plan or updated Plan shall be valid only so long as the conditions and anticipated conditions upon which the Plan and its acceptance were based continue to be applicable.
- The Contractor shall at all times be responsible for ensuring that work is carried out in accordance with a Sediment and Drainage Management Plan or updated Plan, which has been accepted by the Ministry Representative and Environmental Agencies.
- The Ministry Representative or the Environmental Agencies may request the Contractor to update and resubmit its plan(s) at any time, and may require the Contractor to cease work until the update(s) has been submitted and accepted. Whether or not the Ministry Representative or the Environmental Agencies so request, the responsibility for carrying out the work in accordance with a validly accepted Plan lies entirely with the Contractor.

- The Ministry or the Environmental Agencies may order the Contractor to stop work or to take other precautionary or remedial measures whenever the Contractor is carrying out any work that is not in accordance with a Sediment and Drainage Management Plan or updated Plan which has been accepted by the Ministry Representative or the Environmental Agencies, and for which that acceptance is still valid. All costs of any resulting delay shall be borne entirely by the Contractor.

At a minimum, a Sediment and Drainage Management Plan will include the following information and will be prepared in a format satisfactory to the Ministry Representative:

- a) A schedule for the proposed activities, as they pertain to the Sediment and Drainage Management Plan and construction staging, including anticipated duration of construction.
- b) A description of the construction procedures that will be used to limit the potential for erosion and sediment production, including estimates of work areas where applicable (e.g., volume of material in a proposed stockpile site), description of construction equipment to be used, and staging of operations.
- c) A detailed description of the site-specific measures for runoff and drainage management.
- d) A detailed description of the site-specific mitigation measures and design information for erosion prevention and control (e.g., sizing of culverts, ditches or sediment/detention ponds, silt fence specifications, and description of ditching and berming).
- e) A schedule that identifies the various sloped areas by station and the dates in which they will be protected using temporary and permanent revegetation measures, such as hydroseeding.
- f) A detailed description of mitigative measures for ensuring acceptable water quality and quantity at points of discharge to watercourses, including sizes and specifications for any proposed water treatment facilities.
- g) A key plan and drawings, in suitable scale and detail, of the site and proposed mitigative measures and applicable construction procedures.
- h) A written commitment of on-site equipment (e.g., water pumps) and materials (e.g., silt fence, hay bales, rock armoring, and ditch breakers) for erosion, sediment and drainage control to deal with emergency situations that may arise.

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- i) A written commitment of on-site equipment and staff to handle any fish salvage and transfer operations, if required.
- j) Contact names, positions and telephone numbers.

A description of the specific monitoring procedures prior to, during and after completion of construction activities at this site.

165.04.03 Sediment Control Ponds - The Contractor shall construct sediment control ponds where necessary to prevent the release of unavoidably entrained sediments in runoff from the construction site, and shall construct stormwater detention ponds for the temporary and/or permanent control and discharge of stormwater runoff. The Contractor shall provide designs for and construct sediment control ponds, as well as stormwater detention ponds, on a site-specific basis in a manner that conforms to the "Land Development Guidelines", other than for the following exception(s):

- Sediment control ponds and dry or wet stormwater detention ponds shall be designed and constructed to accommodate the 10-year return period storm under developed conditions with a minimum 0.60 metre freeboard to the top of the berm.

The Contractor is referred to Section 3 of the "Land Development Guidelines" for other pond design criteria and Section 8 of that publication, for sample calculations for water flows and pond sizes.

If during construction the settlement pond is filled to capacity and is still required for sediment control, accumulated settled sediments shall be removed from sediment control ponds and stormwater detention ponds. Such sediments shall be disposed of in an environmentally acceptable location and manner.

165.04.04 Maintenance of Drainage Patterns - Except where interceptor ditches or berms are required to divert sediment laden runoff from the site to a sediment control pond, original drainage patterns shall be maintained throughout construction operations. Interceptor ditches or berms shall be constructed to divert water entering the site away from erosion prone areas. The Contractor will not rely on drainage courses or conduits being shown on the Drawings, and will make whatever investigation is necessary. Where a natural watercourse traversing the construction site crosses this interceptor ditch or berm, an armoured or lined ditch or a culvert shall be installed in order to pass accumulated flows through or around the construction site in a manner that maintains the natural runoff pattern, unless otherwise directed by the Environmental Agencies.

All ditches constructed for interception of clean water

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outside the work site(s) to divert it around the work site(s) and for collection of treated water from the work site(s) shall be designed and constructed to accommodate the 10-year return period storm with a 0.3 m freeboard under developed conditions. Temporary and/or permanent drainage ditches, including those constructed for sediment and erosion control shall be designed to prevent high water velocities and erosion by including measures such as check dams, drop structures or erosion-resistant liners or armoring.

165.04.05 Storm Drainage Systems - In order to minimize siltation, the Contractor may be required to block storm drain inlets, or to activate inlets by means of sandbags, berms or swales, as circumstances require. Berms shall be constructed of clean, non-erodible granular material. The Contractor shall maintain, on a regular basis, any inlets activated during the course of construction. Any deficiencies noted in these works shall be corrected immediately in the event that the inlet is plugged and within the same day if the site is relatively dry.

The Contractor shall ensure adequate inspection and correction of any storm drainage system deficiencies for sites within the influence of the Project. During periods of inclement weather, the Contractor shall ensure project staff inspect storm drainage systems throughout the day, and if necessary, make arrangements for inspection and maintenance during regular work stoppage periods, such as evenings or weekends. At a minimum, such inspections shall be carried out at the start of the regular workday, at mid-day in the workday, and one hour prior to end of the regular workday. Furthermore, in the event of flooding problems, the Contractor shall be responsible for any damages or compensation resulting from impacts on residences or businesses caused by a failure or deficiency in the Contractor's design and maintenance of the storm drainage system.

During concrete curb and gutter construction, road surface runoff shall be directed by berms or swales away from concrete which has been poured within the previous 48 hours.

165.05 Clearing and Grubbing

165.05.01 Limits for Clearing and Grubbing - Clearing and/or grubbing shall extend only to the designated limits, as defined in the Contract and the Design and marked on site. The Contractor may be required to use close-cut, no grub practices (i.e., cutting trees at ground level and not removing root system) or undertake hand clearing at environmentally sensitive sites, as designated in the Contract or in the Design.

The Contractor shall prepare a detailed clearing and

grubbing plan in consultation with the Environmental Monitor. The Contractor will obtain approval for this plan from the Environmental Agencies and the Ministry Representative and any necessary tree removal permits from the Ministry of Forests and/or municipal agencies prior to initiating any clearing and grubbing operations within 50 m of any designated watercourse or Environmentally Sensitive Area.

The Contractor shall minimize ground disturbance in the vicinity of any watercourse or Environmentally Sensitive Area, and shall not proceed with clearing and grubbing closer than 50 m from a designated watercourse or Environmentally Sensitive Area prior to marking the limits of the Fisheries Sensitive Zone or Environmentally Sensitive Area. The width of these zones, if not specified in the Contract, will be determined by the Designer in consultation with the Environmental Agencies. The Contractor shall mark the limits of any Fisheries Sensitive Zone or Environmentally Sensitive Area, such as orange flagging tape or orange snow fence, at a minimum height of 1.5 m.

All clearing and grubbing activities in this zone must be granted prior approval by the Environmental Agencies. The Contractor shall not conduct approved grubbing operations within this zone until ready to proceed with earthwork and stabilization.

In areas near designated watercourses or other Environmentally Sensitive Areas determined by the Environmental Agencies to be of high erosion or siltation potential, the surface area of erodible soil exposed at one time may be limited. This will supersede DBSS 200.03 and DBSS 200.04. Where exposed materials are sensitive to erosion, the Contractor shall confine grubbing to an area where excavation and earthwork is to be actively conducted within approximately 30 days following the completion of grubbing operations. In the event that a highway project consists only of clearing and grubbing operations, the cleared ground shall be protected and able to withstand specified periods of inclement weather.

165.05.02 Protection of Vegetation - The Contractor shall protect all vegetation growing outside of the designated and marked areas for clearing and grubbing, as specified in DBSS 769 "Protection and Retention of Vegetation", with the exception of danger trees, which must be hand-felled and removed with minimum disturbance to retained vegetation.

165.05.03 Clearing Activities - Falling of timber into a watercourse is prohibited except in situations in which safety considerations dictate otherwise or unless approved by the Environmental Monitor. Any trees or large pieces of woody debris that accidentally fall into a watercourse and require removal shall be removed in a manner that

minimizes the disturbance of the watercourse and adjacent banks,. Skidding of logs across watercourses will not be permitted. The Environmental Monitor must be present during removal of any large woody debris or trees from watercourses.

165.05.04 Disposal of Combustible Materials - The Contractor shall comply with the Forest Act and the Open Burning Smoke Control Regulation under the British Columbia Waste Management Act. For additional information regarding the regulation, the Contractor should contact regional Environmental Protection staff in the British Columbia Ministry of Environment office and the Fire Control staff in the British Columbia Ministry of Forests.

The Contractor shall prevent heat or smoke damage to all vegetation that has been designated for preservation. The use of waste oil and/or tires as fire accelerators shall not be permitted. The Contractor may be required to use a forced air method of burning. Burning piles shall not be located within 50 m of any watercourse, wetland or other Environmentally Sensitive Area.

In situations in which the material generated as a result of clearing and/or grubbing may not be burned on site, the Contractor shall dispose of it in a manner approved by the Environmental Agencies who may require approval of the British Columbia Ministry of Environment.

165.06 Stripping Operations

165.06.01 Exposure of Erodible Earth - In areas where erosion or siltation is anticipated, the duration of exposure of erodible earth material shall be minimized. In such cases the surface area of erodible earth material exposed at one time shall be determined by the Environmental Monitor, to the satisfaction of the Environmental Agencies and the Ministry Representative. (See DBSS 165.05.01 Limits for Clearing and Grubbing)

165.06.02 Placement of Stripped Material - The Contractor shall avoid placement of stripped materials in areas adjacent to watercourses or other Environmentally Sensitive Areas. Sediment and erosion control measures must be taken prior to and after placement of stockpiles of stripped material in areas where natural drainage or storm water could erode the stockpile and thereby transport pollutants to surface waters. The location of stockpiles and erosion control measures must be approved by the Environmental Monitor, to the satisfaction of the Environmental Agencies and the Ministry Representative prior to placement of stripped materials and may be specified in the Contract. The Contractor shall ensure that all stockpiles are stable.

Polyethylene sheeting or other suitable tarp material shall

be used to cover temporarily exposed steep surfaces or stockpiles of erodible materials, such as topsoil, sand, gravel or roadbase fill. The Contractor shall ensure such erodible materials are properly covered with sheeting or suitable tarp materials immediately after creation of any temporary stockpiles. Such sheeting or tarp materials shall be examined and maintained on a regular basis. The sheeting or tarp materials shall be sufficiently anchored to prevent displacement by winds.

165.06.03 Slope Protection - The Contractor shall employ suitable techniques to prevent the initiation of surface soil erosion and movement of sediments from slopes, particularly those exposed as a result of clearing, grubbing and stripping operations. Acceptable techniques and conditions of implementation of erosion and sediment control measures for slopes are outlined in Section 3 (i.e., entitled "Slope Protection and Surface Protection") of the "Land Development Guidelines" and the MoT publication "Manual of Control of Erosion and Shallow Slope Movement". Compliance with the requirements specified in this Section, as well as any Authority/MoT manual(s) developed specifically for the Project, will be mandatory.

165.07 Earthwork Operations (Subgrade Construction)

165.07.01 Excavation and Disposal of Waste or Surplus Material - The creation and use of any site on Crown or private lands for the placement and disposal of waste or surplus material requires prior approval from the Ministry Representative and may require the approval of representatives of British Columbia Forests and the Environmental Agencies. Unless another time period is specified in the Contract or by the Ministry Representative, not less than fifteen days prior to disposing of any waste or surplus material, the Contractor shall submit to the Ministry Representative for approval, a proposal delineating the locations and extent of the areas in which the Contractor intends to dispose of such material. The proposal shall describe the nature of the material and the methods to be employed in material placement, stabilizing and site revegetation. If a disposal site is required off the right-of-way, the proposal shall also indicate the procedures for any required land clearing activity. No waste or surplus material shall be disposed of until the proposal has been approved. All work shall be done in accordance with the approved proposal.

All waste disposal sites shall be selected such that spoil is prevented from entering any watercourse. The excavated material shall be properly drained, spread and trimmed to a stable slope not exceeding 1.5 to 1, in a manner which minimizes disturbance of watercourses and vegetated areas. All waste sites shall be revegetated immediately after creation of the waste disposal site, or else suitable temporary erosion control measures, such as tarps, shall be

used until revegetation is undertaken. The Contractor is responsible for ensuring that revegetation is successfully accomplished unless otherwise specified in the Contract.

165.07.02 Work in Areas of High Water Table - Work in areas of high water table shall be scheduled to proceed during dry weather periods unless otherwise specified in the Contract. The Contractor shall adopt all necessary mitigation measures to avoid or minimize adverse impacts in such areas.

165.07.03 Drilling and Blasting - Blasting operations shall be conducted in a manner that minimizes the disturbance of residences, businesses and public infrastructure (e.g., schools and churches) and to aquatic and terrestrial habitats and organisms due to shock waves, noise and vibration.

The Contractor shall not conduct blasting within 400 m of fish habitat without the approval of the blasting plan by the Fisheries and Oceans Canada; British Columbia Ministry of Environment Fish and Wildlife officers. The Environmental Agencies may require the Contractor to undertake mitigative measures such as scheduling of works in Timing Windows given by the Environmental Agencies, smaller staggered blasts or use of blasting mats to minimize impacts. Vibrations and shock waves in fisheries habitat resulting from blasts shall comply with the Fisheries and Oceans Canada "Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters".

Blasting operations shall be controlled to minimize the entry of fly rock into watercourses or adjacent to the right-of-way, particularly in an urban setting. If required by the Environmental Agencies, the Contractor shall comply with the Agencies' directions in removal of fly rock from watercourses and Environmentally Sensitive Areas at no cost to the Ministry.

When blasting is to be conducted adjacent to or in a designated environmentally sensitive area, the Contractor shall provide at least 24 hours notice of each blast to the Ministry Representative and to the Environmental Agencies. The Contractor shall provide at least 24 hours written notice to those individuals or groups potentially affected by shock waves, noise and vibration from blasting operations.

165.08 Borrow and Sand / Gravel Pits - All Borrow and Sand/Gravel pit locations, operations, reclamation and revegetation shall comply with the Ministry of Energy and Mines / MoT / Natural Resources Canada joint publication "Reclamation and Environmental Protection Guidelines for Sand, Gravel and Quarry Operations in British Columbia".

165.08.01 Control of Drainage - Prior to borrow excavations, or quarry, sand or gravel pit development, all

surface water entering the site shall be controlled so that its entrance into the operating area is prevented. Drainage shall be controlled throughout borrow operations in order to prevent natural drainage and surface runoff from carrying sediment into adjacent watercourses. The Contractor shall prepare a Sediment and Drainage Management Plan (see DBSS 165.04.02) prior to the creation and/or operation of any borrow excavations or quarry, sand or gravel pit development sites. The Contractor shall also prepare a Reclamation Plan.

165.08.02 Location and Development of Borrow and Sand/Gravel Pits - Clearing for borrow and sand/gravel pits shall comply with DBSS 165.05 - Clearing and Grubbing. All topsoil shall be stockpiled for future reclamation.

Borrow excavations shall not be located in the wetted perimeter of a watercourse or on a stream floodplain at a location likely to create a new channel to the stream at a time of flooding, without the approval of the Environmental Agencies. Borrow sources located within 100 metres of the wetted perimeter of a watercourse or at distances less than 100 m from any water-impounding dyke or dam embankment will require the design of a Professional Engineer or Professional Geologist. Final floor elevations shall be sufficiently high that they will not be subject to fluctuations in the groundwater table.

In erosion-prone areas, overburden removal shall be restricted to an area that will be excavated within one year. The open face(s) of the borrow pit should be no larger than necessary for efficient pit operation. Material should be exhausted at one location in a pit prior to the opening of a new face to remove a similar type and grade of material.

The Contractor shall be responsible for maintaining the functionality of erosion, sediment and drainage control measures within and around borrow and sand/gravel pits throughout all phases of overburden and material removal, as well as during periods of work stoppages. Borrow and/or sand/gravel pits shall be rehabilitated and decommissioned in an environmentally acceptable manner and to the satisfaction of the Ministry Representative and the Environmental Agencies.

To minimize the spread of noxious weed seeds between construction sites and gravel pits/quarries, all crushing equipment and mining vehicles must be cleaned with a power/high pressure washer (manually cleaned in freezing temperatures), before entering any MoT pit or quarry. If the pit contains noxious weeds the crushing equipment and mining vehicles must also be cleaned with a power/high pressure washer (manually cleaned in freezing temperatures) before leaving the pit/quarry. Prior to the production of aggregates the pit floor, crusher/plant location, equipment-parking area, stockpile site(s), pit

face(s) and area to be mined will be inspected by the contractor for the presence of noxious weeds. If noxious weeds are present they must be removed mechanically by the contractor. Noxious weeds are defined as non-native plants species designated on the provincial or regional district lists as defined by the Weed Control Act.

165.08.03 Washing Operations - In locations where siltation of a fish-bearing watercourse may occur, approval shall be obtained from the Environmental Agencies prior to the establishment of aggregate washing operations, and all wash water shall be subject to DBSS 165.04.

Waste or surplus material shall be disposed of at a waste disposal site approved by the Ministry and the Environmental Agencies. The Contractor shall create and designate, with appropriate signing, suitable sites and facilities for disposal of waste or surplus material. In particular, the disposal of deleterious materials, such as surplus concrete or concrete wash water in sites other than those approved by the Environmental Monitor and the Environmental Agencies will be prohibited. The Contractor and the Contractor's Environmental Monitor shall be responsible for ensuring all construction personnel, including subcontractors, are made aware of this requirement. In the event that it is not feasible to install a suitable concrete waste disposal site immediately adjacent to the work site, such as during a concrete pour on a long bridge deck, then the Contractor shall take the necessary precautions to isolate the work site from any watercourse or other environmentally sensitive area and to temporarily collect the concrete waste or wash water and transport it to a nearby suitable disposal facility.

165.09 Detour, Access and Haul Roads

165.09.01 Design, Construction and Operation of Access Roads - Any temporary access, detour and/or haul roads associated with the project shall be constructed to accommodate all required uses and maintained throughout the course of construction operations in a safe, environmentally sound manner.

The location, alignment, design and construction of all detour, access and haul roads shall be subject to the approval of the Ministry and the appropriate Environmental Agencies. Clearing shall extend no further than safe operation requires, or to the edge of cut or toe of fill. Root systems of cleared vegetation shall not be removed except in the area of cuts or actual road surface.

The Contractor shall employ suitable measures to maintain air quality, visibility, and safe conditions in the use of access, detour and/or haul roads associated with the Project.

165.09.02 Drainage and Erosion Control - Drainage

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structures shall be incorporated into and maintained for the duration of the project along all detour, access and haul roads to minimize erosion and maintain drainage patterns.

165.09.03 Abandonment - The Contractor shall winterize haul and access roads at the end of the construction season and shall ensure proper drainage control measures are in place. Culvert inlets and outlets shall be flagged. During periods of work stoppages, the Contractor shall ensure sufficient inspection and maintenance of the access, detour and/or haul roads such that adverse environmental impacts are avoided or minimized. In the event that potential or existing environmental problems are identified by the Contractor, its staff, the Ministry, the Environmental Agencies or the public, the Contractor will take immediate steps to rectify the problem and ensure corrective action is taken to prevent future recurrence of similar problems.

When no longer required by the Contractor, construction roads shall be properly decommissioned, including measures such as blocking such roads off from vehicular traffic, scarifying the compacted surfaces and generally revegetating the area. All drainage and crossing structures shall be removed, and sufficient cross ditches and ditch blocks constructed and stabilized to restore the original drainage patterns and prevent erosion and may include, but may not be limited to decompaction of the road surface, revegetation of exposed soil surfaces, and reforestation.

165.10 Instream Works - In general the Contractor shall comply with the requirements specified in Section 5, "Guidelines for Construction Practices within the Fisheries Sensitive Zone", of the "Land Development Guidelines", as well as those requirements noted below. The Contractor, , shall prepare a detailed set of environmental procedures for any work within a Fisheries Sensitive Zone, within the wetted perimeter of any fish-bearing watercourse (or any watercourse that flows directly into a fish-bearing stream), or for any work with the potential to cause major adverse impacts on a fish-bearing watercourse (e.g., concrete pour for a bridge deck over a fish-bearing watercourse, hydroblasting of bridge substructures over a fish-bearing watercourse, etc.).

No clearing or equipment operation shall take place in a Fisheries Sensitive Zone prior to Environmental Agency approvals. Waste material generated during instream works shall not be stored or dumped within the floodplain unless otherwise approved.

Drainage of waterbodies, such as wetlands, swamps or beaver ponds, shall be subject to the approval of the Environmental Agencies, unless drainage of these areas is specifically required as part of the Contract and has been approved by Fisheries and Oceans Canada and British Columbia Water Management office.

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165.10.01 Provision of Fish Passage - Unless the Contractor has written approval from the Environmental Agencies, any instream works in fish bearing streams shall provide for fish passage. It is the Contractor's responsibility to contact the Environmental Agencies to determine fish passage requirements for the specific location.

The Contractor is required to give two week's notice to the Environmental Agencies and the Ministry Representative of any activities, which may result in stranding of fish, to allow for scheduling of fish retrieval and/or transfer operations.

165.10.02 Management of Water Discharges - During preparation of stream diversions, culvert installations and other operations involving dewatering where drainage could readily reach a designated watercourse, all effluent and silt-laden water shall be discharged to a sediment control pond or a vegetated area for removal of silt prior to its release into that watercourse. This requirement also applies to the control of discharge resulting from curing areas of recent concrete pours for bridges or drainage structure headwalls. The direct discharge or discharge via seepage of untreated, silt-laden water or other deleterious substance into any watercourse is prohibited.

165.10.03 Encroachment of Fill into Watercourses - Embankments which encroach on fish-bearing watercourses shall either be isolated and dewatered, by means of a cofferdam, until surfaced with riprap, or constructed of clean granular material and riprap or shot rock which is free of fine-grained material or other potential contaminants. Riprap composition and placement may be further detailed in the Contract. The method of placement of this material shall be such that disturbance and/or alteration of aquatic habitats is absolutely minimized. Fill material must be entirely contained within the proposed fill cross section.

165.10.04 Temporary Stream Crossings - Prior to construction, the Contractor shall provide the Ministry Representative with a plan describing the proposed locations and types of stream crossings, complete with construction procedures and timing of construction. The Contractor shall forward a copy of the approved plan to the Ministry Representative. Temporary stream crossings shall be subject to the same environmental constraints as permanent crossings, and shall be built to pass, at least, the 10 year return period flood for the time of year during which the structure will be in place. Wherever possible, vegetative cover shall be maintained in order to minimize erosion.

Temporary stream crossings that have been constructed during periods of low precipitation (i.e. summer and late winter) shall be completely removed prior to periods of

increased precipitation (i.e. fall and spring freshet), unless otherwise approved by the Environmental Agencies.

165.10.05 Instream Equipment Operation or Crossings - The entering or crossing of any designated watercourse by construction equipment, when not specified in the Contract, shall require and comply with the written approval of the Environmental Agencies. The Contractor shall notify the Ministry Representative and the Environmental Agencies 48 hours prior to allowing equipment to cross or enter designated streams. The Contractor's Environmental Monitor shall be present while equipment enters into and exits from any designated watercourse.

Upon completion, the banks shall be restored, stabilized and revegetated to prevent erosion. This work shall be completed to the satisfaction of the Environmental Agencies.

165.10.06 Culvert Installations - Culvert installation in designated watercourses shall involve an appropriate method of isolating the work site from the stream, such as the diversion of the stream around the culvert site, and the placement of the culvert in the "dry".

Installation of riprap and other protective works shall be carried out at the earliest possible time following culvert installation in order to prevent erosion and siltation.

165.10.07 Culvert Obstructions - Unless the watercourse is dry, an obstructed culvert shall be cleared by mechanical means. Any variance to using mechanical means to clear wet obstructed culverts must have the prior approval of the Workers' Compensation Board.

165.10.08 Channel Diversions - Channel diversions shall be performed in accordance with the Contract. If not specified in the Contract, methods shall be approved by the Environmental Agencies, and shall comply with the "Land Development Guidelines".

165.10.09 Bridge Construction - Bridge Endfills shall be constructed implementing fully the applicable subsections of DBSS 165, and DBSS 769, Protection and Retention of Vegetation. The Fisheries Sensitive Zone shall not be disturbed until construction of the endfill or crossing structure is ready to proceed. The Contractor may be required to hand fall trees and leave the root systems in place.

165.10.10 Watercourse Clean-up - Final watercourse clean-up shall consist of, but not be restricted to, the removal of temporary haul roads and temporary crossings, the reshaping of the stream to its original configuration, width and depth, the protection of stream banks, revegetation, and the removal of all construction related

material and debris, including any material and debris deposited upstream or downstream of the site as a result of operations. All abandoned temporary diversions shall be plugged and stabilized. In the event that erosion has occurred during the course of construction, the Contractor will be required to recontour, stabilize and revegetate the affected area.

165.11 Ditch Maintenance - To reduce the risk of damage to aquatic habitat and sensitive life stages of fish and other aquatic organisms, the Contractor shall ensure that the excavation and maintenance of ditches is conducted in an environmentally sound manner.

Excavation for ditch cleaning of any ditch that contains or directly drains into fish-bearing waters shall be performed only within Timing Windows as detailed in the "Guidelines for Land Development, Appendix III" or as specified in the Contract.

The Contractor shall consult local Environmental Agencies for the locations of sensitive areas and local Timing Windows prior to commencement of ditch maintenance. Areas identified as Fisheries Sensitive Zones shall be revegetated by the Contractor prior to the close of the timing window.

165.12 Bridge Maintenance - In performing any bridge rehabilitation or maintenance, the Contractor shall follow the procedures specified in the document "Federal Fisheries Guidelines for the Protection of Fish and Fish Habitat during Bridge Maintenance Operations in British Columbia"

The Contractor shall take measures to ensure absolute minimal loss of paint and abrasive material into watercourses during bridge cleaning. Mitigation measures may include placement of ground covers, lined nets or tarpaulins to capture falling debris, blast enclosures to encase the section of the bridge to be abrasively blasted, use of vacuum-shrouded power tools, and use of floating booms and barges to trap floating debris. Similar measures shall also be employed to assist in mitigating paint spray drift.

165.13 Servicing and Operation of Equipment

165.13.01 Transport of Materials - The Contractor shall use equipment and containers that are capable of safely transporting petroleum products and/or hazardous materials in compliance with Section 7.33.1 of the Federal "Transport of Dangerous Goods Regulations" for bulk containers, and Sections 7.21 and 7.23 of the same regulations for materials in packages or small containers. These regulations shall apply to both on-road and on-site transport. In addition to compliance with the Federal Transport of Dangerous Goods Regulations, the

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transportation of fuel trailers, fuel tanks on skids, and non-commercial fuel trucks shall comply with all the requirements of the Motor Vehicle Act and the British Columbia Fire Code.

The Contractor shall take the necessary precautions to prevent the loss of materials during transport on public highways, roads, access roads, and haul routes. Trucks carrying loose materials shall be covered and restraints shall be used to prevent materials from blowing or falling from vehicles. The Contractor shall be responsible for collection and removal of any and all litter deposited by vehicles or equipment along access routes during construction-related activities, including removal of dirt and mud deposited from truck tires on municipal roadways.

165.13.02 Location and Installation of Fuel Storage Facilities - The siting and installation of all fuel storage facilities shall be the responsibility of the Contractor. Fuel storage shall not be located within 30 m of a watercourse, within a watercourse flood plain, or where there is a potential for any spilled fuel to enter a watercourse or groundwater. Fuel storage facilities shall be located on flat or gently sloping ground and shall be dyked to contain at least 125% of the total capacity of the storage containers. Dykes shall be constructed of impermeable material or lined to ensure that petroleum products cannot escape.

All large fuel storage tanks must be locked and secured when not in use. Automatic shut-off nozzles shall be installed on all dispensing units over 250 ℓ capacity. Fuel storage tanks must be drained within one week of completion of construction or within one month of a prolonged shutdown period.

All small fuel storage containers, such as 45 gallon (200 litre) drums, used as a fuel cache shall be installed on a stable storage rack, within an impermeable containment device capable of capturing at least 125% of the total capacity of the storage container(s). A cover, such as a tarp, must be placed over the top of the fuel cache to prevent accumulation of precipitation in the containment device. The small fuel storage container(s) shall contain a metal spigot with a padlock placed on the container when not in use.

In the transport, storage and/or dispensing of fuel and other petroleum-based products, the Contractor shall comply with the requirements outlined in the Ministry of Environment publication: "Environmental Standards & Guidelines for Fuel Handling, Transportation and Storage" (December, 1995).

The Contractor shall be responsible for all costs associated with clean-up and disposal of any escaped toxic and

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hazardous substances.

165.13.03 Servicing of Equipment - The fueling, servicing or washing of machines or equipment within the wetted perimeter or riparian zone of watercourses is prohibited. On-site fueling and lubrication of equipment shall also be conducted as far as possible from detention and sediment control facilities. Servicing should be conducted at designated sites that are properly protected and approved by Fisheries and Oceans Canada and British Columbia Ministry of Environment.

Refuse generated during the servicing of equipment (e.g., air and oil filters, hydraulic fluids, petroleum products) shall be collected and disposed of in an environmentally acceptable location and manner. Where possible, the Contractor is encouraged to recycle lubricants and other waste materials generated during the servicing of equipment and machinery, or alternatively dispose of such materials and refuse at nearby recycling depots. The dumping of oil or other deleterious materials on the ground or in any watercourse is strictly prohibited. The Contractor shall provide a means of catching and retaining drained oil or other deleterious materials and shall properly dispose of these materials.

165.13.04 Equipment Operation in Environmentally Sensitive Areas - Construction equipment shall be operated only within the designated construction site and access roads. Equipment operators shall not be allowed to damage or destroy vegetation or streambanks outside of this area.

The operation of equipment and machinery in a Fisheries Sensitive Zone must be:

- a) authorized by the Environmental Agencies
- b) kept to an absolute minimum, and
- c) undertaken only during the period(s) specified in the Contract.

When working in any designated watercourse, equipment shall use biodegradable hydraulic fluid and shall be steam cleaned of oil, grease and other contaminants deleterious to aquatic species, prior to commencing work. When working in or near any watercourse, the Contractor shall ensure that all hydraulic systems, fuel systems and lubricating systems are in good repair. Equipment with fuel or fluid leaks shall not be permitted to enter the wetted perimeter of any watercourse. Equipment developing such leaks shall be removed immediately and repaired.

165.14 Waste Disposal and Toxic/Hazardous Materials

165.14.01 General - All non-toxic or non-hazardous

wastes which are not designated as combustible waste to be burned on-site shall be either recycled or disposed of in an approved sanitary landfill or other specialized area as indicated in the Contract. Any waste material that is inadvertently dumped in or adjacent to watercourses or other designated environmentally sensitive areas shall be removed by the Contractor and disposed of in an approved manner at the Contractor's expense.

The Contractor shall be responsible for the regular collection and disposal of all waste material generated by employees and sub-contractors. The Contractor shall take the necessary precautions to prevent loss of these materials during transport on public highways and roads, and shall be responsible for cleanup of all of these materials and all litter deposited by employees and subcontractors along access routes during construction-related activities, at no expense to the Ministry. Construction debris shall not be allowed to accumulate on the construction site but shall be collected promptly and regularly removed from the site. The Contractor shall ensure that waste materials are placed and stored in suitable containers. Waste material shall be disposed of at an approved waste disposal site. The Contractor shall be responsible for providing and regularly servicing animal-proof refuse containers and for ensuring that all employees and subcontractors dispose of wastes to keep the Project clear of waste and garbage.

165.14.02 Spill Clean-up Plans for Toxic/Hazardous Materials - Contingency plans for the clean-up of toxic or hazardous spills shall be prepared prior to construction and submitted, together with a list of spill abatement equipment to be stored on the job site,. The Contractor shall have on site any additional equipment or materials deemed necessary to deal with a potential spill. For operations adjacent to a watercourse, an approved spill kit is to be present. The Contractor shall promptly replace any used spill abatement and clean-up materials and maintain a sufficient inventory of materials throughout construction operations. For operations being conducted adjacent to or within the wetted perimeter of a watercourse or other Environmentally Sensitive Area, the Contractor shall have an approved spill kit ready for use nearby.

The Contractor shall immediately report any spill of any toxic or hazardous material verbally to the Ministry Representative and the Provincial Emergency Program (24 hour phone line: 1-800-663-3456). Written notification of the spill must follow within two weeks of this verbal report. The Contractor shall immediately take the necessary steps to abate the discharge and provide the necessary labour, equipment, materials and absorbents to contain and remove the spill, clean up the affected area, dispose of waste materials at an approved disposal site, and restore the area to the satisfaction of the Environmental Agencies, at the Contractor's expense. Any soil contaminated by spills shall be removed and replaced by comparable substitutes at the expense of the Contractor.

Contaminated soil and vegetation removed shall be disposed of in an approved waste disposal site.

The Contractor shall document any spills observed in the vicinity of the Project that are not the result of Project-related activities, and notify the Environmental Agencies of such incidents.

165.14.03 Contaminated Sites - If an area within or adjacent to the project site has been identified as a possible source of contaminated or hazardous material and the defined contaminated or hazardous material has not been removed prior to the start of the project, the Contractor shall notify the Ministry Representative at least two weeks prior to the time work is scheduled in or adjacent to that area.

In the event that the Contractor locates material on the project site believed to be contaminated or hazardous, and which has not been previously identified, the Contractor shall immediately cease work in that area and notify the Ministry Representative. The Ministry Representative will seek investigation and disposal recommendations from regional staff of the British Columbia Ministry of Environment, Environmental Protection office. No work shall proceed in the identified or suspected area until such time as these materials have been removed to the satisfaction of the Ministry Representative, the Ministry of Environment and the British Columbia Workers' Compensation Board. Unless it is specified in the Contract, or agreement is made to carry out such work, the Contractor is not responsible for the removal of contaminated or hazardous materials, which are not the result of the Contractor's actions.

165.14.04 Concrete Wastes - The Contractor shall isolate fresh concrete or cement from any designated watercourse for 48 hours after placement. Containers or trucks carrying cement or fresh concrete shall be washed at a site approved by the Environmental Agencies. Concrete wastes, including wastewater from batching or cleaning, shall only be disposed of at approved and designated disposal sites (i.e., location designated with proper signing). All cement-contaminated wastewater from cleaning or mixing is to be considered toxic, and must be prevented from entering any designated watercourse for at least 48 hours to allow the water to reach neutral pH. Any cement or concrete-contaminated wastewater shall be tested prior to release into a designated watercourse. In the event that such wastewater pH levels are unacceptable in terms of water quality for fish and other aquatic species, the Contractor shall take the necessary measures to contain and treat such wastewater until acceptable pH levels are achieved (i.e., pH levels are the same as the receiving waters).

The Contractor shall securely store on-site and use suitable

equipment and materials for the mitigation of concrete spills into or in areas adjacent to watercourses. For example, cylinders of gaseous carbon dioxide shall be kept on the Project site, which shall be used in the event of concrete or concrete leachate discharges into any watercourse. During any concrete pour within 15 m of, or in work areas above the wetted perimeter of any designated watercourse, the Contractor shall ensure that carbon dioxide cylinders and suitable application devices (e.g., weighted soaker hoses) are available on-site and ready for use in the carbonation of water columns to neutralize any concrete leachate that is inadvertently discharged into the watercourse. Where concrete leachate is allowed to enter settling ponds, such that pH levels become very high, bubbling with carbon dioxide may not be an effective buffering agent. In such cases, it may be necessary to use other methods, such as acid buffers.

Aged, broken concrete shall only be used as riprap with the approval of the Environmental Agencies. The Contractor shall remove broken concrete or concrete wastes that have been inadvertently placed in non-approved sites on the Project and dispose of them at an approved waste disposal site.

165.14.05 Petroleum Wastes - Refuse generated during the servicing of equipment shall be removed from the site and disposed of in a location and manner that has been approved. The dumping of oil or other deleterious materials (such as diesel used to wash out dump boxes) on the ground is prohibited. Where facilities are located within a reasonable distance, the Contractor shall dispose of wastes at recycling depots.

Solids, sludges and other pollutants generated as a result of construction or removed during the course of treatment or control of wastewaters shall be disposed of in a manner that prevents their direct or indirect discharge to any watercourse or groundwaters. Effluent generated by the water scrubber of an asphalt mixing plant must be given retention time in suitably sized, impermeable settling ponds prior to release into an adjacent watercourse. The required retention time will be determined by in consultation with representatives from British Columbia Ministry of the Environment.

Asphalt pavement shall be stockpiled for recycling in a specified location, or disposed of in a location approved by the British Columbia Environmental Protection branch.

165.15 Pesticides - The use of all pesticides is subject to pre-approval. The use of herbicides for vegetation control, other than noxious weeds, is not permitted. The Contractor shall comply with all Federal, Provincial and local regulations relative to the storage, use, and proper disposal of pesticides. Relevant legislation includes the Federal Pest Control Products Act and the British

Columbia Pesticide Control Act. All pesticide wastes, washwaters, solvents, and containers shall be disposed of in compliance with the British Columbia Waste Management Act, Special Waste Regulation.

165.16 Air and Noise Pollution

165.16.01 Noise and Emissions - All activities, equipment, processes and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with Federal, Provincial and local regulations governing noise levels and air emission standards.

165.16.02 Dust Control - Application and handling of any dust palliative, with the exception of water, shall be in compliance with the Ministry standards as given in "Maintenance Guidelines for Dust Palliatives and Gravel Road Stabilization".

Dust control techniques may also be required during other construction operations, including but not limited to demolition, drilling, sand blasting and concrete cutting.

165.17 Use of Water

165.17.01 Authorization for Use - For any source of water not specified in the Contract, the Contractor is required to contact British Columbia Ministry of Sustainable Resource Management / Ministry of Environment Water Management office before any water is diverted, impounded, pumped or used for any purpose, including dust control, compaction, or operation of a work camp. Authorization in the form of an approval for short term use of water may be required from that agency. The Contractor should be aware that, if required, a water application approval may take at least six weeks to process.

Downstream water flow must be maintained at all times during water takings in fish-bearing waters.

Prior to commencing any work which may affect potable water supplies downstream of the construction area, the Contractor shall ensure that all owners of licensed water intakes have been notified.

Water sources must be approved. In order to reduce the impact on local water supplies and watercourses, the Contractor may be required to use uncontaminated wastewater, such as that pumped from the surface of sedimentation basins.

165.17.02 Screened Intake Requirements - The intakes of all pumps or diversions used to withdraw water from fish-bearing watercourses shall be screened in accordance with the Fisheries and Oceans Canada "Freshwater Intake

End-of-Pipe Fish Screen Guideline".

The Contractor shall provide and maintain stable access routes to all water withdrawal sites. The location of all such routes shall be subject to the approval of the Environmental Agencies.

165.18 Support Facilities

165.18.01 Location and Operation of Support Facilities - The preservation of trees, shrubs, ground cover, fish and wildlife must be considered in site selection and construction of all temporary support facilities. During site preparation, vegetation shall be removed using selective hand clearing in preference to blanket clearing with heavy machinery, retaining vegetative cover wherever possible. The Contractor shall locate temporary field offices, storage, plant and other facilities on pre-existing cleared portions of the job-site or on areas to be cleared during the course of routine construction.

Where possible, for aesthetic purposes, work camps and parking areas shall be located behind a vegetative screen buffer. Work vehicles and heavy equipment shall be parked in designated locations only.

The Contractor shall abide by all pollution control practices, laws, ordinances and regulations applicable to the construction of work camps and support facilities. The Contractor shall obtain the approval of the British Columbia Ministry of Health, the British Columbia Water, Land and Air Protection Environmental Protection and Water Management offices, and any applicable local authority prior to the installation and/or operation of sewage disposal and potable water distribution systems.

Work camps, field office facilities and work sites shall be kept clear of litter and garbage. The Contractor shall be responsible for providing and regularly servicing animal-proof refuse containers and for instructing all employees to dispose of food wastes accordingly. Sanitary landfill operations shall be located well away from the main camp in order to minimize conflicts with wildlife.

Combustible solid wastes shall be incinerated on a regular basis, subject to all applicable emission guidelines. Solid waste containers shall be large enough to contain all of the wastes generated between collection periods. The containers shall be constructed such that spilled liquids are contained and access by insects and wildlife is prevented. Storage areas and containers shall be maintained in a sanitary condition and shall be covered to prevent spreading of wastes by water, wind or animals. Transportation of solid waste shall be performed in a manner which prevents littering during transit to the disposal site.

Sanitary landfill sites shall be located a minimum of 450 m from watercourses or campsites, and shall be situated such that contamination of any stream, lake or groundwater system is avoided. The location of all sanitary landfill sites must be approved by British Columbia Ministry of Environment, Municipal or local officials. The bottom of the landfill site shall be located at least 2 m above the water table. Trees and other vegetation shall be removed progressively as the size of the landfill increases in order to minimize erosion by wind and water.

Sanitary wastes shall not be discharged into watercourses or on the soil surface. All temporary toilets shall be equipped with approved septic tanks having safe drainage or with closed holding tanks which are emptied only into approved treatment plants or sewage tanker trucks. All temporary toilets used on -site shall be placed in environmentally acceptable areas, and shall be secured to avoid or minimize damage from vandalism.

165.18.02 Abandonment of Sites - Upon completion of construction, all temporary support facilities and camp infrastructure, including buildings, equipment, lumber, refuse, surplus materials, fencing and other such items shall be removed. The original drainage pattern shall be re-established, and all disturbed areas shall be revegetated.

The Contractor shall ensure that all project-related sites are left in an environmentally acceptable manner, subject to the approval of the Ministry Representative and the Environmental Agencies. Decommissioned construction areas, material sources and access roads shall be reclaimed by the Contractor such that as much of the original forest, wildlife, agricultural productivity, recreational use, etc. as possible is restored or enhanced.

165.19 Protection of Livestock and Wildlife

165.19.01 Protection of Livestock and Wildlife - Harassment of livestock or wildlife in and adjacent to the project site is prohibited. The presence of livestock or wildlife in or adjacent to the project site, field office trailers or construction camp shall not be encouraged by feeding. The Contractor is required to inform work crews of the location of wildlife and livestock crossing sites situated within the boundaries of the construction area.

If it is necessary to arrange the removal or transfer of beavers, bears or other wildlife from the work-site or camp the Contractor shall contact a British Columbia Ministry of Environment Fish and Wildlife representative prior to taking action, and follow the course of action recommended.

165.19.02 Disturbance of Fish and Wildlife - Rules regarding hunting, fishing and the discharge of firearms by the Contractor, employees and sub-contractors, within the

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project area during the period of construction, shall be made in consultation with the Ministry of Environment Fish and Wildlife office. The Contractor shall be responsible for ensuring compliance with these rules.

165.20 Archaeological and Paleontological Discoveries

- In the event that any item of particular archaeological, heritage, historical, cultural or scientific interest is found on the project site, such item(s) shall remain the property of the Province and the Contractor shall, on making or being advised of such a find, immediately cease operations in the affected area, minimize activities which create ground disturbance in and adjacent to the affected area, and notify the Ministry Representative and the Archaeology Branch of the British Columbia Ministry of Sustainable Resource Management. Work shall not resume within 30 m of the discovery site until an appropriate directive has been received from that agency.

To protect archaeological and paleontological sites that are situated within or adjacent to a project site, the Contractor may be required to use a variety of mitigative measures, including but not limited to drainage or erosion control, slope stabilization measures, or erecting fences or other

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suitable barriers to protect archaeological or paleontological sites that are situated within or adjacent to a project site. The costs associated with such mitigative measures will be borne by the Ministry, unless otherwise specified in the Contract.

A buffer zone, in which no land alteration or other activity is permitted, may be required to ensure adequate site protection. The width of this buffer zone shall be determined by the Archaeological Branch of the British Columbia Ministry of Sustainable Resource Management in consultation with a representative of the local First Nation(s). The Contractor shall be responsible for the actions of employees and sub-contractors with respect to site vandalism and the unlicensed collection of artifacts from designated archaeological sites in and around the construction area.

165.21 Resolution of Disputes - In the event that a dispute arises between the Contractor and the Ministry, or the Environmental Monitor and the Ministry regarding environmental matters related to the project, the Ministry, or where appropriate, the Environmental Agencies, will have the final decision.

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Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

PART A – GENERAL

194.01 General - Traffic management requirements will be as specified herein and as specified in the Contract.

The Contractor’s Traffic Management Plan, Construction Schedule and its provisions for traffic control and safety will be based on providing safe passage through the Work Zone for all road users (i.e. cyclists, pedestrians and motorists). The Contractor will at all times make provisions for traffic through the Site to a sufficiently high standard to ensure the safety of the workers on the Project, the safety and the convenience of the travelling public, driver expectancy, and the protection of the Work Area. The Contractor will supply and maintain all traffic control devices and personnel necessary to provide all traffic control.

The Contractor’s accommodation for pedestrian and vehicular traffic, and proposed traffic control procedures, for each work operation, will require approval by the Designer, Quality Manager and Ministry Representative prior to the start of that operation.

Any one or more of the advance warning area, transition area, buffer zone and termination area of the traffic control (work) zone may be outside the Limits of Construction, but this will in no way diminish the Contractor’s responsibility to meet the requirements of the Traffic Management Plan.

194.02 Definitions - For purposes of this Section, the following general terms are defined in the Traffic Management Guidelines for Work on Roadways:

- Traffic Management Plan
- Traffic Management Strategy
- Traffic Control Plan
- Incident Management Plan
- Public Information Plan
- Implementation Plan

In addition, the following terms are used in this Section and defined below:

“Work Area” refers to an area that contains the work activity and is closed to traffic and set aside for the exclusive occupation by workers, equipment and construction materials. Work areas may remain fixed in location or may move as work progresses.

“Work Zone” as defined in the Traffic Control Manual for Work on Roadways.

“Construction speed zone” as defined in the Traffic Control Manual for Work on Roadways.

194.03 Standard Documents – Traffic Management Plans shall be developed in accordance with standards defined in the latest version of the following documents:

- MoT Traffic Management Guidelines for Work on Roadways (TMG)
- MoT Traffic Control Manual for Work on Roadways (TCM)
- MoT Electrical and Traffic Engineering Manual and all current Technical Bulletins
- TAC Geometric Design Guide of Canadian Roads
- MoT Supplement to TAC Geometric Guide
- Workers’ Compensation Board (WCB) Regulation

All Ministry Publications listed above can be purchased from:

GOVERNMENT PUBLICATION SERVICES
MINISTRY OF MANAGEMENT SERVICES
PO BOX 9452 STN PROV GOVT
VICTORIA BC V8W 9V7

www.publications.gov.bc.ca/queries/service.html

Email: QPPublications@gems5.gov.bc.ca

PHONE: 1-800-663-6105

FAX: (250) 387-1120

194.04 Traffic Control Supervisor - The Contractor will designate a traffic control supervisor who has the Contractor’s authority to respond to traffic control requirements and who will provide surveillance of traffic conditions through the Work Zone. This person or qualified designate will be available at all times, both when the Contractor is working and during weekends or other periods when the Contractor’s forces are not active on the Project, to respond to calls from the police and from representatives of the Ministry concerning damage or deficiencies in the traffic control devices and the passage for traffic through the Work Zone.

The traffic control supervisor shall meet the requirements of the TMG and WCB Regulation and shall not be the Contractor’s site superintendent.

194.05 Compliance with Acts and Regulations - The Contractor shall comply with the requirements of any legislation, Regulations and by-laws as are in force for the regulation of traffic or use of any road upon or over which it

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is necessary to carry out work or to haul materials or things.

PART B – PLANNING AND SCHEDULING

194.11 Provide Traffic Management Plan - The Contractor shall prepare a Traffic Management Plan (TMP) in accordance with the Ministry definitions and guidelines specified in the Traffic Management Guidelines for Work on Roadways Manual.

The Contract will specify the Traffic Management Strategy and required documentation for the Traffic Management Plan.

The Traffic Management Plan will be fully integrated with the Contractor's plan and schedule for carrying out the work, comply with the requirements of the TCM, the Traffic Management Guidelines for Work on Roadways, the Traffic Management Strategies listed below, and with the provisions of the Contract.

194.12 Traffic Management Plan Review – The Ministry Representative may review the Contractor's Traffic Management Plan for general conformance with the requirements of the Contract for sufficiency of detail to provide a complete and unambiguous traffic control layout. No review or change requested by the Ministry Representative in any way relieves the Contractor of any of its responsibilities for ensuring safe and adequate traffic management. No work that effects traffic will be permitted until the Ministry Representative accepts the Traffic Management Plan.

Where the Traffic Control Manual shows a choice of traffic control layouts for a given specific situation, the Ministry Representative may request the Contractor to use an alternative layout which is acceptable.

The following time periods are required for plan review and acceptance unless otherwise specified in the Contract:

- A Traffic Control Plan shall be submitted to the Ministry Representative for review at least fifteen (15) working days prior to the start of any Works effecting traffic flows. The following conditions shall apply:
 - Any plan modifications shall be submitted to the Ministry Representative for review at least ten (10) working days prior to any changes being made in the field.
 - A staged plan shall be submitted to the Ministry Representative for review at least ten (10) working days prior to implementation of a new stage.
- The Implementation Plan, if required, shall be submitted to the Ministry Representative for review at least fifteen (15) working days prior to the start of any Works effecting traffic flows.
- The Public Information Plan, if required, shall be submitted to the Ministry Representative for review at

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least fifteen (15) working days prior to the start of any Works effecting traffic flows.

- The Incident Management Plan, if required, shall be submitted to the Ministry Representative for review at least fifteen (15) working days prior to the start of any Works effecting traffic flows.

PART C – TRAFFIC MANGEMENT OPERATIONAL DETAILS

194.21 Speed Zones - . Reduction in speed limits may take several forms as defined in the TCM 1.4.6. Construction speed zones within the Project will be determined at the discretion of the Road Authority or as specified in the Contract.

The Contractor's work plan, Construction Schedule and its provisions for traffic control and safety will include references to the reduced posted speeds referred to in DBSS 194.21.

The location and length of posted speed reduction zones shall be adjusted daily, or more frequently as appropriate to the Work, to provide the shortest reduced speed zone practical. For example, on a resurfacing project, the reduced speed limit would usually be invoked around active operations such as milling, priming, paving, and, if necessary, at access points to pits and the plant, but will not generally be acceptable for areas of the Site used only for haul.

194.22 Use of Channelling Devices and Taper Rates - Traffic cones, temporary highway delineators, standard barricades or other marker devices such as wooden or metal saw horses, temporary marking tape, etc., shall be used in the following circumstances for channelling traffic:

- a) from one lane to another or for merging traffic where a reduction in the number of lanes must be effected
- b) around a hazard on the travelled way
- c) through an area of unfinished construction where the intended traffic lanes are not self-evident
- d) at any other location where, in the Designer's or Ministry Representative's opinion, channelling will ensure the safe passage of public traffic.

Minimum taper rates and spacing between cones or delineators shall be as shown in TCM.

194.23 Equipment on the Travelled Way - When working on the travelled way equipment shall be placed in such a position as to present a minimum of interference and hazard to the travelling public. Equipment units shall be kept as close together as working conditions will permit and preferably on the same side of the travelled way. Equipment shall not be left overnight on the travelled way but shall be

located so as to avoid the possibility of an accident.

194.24 Roadway Configuration - The Contractor shall arrange to keep interconnected lanes of the highway open to traffic at all times with the least amount of inconvenience to the travelling public unless otherwise authorized by the Ministry Representative.

194.25 Roadway Condition - The Contractor shall keep the travelled way well-graded, free of potholes and of sufficient width that the required number of lanes of traffic may pass. The subgrade shall be completed progressively in order that gravel surfacing may follow in an orderly manner. Prior to tearing up a portion of the existing travelled way the Contractor shall obtain Ministry Representative approval and shall also have available a sufficient supply of crushed gravel, or another approved product, to ensure a smooth riding surface during the work.

194.26 Closures – Road closures shall not be permitted until the Contractor requests and receives written permission from the appropriate authority in the Ministry of Transportation. This request shall be submitted in writing not less than fifteen (15) days in advance of the closure.

Upon receiving written permission for the closure, the Contractor must notify the local police, fire, ambulance, municipality, school board, and public transit at least seven (7) days in advance of the closure.

The public must be notified by local radio and newspaper at least (5) days in advance of the closure. The Contractor shall arrange any public announcement relating to the Contract and incorporating the Ministry logo through the Ministry Representative and Corporate Writing Services. Such advertisements will be made at the Ministry's expense. Notices or other advertisements of the Contractor unrelated to the Contract or where the Ministry's logo or name is not incorporated may be made by the Contractor at the Contractor's expense.

All costs related to the above shall be borne by the Contractor.

194.27 Detours —Where detours are required for the execution of the work, the Contractor shall provide well graded, gravelled detours or temporary roads to facilitate the passage of traffic around the restricted construction area. The Contractor shall be responsible for signs, maintenance of same and maintenance of the detour or temporary road. The Contractor shall consider the condition of the pavement used for detours and its impact on the safety and function of the detour. Milled surfaces upon which traffic is to run shall be clean and allow adequate drainage.

The minimum design requirements for any detours will be specified in the Contract.

Where the anticipated detour extends beyond the existing road surface, the Contractor will submit an engineering design to the Ministry Representative for review, a minimum of fourteen (14) days in advance of building the detour. The engineering design will include the design speed, the horizontal and vertical geometry, plus evidence that the design vehicle is accommodated for all movements and that all the requirements of this Contract are satisfied.

Where the anticipated deviation is minor, the Contractor may apply to the Ministry Representative, in writing, for approval to proceed without a formal design. Such approval does not relieve the Contractor of any of its responsibilities for provision of a safe site.

194.28 Access to Property - During operations the Contractor shall provide and maintain reasonable road access and egress to property fronting along or in the vicinity of the work unless other reasonable means of road access exists. The Ministry Representative will be the sole judge of what may be deemed reasonable road access.

194.29 Winter Lay-Up – In the event that the Work is stopped due to winter conditions, the Site is to be left in a condition as specified in the Contract or as deemed acceptable by the Ministry Representative.

194.30 Delays – All major and minor delays to the travelling public will be tracked by the Contractor, documenting location, duration, queue length and delay incurred.

The Contractor will monitor the queue lengths created by any delay to the flow of traffic. Traffic must be cleared prior to starting another delay unless authorized by the Contract. If the traffic delays exceed those allowable under the Contract, the Contractor shall immediately cease construction activities and make all the travel lanes available to traffic as quickly as possible. Resumption of roadway operations shall be permitted as traffic levels dictate.

PART D – TRAFFIC CONTROL DEVICES

194.41 Traffic Signals - Short one-way sections, such as bridge and culvert construction detours, etc., may be controlled by traffic signals and it is acceptable where the restriction will be in effect for an extended period. The use of signals on long one-way zones is not recommended as delays to traffic may be of considerable length and might not be accepted by the motorist. No signal installation shall be permitted without the approval of the Ministry Representative.

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Where traffic signals are requested by the Contractor, the Contractor shall arrange to have a qualified Traffic Engineering consultant prepare a Traffic Engineering study for the signal. The study shall document the following:

- Site layout
- Anticipated volumes
- Requirements for advance warning signs
- Actuation
- Proposed traffic signal timing plans

The Contractor will submit the study to the Ministry Representative for review. The approval for the installation of the signals will be determined by the Ministry Representative.

If the proposed traffic signal installation is approved by the Ministry Representative, the Contractor shall:

- Prepare a traffic signal design, signed and sealed by an electrical engineer registered with the APEGBC
- Supply and install all traffic controller equipment
- Supply power
- Operate and maintain the signals

Changes to the signal timing plans shall only be prepared by a qualified professional traffic engineer experienced in traffic signal timings. Traffic controller technology used shall comply with industry standard practice and shall have a conflict monitoring mechanism that will ensure signal malfunctions/conflicts result in the signal going to a flashing red state. Signals shall be vehicle actuated unless otherwise approved by the Ministry Representative. Signal operations shall conform to TCM 2.2.8 and the *Electrical & Traffic Engineering Manual*.

Where the work activity impacts the operation of an existing signal, the Contractor must submit a written notification to the Ministry Representative a minimum of ten (10) days in advance of the disruption to the signal.

194.42 Pilot Cars – The use of pilot cars may be warranted where public traffic must use a particularly hazardous route, or where traffic is required to remain in one lane, or change periodically from one lane to another, or negotiate a section of construction at restricted speed. Pilot cars shall be operated in conjunction with flag persons stationed at each end of the restricted section. When required, the Contractor shall provide sufficient pilot cars, as may be required from time to time, to keep a steady and controlled flow of traffic moving around or through the construction area.

Pilot cars shall be equipped with the following:

- a) A sign or signs with minimum 200 mm letters, designating the vehicle as a pilot car, and showing the message in both directions. Signs shall be illuminated during the hours when headlights must be used. Signs

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shall not be displayed when the vehicle is not being used for piloting.

- b) Amber flashing lights mounted on the roof at either side so as to be clearly visible from both directions. The flashing lights shall be in use for both day and night piloting.

194.43 Use of Flag persons – It is generally expected that flag persons will be required in the following situations:

- a) when public traffic is required to pass working vehicles or equipment which may block all or part of the travelled roadway.
- b) when it is necessary to institute a one-way traffic system through a construction area or other blockage where traffic volumes are heavy, approach speeds are high, and a traffic signal system is not in use.
- c) in high speed, high volume areas where temporary protection is required while other traffic control devices (barricades, cones, signs, etc.) are being erected or taken down.
- d) for emergency protection when other traffic control devices are not readily available.
- e) in all situations, where adequate protection for workers, working equipment and public traffic is not provided by other traffic control devices.

194.44 Traffic Signs – All standard signs, new and replacement, shall meet current Ministry specifications. The *Ministry Specifications for Standard Highway Sign Materials, Fabrication and Supply* are located on our Ministry web page at::

www.th.gov.bc.ca/publications/eng_publications/geomet/geometsigns.htm

Prior to the commencement of work the Contractor shall supply all posts, hardware and equipment required for the proper installation and maintenance of the project (C-35) signs and "Construction Ahead" (C-18) signs. The Contractor shall place the signs as indicated in the TCM or as directed by the Ministry Representative.

Upon completion of the project the Contractor shall remove the C-35 signs and the C-18 signs, posts and hardware when directed by the Ministry Representative. The removal of the signs shall also include the backfilling, compacting and dressing of the postholes to the satisfaction of the Ministry Representative.

The signs shall be erected in advance of all highway and bridge construction projects whether undertaken by contract or day labour. The signs may be omitted at the direction of

the Ministry Representative if the project is not in public view.

The Contractor shall supply and maintain all necessary signs and traffic control devices required by the Design, this specification and the TCM. All signs and devices used must conform to the standards detailed in this manual.

194.45 Barricades, Lights, Delineators, Traffic Lines -

The Contractor shall provide, erect and maintain all types of temporary marker devices including traffic line marking tape, barricades, fences, delineators, flare-pots, battery operated amber flashing lights and 110 volt steady burning or simultaneous flashing lights, in order to ensure safety to the workers and the general public. These devices shall be as required by the Contract and the TCM.

Flashing amber lights, if deemed necessary by the Designer, are used for extra night time effectiveness and the batteries of the flashing lights shall be checked each day.

Battery operated flashing lights, if two-faced, and if used to mark the right hand edge of a travelled lane, must have one face covered so that the light is not visible to traffic travelling in the other direction. Flashing lights having two faces showing in opposite directions may be used only if it is necessary that the obstruction or lane edge being marked be seen from both directions of travel. They should not be used in a line of delineators through an area of incomplete construction except where traffic must be diverted and a specific hazard exists.

Temporary road construction lighting installations shall be positioned as shown in FIGURE 1: Positioning of Temporary Lighting Adjacent to a Highway to minimize glare and resulting impaired driver vision. Lights shall be aimed away from any approaching traffic and at an angle of less than 45 degrees above vertical. Where lights cannot be located as shown then temporary glare screens shall be used to shield the traffic from the light source. These glare screens shall be metal or an opaque plastic material designed to shield the lighting from the eyes of the driver.

The Contractor shall be responsible for the application and removal of all temporary pavement marking and reflective devices. When traffic lanes have to be redefined for Long Duration Work, the Contractor shall eradicate all redundant temporary or pavement markings that are not required for the intended traffic patterns.

Class I and Class II standard barricades are illustrated in the TCM. Temporary delineator posts shall be as shown on SS Drawing SP194.02. In speed zones of 50 km/h or less, the minimum height of traffic cones shall be 450 mm. Where the maximum speed limit is over 50 km/h, the minimum height of cones shall be 700 mm.

194.46 Changeable Message Signs –The use of changeable message signs (CMS) may be specified in the Contract. Each sign must be portable. When in operation, the CMS shall be a minimum of two (2) metres from the bottom of the sign display to the road surface, and shall be level and capable of pivoting for sighting purposes. The specifications of the sign are as follows:

Sign unit:	Yellow/Orange LED display
Sign display:	3 lines with 8 characters per line
Character size:	450mm (18 inches)
Character matrix:	5 x 7
Remote dial-up access:	By cellular phone or equivalent

A full matrix sign may be used given that it has the display parameters noted above.

The Contractor is responsible for the CMS including but not limited to bringing the signs to the Project, moving and setting-up, providing storage as required including moving the signs into and out of storage, maintaining the signs in full operating condition, ensuring the correct message is being displayed, damage to or loss of the signs and returning the signs to the supplier. The Contractor shall provide to the Ministry Representative with a description of the messages displayed and the procedures of how the messages on the CMS will be changed when the Contractor is on and off site.

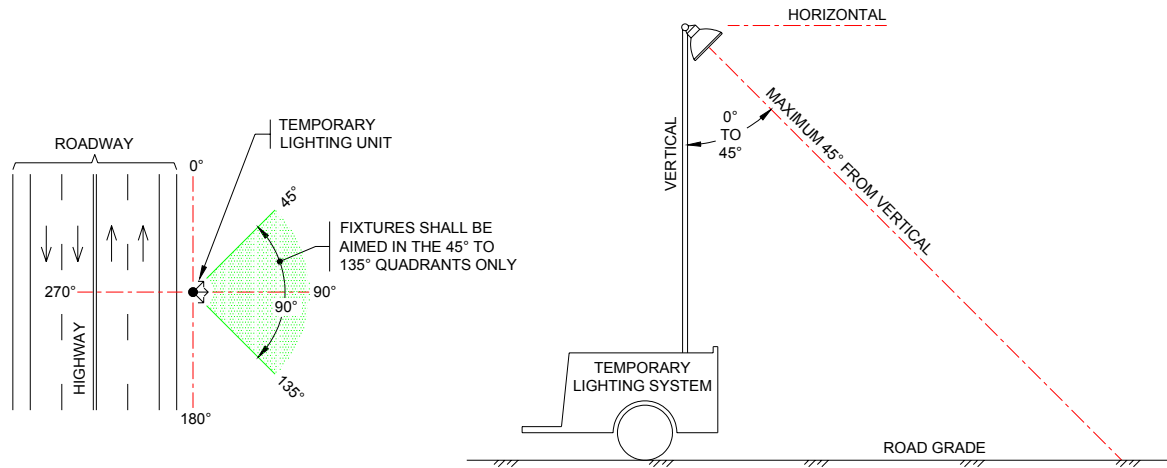


FIGURE 1: Positioning of Temporary Lighting Adjacent to a Highway

PART E – GENERAL MAINTENANCE

194.51 Maintenance - The Contractor shall be responsible for the continuing maintenance of all traffic control devices in use as follows:

a) Signs, etc., not applying to existing conditions shall be removed or covered. If covered, such as after sundown or during periods when work is suspended, the covering shall be placed over the sign so as to totally obliterate the message thereon. Where operations are carried out in stages, only those devices or signs, which apply to the current stage, are to be left in place or uncovered.

b) Signs shall be checked daily for legibility, damage, suitability and location. Dirty, damaged,

unsuitable or misplaced signs shall be cleaned, repaired or replaced. Signs and delineators with a reflective surface shall be cleaned as frequently as necessary to ensure full reflectivity. As considerable damage may be inflicted on signs and devices during a weekend, the Contractor shall conduct a check for replacement or repairs before the rush hour on Monday morning. Similarly, high traffic volume and recreational routes shall be checked during the weekend or at any other time that works is not in progress.

During hours when headlights are required, signs that have not been treated with a reflective coating shall be illuminated. After sundown all signs shall be checked for visibility and those that cannot be seen clearly shall be adjusted or replaced.

SECTION 200

CLEARING AND GRUBBING

200.01 Clearing - Except for trees and shrubs to be preserved as indicated on the Drawings or designated by the Designer, "Clearing" shall mean the complete removal and disposal of all standing and fallen trees, stumps, logs, upturned roots, rotten wood and all other vegetation growth, and accumulations of rubbish of whatsoever nature, and any other objectionable material from the area shown on the Drawings, or as directed by the Designer. Protective measures for the protection and retention of vegetation are specified in DBSS 769.

It shall also include the removal of existing cribwork, guard rail, fences, siphon structures built of timber and/or metal, culvert pipes of all types and timber box culverts within the limits of the work; plus removal of concrete buildings or their foundations, concrete bridge piers or abutments and their footings, concrete siphon boxes or concrete box culverts.

The area to be cleared shall include those areas required for the highway right-of-way, borrow pits, quarry sites, gravel pits and access roads thereto, if ordered by the Designer; off-take ditches or other drainage ditches and channels for stream diversions either within or without the right-of-way; clearing of debris in streams as indicated on the Drawings, or as directed by the Designer within the Site; foundations for structures and the right-of-way as shown on the Drawings, or as directed by the Designer, for intersecting public and private road approaches or diversions of same outside the main highway right-of-way. All such areas are hereinafter referred to as the "Area."

200.02 Disposal of Material - All material, slash and debris resulting from clearing operations shall be disposed of by burning unless there are specific provisions or open burning regulations for otherwise disposing of same. Unmerchantable timber, stumps, etc., shall not be disposed of by pushing outside the clearing and grubbing right-of-way. All trees shall be felled within the Area but, in the event of any trees falling outside the Area, such trees shall be cut up and together with all debris and slash therefrom, disposed of

off-Site or, where permitted by the Contract and burning regulations, brought back to the Area and there burned. The Contract or the Designer may designate certain trees or shrubbery to be left standing, in which case the Contractor shall take every precaution not to damage or injure such trees or shrubbery in felling adjacent timber, burning or any other clearing operations as specified in DBSS 769.

Such trees or shrubbery are to be limbed or thinned to such height and extent as may be directed by the Designer.

Except as hereinafter provided, all slash and debris shall be disposed of off-Site or, where permitted by the Contract and burning regulations, piled and burned at points located centrally in the Area. The number of fires to be started at any one time shall be limited to the capacity of the Contractor's equipment and organization to provide adequate protection against the spreading of the fires to adjacent timber or property.

All burning shall be carried out subject to the provisions of the Open Burning Regulation, the Forest Act and regulations thereto. In the event of regulations prohibiting burning, the slash, debris, etc., will be disposed of off-Site or may be piled along the sides of the Area and burned at a later time when permitted by the regulation. When the regulations do not allow burning prior to the Completion Date, the material shall be disposed of off-Site prior to the Completion Date.

200.03 Grubbing - Grubbing means the entire removal and disposal by burning as described in DBSS 200.01 and DBSS 200.02 of all stumps, roots and embedded logs to a depth of 0.6 m below the ground line or other such deeper depth as required by the Designer.

Grubbing shall be carried out over the entire Area as defined in DBSS 200.01. Grubbing shall be fully completed in advance of grading operations.

200.04 Danger Trees - This item shall consist of removing any leaning or dangerous trees or snag outside the clearing Area.

Such trees shall be felled and disposed of as provided for in DBSS 200.01 and DBSS 200.02,

The Contractor will not be required to grub the stumps of any danger trees unless required by the Designer.

200.05 Not Used

200.06 Mail Boxes - Where it becomes necessary to remove or otherwise disturb existing mail boxes within the limits of any project, the Contractor will be required to install the boxes temporarily in such a position that their usefulness will not be impaired. After construction work has

been completed, the boxes shall be re-installed at positions designated by the Designer and acceptable to Canada Post. No new posts or materials will be required, except that any damage caused by the Contractor to either boxes or supports, due to the Contractor's negligence, shall be repaired by the Contractor at the Contractor's expense.

200.07 Removal of Existing Signs and Symbols

When construction operations are started, the Contractor shall remove all existing Signs and Symbols of the British Columbia Ministry of Transportation not needed for the safe and orderly direction of traffic, and any other authorized signs within the limits of the right-of-way, and shall deliver them to such point as directed by the Ministry Representative.

SECTION 201

ROADWAY AND DRAINAGE EXCAVATION

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

DESCRIPTION

201.01 General - Roadway and Drainage Excavation shall include all excavation and the construction of all embankments required for the formation of the roadbed, parking areas and look-outs; excavation for any drainage ditch, off-take ditch or channel for stream diversion within or outside the right-of-way; removal of surcharge material, topsoil and organic waste material from the roadway, and of topsoil and unsuitable overburden from any borrow pit or any available Ministry or Crown gravel pit, and disposal of same, as may be directed by the Designer; excavation of materials below grade; excavation of borrow pits; the grading necessary to construct any frontage road, gravel pit access road, borrow pit access road or any other access road, public or private; the grading of connections to intersecting roads, public or private; the hauling and disposal of all excavated material, and the trimming and shaping of all excavations and embankments. All Works will be confined to the right-of-way except where agreements for access rights are in place for other lands, public or private.

201.02 Extent of Work - The dimensions of the excavations and embankments shall be as shown on the Drawings or the Design but the Designer may increase or decrease the width of the roadbed or the ratio of the slopes as conditions and circumstances may necessitate.

Construction Grade is defined as the grade upon which the Asphaltic Pavement is laid.

Subgrade is defined as the grade upon which the first layer of select granular sub-base or base material is laid.

MATERIALS

201.11 Description of Material Types - Excavation shall be classified under the following material types:

- a) Type A
- b) Type B
- c) Type C

d) Type D

The material encountered in any highway excavation shall be classified as one of the four types listed above.

In no case shall a material be classified using percentages of two or more types.

It is possible that material may change at some level in the excavation. Where such a change occurs, sufficient field measurements will be taken to establish the boundary between the two types of material.

201.11.01 Type A - Solid Rock - Type A shall include all forms of "solid rock in place" occurring in masses, ledges, seams or layers of sufficient hardness to require breaking by continuous drilling and blasting before excavation and removal.

It shall also include detached masses of rock or boulders individually containing a volume of 1.5 m³ or more.

201.11.02 Type B - Materials Containing More Than 50% Loose or Broken Rock - Type B Material shall mean loose or broken rock, boulder gravel, or any other material containing at least 50% boulders or broken rock, having a size greater than 0.03 m³ but less than 1.5 m³ and in a state not requiring loosening, or drilling and blasting for removal.

Any excavation or portion thereof, containing the 50% boulders or broken rock of the size described above, shall be classified as this type of material and will be paid in its entirety under this category.

Any excavation, not containing 50% boulders or broken rock of the size described above, shall be classified in its entirety as Type D Material, and in that event no allowance will be made for the smaller percentage of boulders or broken rock in the material.

201.11.03 Type C - Materials Requiring Ripping - Type C shall include those materials of such density or so firmly cemented together that a force of at least 360 kN per linear metre of ripper shank or ripping equipment embedded in the material is required to loosen the material. If the material can be loosened with a lesser force, then the material will be classified as Type D.

If a means other than ripping equipment is used to loosen materials, the force generated must be equivalent to that specified above.

Where deemed necessary by the Quality Manager, a ripping test will be conducted using a bulldozer or other appropriate equipment, under suitable weather conditions, that will develop sufficient traction and effectively deliver a force of 360 kN per lineal metre of ripper shank embedded into the alleged Type C. The material will only be classified as Type C if it cannot be loosened under such an applied load.

201.11.04 Type D - All Other Materials - Type D shall include all other materials of a nature not included in the foregoing definitions of Type A, Type B, or Type C; regardless of the nature or condition of the material or the method used to excavate or remove.

Type D shall also include any unsuitable materials of an organic nature, unless such materials have been specifically set apart in the Design or the Special Provisions of the contract.

201.12 Unsuitable Material - Unless otherwise shown, specified or directed, all topsoil and organic material shall be stripped from the highway cut and fill areas.

Where additional material is found above or below subgrade in an excavation or in the foundation of an embankment, which in the opinion of the Designer or Quality Manager is unsuitable, such material shall be removed. Soft clays and peats are examples of normally unsuitable materials.

Backfilling, where required, shall be carried out with approved materials, as ordered by the Designer or Quality Manager..

Material that is unsuitable for the construction of embankments shall be disposed of in a geotechnically and environmentally safe manner.

Upon completion of the road grade, topsoil and organic material suitable for growth of ground cover shall be spread on the cleared right-of-way and up the fill slopes to generally blend in with the cross-section, to a nominal depth of 200 mm. Care shall be taken that proper drainage is maintained. This topsoil shall be trimmed to a neat appearance preparatory to seeding by others. Surplus organic materials shall be disposed of off-Site or on-Site with the approval of the Ministry Representative

CONSTRUCTION

201.31 Rock Cuts- See DBSS 204

201.32 Dangerous, Loose and Overhanging Rock - The Contractor shall be required to remove dangerous, loose and overhanging rock within or outside the limits of the highway right-of-way, to ensure the safety of the Site and the public

201.33 Not Used

201.34 Not Used

201.35 Not Used

201.36 Rock Embankments - This section applies to embankments constructed from material containing more than 15% by volume of rock larger than 150 mm.

Embankments shall be constructed in layers equal in thickness to the largest size of the material but not exceeding 0.7 m. Greater lift thicknesses will be permitted by the Designer under special conditions provided the Contractor can spread the larger material satisfactorily and achieve the design density and stability in the embankment.

The material shall be deposited and spread so that the larger rocks are well distributed and the intervening spaces are filled with smaller sizes as may be available to form a stable embankment. The finer portion of excavated rock shall be retained for the top transition layer. Each layer shall be compacted by routing the loading construction equipment over the entire width, supplemented by additional compaction equipment, as necessary to ensure a stable embankment.

When a rock embankment is overlain by an earth embankment or by sub-base or base course materials, the top 0.5 m of the rock fill shall be sealed with smaller rock particles and suitable soil materials, if necessary, to prevent the uppermost layers penetrating into voids in this rock embankment.

Where permitted by the Designer, and where the width is too narrow to accommodate equipment, material for the toe of the side hill rock fills may be placed by end dumping until sufficient width of the embankment has been formed to carry equipment, after which the remainder shall be placed in layers and compacted as specified. Any loose material left on the slopes by end dumping shall be incorporated in the fill and compacted.

When embankments are made on hillsides or where a new fill is to be applied upon an existing embankment, the slopes of the embankment or original ground (except rock) shall be terraced in a continuous series of steps a minimum of 1.5 m wide as the embankment rises.

The material from step excavation shall be spread and compacted into the adjoining embankment. No additional payment will be made for excavation or for placing step material in the adjoining fill.

201.37 Earth Embankments - This section applies to embankments constructed from material containing less than 15% by volume of rock larger than 150 mm. Embankments shall be constructed in such a manner that they shall be completely stable with reference to designated traffic loading.

The natural surface shall be excavated to remove organic soils or other unsuitable material, as directed by the Designer.

The earth embankment shall then be constructed in successive horizontal layers not exceeding 200 mm in loose thickness except that the top 500 mm shall be constructed in layers not exceeding 100 mm in loose thickness. Each layer shall be compacted to minimum 95% of the laboratory density obtained by the current ASTM test method D 698, except in the top 300 mm of the embankment, which shall be compacted to minimum 100% of the laboratory density.

The above maximum lift thickness requirements may be waived where the Contractor can:

- demonstrate that the proposed compaction equipment can uniformly compact a thicker layer;
- attain the required degree of compaction at all levels within the lift; and
- supply compaction testing equipment and services for Quality Control and Quality Assurance that will reliably test to the full depth of the proposed lift thickness.

No organic soils shall be placed in the embankment. Soils with high moisture content that cannot be compacted to the required density shall not be employed without prior aeration and drying.

When embankments are made on hillsides or where a new fill is to be applied upon an existing embankment, the slopes of the embankment or original ground (except rock) shall be terraced in a continuous series of steps a minimum of 1.5 m wide as the embankment rises.

Where suitable for embankment, the material from step excavation shall be spread and compacted into the adjoining embankment.

The Contractor shall be responsible for selecting equipment and methods of attaining the specified degree of compaction.

201.38 Frozen Material - The use of frozen material in embankments will not be permitted; the only exception is broken rock containing less than 15% passing a 4.75 mm sieve. Frozen excavated material which will be suitable when dry may be stored and allowed to thaw and dry, and then placed in the embankment.

201.39 Snow Removal - Snow overlying the surface of a cut, or the site or surface of an embankment shall be removed and deposited beyond the slope stakes.

201.40 Bridge End Fill - Material for bridge end fill shall be in accordance with DBSS 202.04 and DBSS 202.05. Construction of bridge end fill shall be in accordance with DBSS 202.23.

201.41 Transition Sections - Subgrade, other than solid rock, shall be subcut 1 m deep at the line of transition from cut to embankment. The subcut shall taper to zero depth 8 m within the cut. The embankment construction shall be carried back over the subcut only after the embankment has reached the level of the bottom of the subcut

201.42 Slopes and Slides - The slopes of all excavations and embankments shall be trimmed and maintained neatly and evenly to the line and slope indicated on the Design or as directed by the Designer.

No undercutting of slopes in will be permitted.

201.43 Ditches - Ditches which may be considered necessary for the proper drainage of the work shall be constructed at such points and to such cross-section, alignment and grade as the Designer may direct. This shall include inlets and outlets to culverts and ditching of all kinds. Ditching quantities will be considered as ordinary excavation quantities and will be measured, classified and paid for as such.

201.44 Borrow - Borrow shall consist of the excavation and disposal of suitable and satisfactory material obtained from borrow pits for the construction of embankments, subgrade or shoulders.

Borrow pits shall be so excavated that they will drain to the nearest natural outlet, or to an outlet designated by the Designer. Side slopes of borrow pits in all cases shall be dressed as required by the Designer to obtain stable slopes..

201.45 Not Used

201.46 Watering - Water for compacting embankments, constructing subgrades and surfacing, and for laying dust caused by grading operations and traffic, shall be applied in the amounts and at the places designated by the Quality Manager. Water shall be applied by sprinkling with tank trucks equipped with spray bars and suitable control apparatus

The Contractor shall make all necessary arrangements for obtaining water.

201.47 Finishing of Roadway - Before acceptance and final payment is made, the entire roadway, including the roadbed, shoulders and ditches shall be neatly finished and trimmed to the lines, grades and cross-sections shown on the Drawings, or as directed by the Designer, to reproduce smooth surfaces, slopes and a uniform cross-section. Subgrade shall be finished within a tolerance of ± 15 mm except for rock cut fills where the tolerance shall be ± 50 mm.

All drainage ditches, waterways and culverts shall be opened up and cleaned out to restore them to their full effectiveness.

All loose rock and boulders within the right-of-way resulting from grading and grubbing operations shall be gathered up and buried, or otherwise disposed of.

The Contractor shall grade all portions of the right-of-way outside the Excavation and Embankment areas to conform to the general ground line.

201.48 Surcharge Pre-consolidation -

Pre-consolidation by surcharging shall be carried out where indicated on drawings and/or Special Provisions, or as directed by the Designer. Embankments on these areas may be placed directly on the natural ground without removal of the organic materials, only if so directed by the Designer

The Contractor may place the initial lift of embankment to a minimum depth required to carry the Contractor's hauling equipment. The remainder of the embankments shall be constructed in accordance with procedures set forth in this Section; except that compaction will not be required on the surcharge material above construction grade.

To avoid shear failures, the rate of construction shall be rigidly controlled by instrumentation installed by the Contractor.

The surcharge shall remain on the embankments for a period determined by the Designer, and adjusted as may be indicated by the instrumentation.

Should any of the instrumentation become damaged or rendered unusable by the construction operations, same will be replaced by the Contractor.

201.49 Back Slope Stabilization - Drainholes, rock bolts, mesh and/or shotcrete may be required where rock is being excavated.

The backslope stabilization requirements will be assessed by the Designer during construction and the amount and location of the drainholes, rockbolts, mesh and shotcrete may be changed or deleted according to the condition of the rock encountered in the field.

SECTION 202

GRANULAR SURFACING, BASE AND SUB-BASES

PART A - SCOPE OF SPECIFICATION

202.01 Preliminary and General - This specification describes the classification, the materials and the professional standards required for the production of granular aggregates and the construction of granular surfacing, granular base and select granular sub-base.

PART B - MATERIALS

202.02 Aggregate Classification

202.02.01 Crushed Surfacing Aggregates:

i) High Fines Granular Surfacing Aggregate (HFSA): HFSA is used for surfacing of gravel roads and when paving is not scheduled for a few years. Cohesion for this aggregate is achieved by plastic fines.

202.02.02 Crushed Base Course Aggregates: These are high strength, high load bearing, high quality, crushed granular base materials. As these materials are not well suited for long-term traffic, they are usually overlaid by surface course materials (HFSA or asphalt/concrete pavement).

i) Well Graded Base (WGB): WGB is the standard base course material used for pavement structures, well graded with moderate permeability.

ii) Intermediate Graded Base (IGB): IGB is intermediate in gradation and permeability between well graded aggregate and open graded aggregate.

iii) Open Graded Base (OGB): OGB is a highly permeable, gap graded aggregate.

202.02.03 Sub-Base Aggregates – A granular material placed between the sub-grade and the base course aggregates, providing strength to the pavement structure.

i) Select Granular Sub-Base (SGSB): SGSB is the standard aggregate, crushed or screened, placed directly above subgrade, with moderate permeability and a wide gradation.

ii) Intermediate Graded Sub-Base (IGSB): IGSB is a higher permeability, crushed sub-base aggregate.

iii) Open Graded Sub-Base (OGSB): OGSB is a highly permeable, crushed sub-base aggregate.

202.02.03 Bridge End Fill (BEF): BEF is quality granular fill placed behind and below a bridge abutment to provide good drainage, a smooth transition from the bridge approaches to the bridge structure, and a suitable material through which to drive piles.

202.03 General Description of Work - The aggregates for granular surfacing, base and sub-base may be supplied either by the Contractor or produced from a Ministry provided source. Production of granular surfacing and granular base requires crushing and placing in stockpile. Production of select granular sub-base may be by crushing, screening or direct excavation.

Granular aggregate shall be loaded from the stockpile, crushing and screening plant, or pit face, as may be applicable; hauled out to the highway, placed accurately without segregation and thoroughly compacted to established line and grade.

The Contractor shall maintain the prepared surface of the base course aggregate until it has been paved or until completion of the contract, whichever is applicable.

202.04 Aggregate Quality

202.04.01 General - Granular aggregate shall be composed of inert, clean, tough, durable particles of crushed rock, gravel, sand and fines capable of withstanding the deleterious effects of exposure to water, freeze-thaw, handling, spreading and compacting. The aggregate particles shall be uniform in quality and free from clay lumps,

wood and free from an excess of flat or elongated pieces.

Aggregates for surfacing, base, sub-base and bridge end fill will be tested in accordance with the Table 202-A:

TABLE 202-A AGGREGATE QUALITY TESTS

BASED ON ASTM	TITLE OF TEST
C 136	Sieve Analysis of Fine and Coarse Aggregates
C 117	Wash Test of Aggregates
C 88	Soundness of Aggregate by Use of Magnesium Sulphate.
D 2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 6928	Abrasion Loss by Micro-Deval
D 4318	Plastic Limit Determination
C 295	Standard Guide for Petrographic Examination of Aggregates for Concrete
DBSS 202 Appendix 1	Fracture Count on Coarse Aggregate

202.04.02 Primary Quality Tests - All aggregates for surfacing, base, sub-base, and bridge end fill shall meet the requirements of Table 202-B.

TABLE 202-B AGGREGATE PROPERTIES

TEST	Test Result							
	Surfacing Aggregates	25 mm Base Course			Sub-Base Aggregates			Bridge End Fill
	HFSA	WGB	IGB	OGB	SGSB	IGSB	OGSB	BEF
Sand Equivalent	≥ 20	≥ 40	≥ 40	≥ 40	≥ 20	≥ 20	≥ 20	≥ 20
Micro-Deval loss factor	≤ 25%	≤ 25%	≤ 25%	≤ 17%	≤ 30%	≤ 25%	≤ 25%	≤ 30%
Fractured Faces Method "A"	≥ 50	≥ 50	≥ 50	≥ 50	n/a	≥ 50	≥ 50	n/a
Plasticity	≤ 6	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Where the Ministry has pre-existing test results, the Ministry shall make this information available to the Contractor and the Contractor will be able to rely on the data and not have to perform the corresponding tests on materials extracted from the investigated portions of the pit or quarry.

In circumstances where historic performance of material from a source has proven satisfactory, the Ministry may,

waive any or all of the aggregate testing required in DBSS 202.04.

202.04.03 Secondary Quality Tests - All aggregates for surfacing, base, sub-base, and bridge end fill failing any primary quality test indicated in DBSS 202.04.02 shall further be tested as follows to determine acceptability or, at the Contractor's option, a new source shall be found.

i) If the Micro Deval test results show that the material fails, then the soundness shall be reassessed by use of Magnesium Sulphate (ASTM C 88). The material will be considered acceptable if the loss after 5 cycles is less than:

- 20% for coarse aggregate (the material retained on or above the 4.75 mm sieve)
- 25% for fine aggregate (the material passing the 4.75 mm sieve)

ii) If the aggregate fails any of the Sand Equivalent, Micro-Deval or Magnesium Sulphate tests, it shall be examined using the Standard Guide for Petrographic Examination of Aggregates for Concrete (ASTM C 295) to determine the cause of failure. The Contractor's Quality Manager shall review the test results and, with the approval of the Ministry Representative, determine whether the material is acceptable or not.

202.05 Aggregate Gradation

Gradation shall be determined in accordance with ASTM C 136 (Dry Sieve) and, for the material passing the 0.075 mm sieve, ASTM C 117 (Wash Test).

202.05.01 Aggregate shall have a gradation that defines a curve (% passing versus log sieve size) with a slope between adjacent sieves, equal or intermediate to the corresponding slopes of the boundary curves defined by the specification. Gradations shall fall within the limits, for the specified classification, shown in Table 202-C.

TABLE 202-C AGGREGATE GRADATIONS

SIEVE SIZE	Percent Passing (%) Sieve Size							
	Surfacing Aggregates	25 mm Base Course			Sub-Base Aggregates			Bridge End Fill
	HFSA	WGB	IGB	OGB	SGSB	IGSB	OGBS	BEF
(mm)								
75	---	---	---	---	100	100	100	100
50	---	---	---	---	---	55 – 100	70 – 100	30 – 100
37.5	---	---	---	---	---	40 – 80	50 – 85	---
25	100	100	100	100	---	---	---	---
19	85 – 100	80 – 100	65 – 100	75 – 100	15 – 100	17 – 40	15 – 55	20 – 100
9.5	60 – 85	50 – 85	---	30 – 65	0 – 100	---	---	---
6.3	---	---	---	---	---	---	0 – 20	---
4.75	40 – 70	35 – 70	30 – 70	---	---	---	---	10 – 60
2.36	---	25 – 50	15 – 40	5 – 30	---	10 – 25	0 – 10	---
1.18	20 – 50	15 – 35	10 – 30	0 – 10	---	---	---	6 – 32
0.600	---	---	---	---	0 – 100	---	---	---
0.300	10 – 30	5 – 20	5 – 15	0 – 8	0 – 15	4 – 15	0 – 8	4 – 15
0.075	5 – 15	0 – 5	0 – 5	0 – 5	0 – 5	0 – 5	0 – 5	0 – 5

202.05.02 Rut Resistance – Any aggregate supplied shall, in addition to meeting the gradation requirements specified above, not rut when proof rolled with a fully loaded tandem axle truck. Any aggregate which does rut shall be removed and replaced, or blended with suitable aggregates, to meet both the gradation requirement and the rut resistance requirement.

PART C - USE OF MINISTRY-PROVIDED PITS OR QUARRIES

202.06 General – Ministry-provided pits and quarries are those identified in the Contract which the Ministry is offering to the Contractor as potential aggregate sources.

They may include pits and quarries:

- a) owned by the Ministry
- b) leased by the Ministry, or
- c) attained by the Ministry through special agreement with the landowner.

Use of such pits and quarries shall be at the Contractor's option unless the Contract clearly state that the source shall be used for specific purposes.

When a Ministry pit or quarry is provided for the Contractor's optional use under the Contract, the Contractor, by entering the pit or quarry, will be deemed to have accepted all obligations, risks and costs for the production of aggregate meeting the requirements of Part B of this section. The Ministry gives no warranty that its pit or quarry will meet the quality and quantity requirements.

Where a pit or quarry is designated as a mandatory source, the Ministry waives the aggregate quality requirements of DB SS 202.04.02 for aggregates required by the Ministry to be produced from that source.

202.07 Source of Supply - The Contract documents may identify one or more pits or quarries, for use as aggregate sources at the Contractor's discretion.

The Ministry will provide those gravel pits or quarries and the right-of-way to those pits or quarries and will pay the cost of royalties and fencing. The cost of constructing and maintaining access roads shall be considered as part of the cost of producing the construction aggregates and shall be payable by the Contractor. The Ministry will exercise its best judgement in the selection of the pit or quarry sites; however, the failure of the pit or quarry to yield materials of uniform quality shall not constitute grounds for a claim by the Contractor against the Ministry.

The Contractor shall be satisfied as to the gradation and other characteristics of the raw material in the Ministry provided pit or quarry and as to the nature and amount of work required to produce materials which shall meet all gradation requirements, and the Contractor shall, at the Contractor's expense, remove any objectionable materials from the aggregate.

202.08 Development of Pit or Quarry - Before any material for aggregate is excavated from the pit or quarry, the site shall be cleared and grubbed by the Contractor, and all debris disposed of to the satisfaction of the Ministry Representative. If topsoil or undesirable overburden exists, these materials shall be stripped and placed in separate stockpiles to the satisfaction of the Ministry Representative for future use in pit or quarry reclamation.

The Contractor shall take adequate precautions and actions to prevent pollution of the air, watercourses and adjoining land by the stockpiled material. The Contractor shall provide any protection necessary to protect the stockpile from erosion.

Watercourses located within or immediately adjacent to the gravel pit or quarry operations are to be protected against pollution. Where it is necessary to divert watercourses, application shall be made to Ministry of Environment, or the appropriate Federal agent, prior to such diversion being undertaken. Upon termination of operations, the watercourses shall be restored by the Contractor to as close to their original condition as is practicable.

The Contractor shall not operate the pit or quarry in a manner which will contaminate remaining granular material nor leave the pit or quarry in a condition which will limit its future use.

The Contractor shall follow the pit development plan, provided by the Ministry Representative. Stockpile sites in

Ministry-provided sources shall be per the pit development plan.

202.09 Use of All Materials - Any Ministry provided pit or quarry, once entered and developed, shall be used to its full potential. Normally, the Contractor shall produce select granular sub-base by selection or screening, provided that oversize reject aggregate is removed and properly placed in a stockpile for later crushing and use. However, if 5% or greater oversize occurs, pit run aggregate shall be crushed to produce 75 mm crushed granular base for use in place of select granular sub-base.

For the production of crushed surfacing and base aggregates, as well as IGSB and OGSB, the Contractor shall provide crushing equipment such that all aggregate which will pass through 375 mm x 450 mm slotted openings shall be used for the production of crushed aggregate; rocks which will not pass through these openings shall be stockpiled or disposed of to the satisfaction of the Ministry Representative. Crushing and screening equipment shall be provided with adequate facilities and capacity to bleed off reject aggregate in usable condition, or otherwise remove any excess of fine aggregate, dust or objectionable aggregate coatings that may be present in or on the aggregate, so as to make it generally acceptable for use. No portion of the products of crushers or screening plants that can be used shall be wasted. .

202.10 Unsuitable Materials - The rejection or addition of any particular size material necessary to produce gravel conforming to specification requirements shall be the responsibility of the Contractor.

202.11 Change of Ministry Provided Pit or Quarry - If the Ministry Representative requires a move to a new Ministry provided pit or quarry the Contractor shall be given notice in writing. The Contractor will not receive any allowance or compensation to cover such a move.

202.12 Pit Cleanup - When the Contractor discontinues operations in any pit or quarry, the Contractor shall trim the sides of pit excavations, waste piles and stockpiles to a 1.5H to 1V slope, or such other slope as the Ministry Representative may direct, open up such drains or ditches as may be required to prevent water standing therein, and leave the site in a neat condition, all to the satisfaction of the Ministry Representative. The trimming, sloping, ditching and draining of the pit or quarry, as well as maintenance of the access roads, shall be considered part of the cost of producing the granular aggregate.

If a pit has been fully depleted and is to be abandoned, the Contractor may be requested to reshape the sides to a slope not steeper than 2H to 1V using the stockpiled overburden if necessary, and cover same with any topsoil previously removed and stockpiled, all to the satisfaction of the Ministry Representative. In such cases, the replacing of stockpiled overburden and topsoil will be paid for in accordance with DBSS 202.32.

202.13 Work in Ministry Pits or Quarries – All work in a Ministry pit or quarry will be in accordance with DBSS [145.26](#).

PART D - CONTRACTOR SUPPLIED AGGREGATES

202.14 Preliminary and General - Aggregates, when supplied from private pits or quarries, shall meet the requirements of DBSS 202, Part B.

202.15 Development and Clean Up of Private Pits or Quarries - Pit or quarry development and cleanup shall be in accordance with local and Provincial Regulations.

202.16 Contractor to Pay All Costs – The Contractor shall bear and pay all costs including applicable royalties for provision of granular aggregates supplied from non-Ministry-provide sources. The Contractor shall also pay all costs for any move of the equipment that may be ordered or required because a pit or quarry of the Contractor's choosing proves unsuitable for production of the contracted quantity of granular aggregates meeting the

requirements of DBSS 202.

PART E - PRODUCTION OF CRUSHED AGGREGATE

202.17 Equipment and Plant - The Contractor shall provide and maintain in good operating condition, all plant and equipment necessary to comply with the requirements of this specification. Such plant and equipment shall be of a type and capacity to ensure proper construction and maintenance of access roads, development of the pit or quarry, maximum use of the pit or quarry, production of granular aggregates to the standard of uniformity required, and adherence to the construction schedule.

Adequate sampling facilities shall be installed by the Contractor at the discharge end of the production conveyor. The Contractor shall ensure that the plant and equipment meet the requirements of the current Pollution Control Act and Workers' Compensation Board Regulations.

202.18 Working of Pit - A pit shall be worked in such a manner as to ensure that granular material excavated and fed to the crushers, screening plants or loaders shall be as uniform as possible. This may require the use of equipment capable of deep excavating through horizontal gravel layers or carrying out selective digging or cross blending over a large area of the pit. Before commencing production, the Contractor's quality management plan shall describe the proposed method of production.

202.19 Crushing Operations - The Contractor shall adjust the crushers and/or screening plants and provide such screens as may be necessary to produce and maintain acceptable gradations of granular aggregates.

202.20 Crusher Gradation Control

202.20.01 Design Aggregate Gradation

For each aggregate gradation classification specified for production, field and/or laboratory tests shall be performed by the Contractor to select a single gradation curve within the "banana" specification (Table 202-B), the "Design Aggregate Gradation" (DAG), which will be the target for crusher control. The Contractor shall declare the DAG, in writing to the Quality Manager, within production of the first 10% of the Approximate Quantity of a given aggregate classification.

As part of its quality audit program and for payment purposes, the Ministry may sample the stockpile to assess aggregate gradation compliance to contractual requirements.

202.20.02 Variation Limits

The running average of four (4) consecutive tests, on each applicable individual sieve size specified in Table 202-C, shall be maintained at all times within the limits specified in that Table.

The maximum permissible variation from the DAG curve, on each applicable individual sieve size specified in Table 202-C, of the mean of any four (4) consecutive tests shall also be within the limits specified in Table 202-D.

TABLE 202-D AGGREGATE GRADATION VARIATION LIMITS

SIEVE SIZE	VARIATION LIMITS (% PASSING)
4.75 mm and larger	± 5
1.18 mm to 2.36 mm	± 3.5
0.300 mm and 0.600 mm	± 2
0.075 mm	± 1

202.20.03 Field Adjustment of Design Aggregate Gradation

The Contractor may make a maximum of two (2) field adjustments to the Design Aggregate Gradation, to accommodate minor changes in pit characteristics or to enhance production efficiency.

A field adjustment to the Design Aggregate Gradation is defined as a change in declared target gradation of the various aggregate sizes within the specified limits shown in Table 202-C which does not require a supplementary formal review. The maximum adjustment for individual sieve sizes for each adjustment are as permitted in the Table 202-E.

TABLE 202-E – FIELD ADJUSTMENT OF DESIGN AGGREGATE GRADATION

Sieve Designation (mm)	Maximum Field Adjustment (% Passing)
19 and larger	± 3.0
9.5	± 2.5
2.36 and 4.75	± 2.0
0.600 and 1.18	± 1.5
0.150 and 0.300	± 1.5
0.075	± 1.0

A proposed Design Aggregate Gradation field adjustment shall be submitted in writing with supporting documentation (showing original DAG, current stockpile average gradation, and proposed field adjustment and the new DAG) to the Quality Manager. Upon receipt of the proposed field adjustments, the Quality Manager will assess the adjustment for conformance with the contract requirements and notify the contractor whether or not it is acceptable in a timely fashion.

No field adjustment shall be acceptable if it results in a change from the current Design Aggregate Gradation which fall outside the limits defined in Tables 202-C. The variation limits specified in DB SS 202.20.02 shall apply to the adjusted DAG.

The Contractor shall have the moisture/density relationship established per ASTM test method D 698 for each original DAG, and one after each field adjustment thereto.

202.20.04 Declaration of a New Design Aggregate Gradation

Should there be a substantial change in the character of aggregate exposed in the pit face as the work proceeds, the Quality Manager may authorize a change in the declared Design Aggregate Gradation, which would then also be eligible for field adjustment in accordance with SS 202.20.

A maximum of one change to the declared DAG is to be permitted.

202.21 Stockpiling

202.21.01 All crushed aggregates shall be stockpiled prior to use.

202.21.02 Stockpile sites shall be cleared of all vegetation, trees, brush, rocks or other debris and a uniform gravel surface prepared before the stockpile material is deposited on the stockpile site.

202.21.03 Stockpiles shall be constructed on the designated site and when completed shall be neat and regular in shape, occupying as small an area as is practicable. Spilling of material over the edges of the piles shall not be permitted.

202.21.04 The Contractor shall ensure that stockpiles shall be built up in layers not to exceed 1 m in thickness.

202.21.05 The Contractor shall prevent dirt being tracked onto the crushed aggregate.

202.21.06 The Contractor may build the final stockpile by bulldozing the aggregate from a feed pile at the end of a production belt provided that the following are maintained:

- i) The bulldozer(s) to be used shall be equipped with U-shaped pushing blades.
- ii) The aggregate does not become contaminated with oversize material, mud or other objectionable material picked up from the pit floor or general working areas.
- iii) The crushed granular aggregate is distributed evenly over the final stockpile area in lifts not greater than 150 mm in depth.
- iv) The cone of the feeder pile at the end of the production belt shall not, without express permission, be allowed to build up to a greater height than 2 m.
- v) No appreciable segregation or degradation shall occur in the main stockpile as a result of using this method.

PART F - CONSTRUCTION METHOD**202.22 Weather and Job Conditions**

202.22.01 No construction shall be undertaken during snow, heavy rain, freezing or other unsuitable conditions. Aggregate shall not be placed upon a frozen, wet, muddy or rutted sub-grade, sub-base, base or surface.

202.22.02 When the sub-grade is soft due to excessive moisture, the placing of granular sub-base shall be stopped until rutting or displacement of the lower layers can be prevented by reduced loading or by other means.

202.23 Bridge End Fill - Construction of the bridge end fill shall not commence until the Designer has assessed the pertinent foundation conditions that may affect the future stability of both the bridge and embankments and has authorized continuation of construction.

The bridge end fill shall be laid out by extending back from the bridge abutment station, a distance of 8.0 m along centreline (and transversely parallel to the abutment) at finished grade and thence to a 1.5:1 backslope. The front slope, shall start at the bridge abutment station.

The bridge end fill shall be constructed to the subgrade elevation.

The material shall consist of mineral soil with properties and gradation in accordance with DBSS 202.04 and 202.05.

The bridge end fill shall be constructed in successive horizontal layers not exceeding 150 mm in loose thickness.

Each layer shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698.

The determination of field density shall follow a method approved by the Quality Manager.

202.24 Thickness of Granular Courses - Crushed surfacing course, crushed base courses and sub-base courses shall be constructed to the specified thickness and dimensions as shown on the design or as described in the Special Provisions.

Normally, on new construction, crushed bases shall be constructed 300 mm thick (in individual lifts with compacted thickness of 150 mm) unless otherwise approved by the Designer. Additional base or sub-base granular materials will be of such thickness as may be considered necessary to provide supporting strength for the flexible pavement structure.

202.25 Construction of 75 mm Sub-Base

202.25.01 Aggregates for sub-base shall be delivered to the roadbed as uniform mixtures and shall be spread in layers without segregation, preferably through an approved aggregate spreader. Granular aggregate shall not be end dumped from trucks in piles on the grade. The Quality Manager may permit spreading from the tailgate of trucks or from centre dump units, provided the Quality Manager is satisfied that the work will be well controlled and segregation will not occur.

When the sub-grade below granular aggregate sub-bases consists of cohesionless sand, and permission is granted by the Designer, a portion of the granular aggregate sub-base or base may be dumped in piles upon the sub-grade and spread ahead in sufficient quantity to stabilize the sub-grade. Segregation of aggregates shall be avoided and the material as spread shall be free from pockets of large or fine material. Segregated materials shall be remixed until uniform.

Where the required thickness is 150 mm or less, the granular base or sub-base may be spread and compacted in one layer. Where the required thickness is more than 150 mm, the aggregate shall be spread and compacted in two or more layers of approximately equal thickness; the maximum compacted thickness of any one layer shall not exceed 150 mm. Each layer shall be spread and compacted in a similar manner. The Contractor may lay a thicker lift, after demonstrating that the material can be thoroughly and uniformly compacted to the required density without degradation. At locations where the granular base or sub-base is to be placed over areas inaccessible to the spreading equipment, the granular sub-base or base may be spread by any means to obtain the specified results.

202.25.02 Immediately following spreading, the material shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698.

If, because of the nature of the granular aggregate, the Quality Manager considers that the results from the above test will be unreliable or the use of the test for density measurements is impractical, then the Quality Manager may order that each lift or course of aggregate shall be continuously and thoroughly rolled until successive passes of a vibratory roller results in an increase in density of less than 10 kg/m³

So that development of new compaction equipment will not be inhibited, the Quality Manager may give permission for the substitution of new or alternative compaction equipment if the Quality Manager is satisfied that such equipment will provide equal or superior compaction performance.

202.25.03 Subject to the concurrence of the Quality Manager, the Contractor may water the sub-base aggregates as required to aid in attaining the specified density.

202.25.04 The completed surface of the Sub-base course shall conform to the required line, grade and cross section as shown on the Design to an accuracy ± 15 mm, neither uniformly high nor low.

202.26 Construction of 25 mm Crushed Base Course

202.26.01 Crushed 25 mm base course aggregate shall be placed on a properly prepared Sub-Base surface to such depth or at such rates as may be specified. If the Quality Manager is of the opinion that the finished surface of the Sub-Base does not meet the requirements of DBSS 202.25.04 but has been thoroughly and densely compacted and should not be disturbed, the Quality Manager may order that the surface of the Sub-Base be corrected to the true cross section, line and grade, and within the tolerances specified by use of a levelling course of crushed 25 mm base course aggregate.

The 25 mm crushed base course shall be constructed in such a manner that the aggregate is neither segregated, contaminated nor degraded. End dumping will not be permitted. The thickness of the 25 mm crushed base course shall be substantially uniform and the minimum thickness shall not be less than the nominal thickness shown on the Design or ordered by the Designer. If the Contractor is unable to provide adequate manually operated equipment or workers of sufficient skill to lay the 25 mm crushed base course aggregate within the tolerances specified, the Contractor shall lay the aggregate through an approved electronically controlled spreading machine.

202.26.02 Compaction - Immediately following spreading, the 25 mm crushed base course aggregate shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698.

The method of compaction to be employed may be selected by the Contractor, but shall be subject to approval by the Quality Manager.

202.26.03 Watering - If required, water shall be applied to attain the specified density.

202.26.04 The completed surface of the granular base course shall conform to the required line, grade and cross section as shown on the Design to an accuracy ± 10 mm, neither uniformly high nor low.

202.27 Equipment for Watering - Water shall be applied from a distributor of the pressure type, equipped with a spray bar mounting nozzles similar to those used on asphalt distributors and capable of applying the water accurately and uniformly. Splash plate type distributors or those equipped with spray bars that eject fine streams of water will not be permitted. The distributor must be provided with a satisfactory means for accurately measuring the quantity of water sprayed. If the Quality Manager so requires, measuring equipment shall be calibrated under the Quality Manager's inspection.

202.29 Proof Rolling and Stabilization- Before acceptance, each compacted course of base course aggregate shall receive one complete coverage by the tires of a truck having a 9 tonne single axle dual tire or 17 tonne tandem axle group with dual tires with a tire pressure of 600 kPa.

Any areas where rutting or displacement occurs shall be either excavated and replaced or stabilized by the addition of suitable blending material incorporated uniformly into the base.

Blending may be performed at the pit or quarry or on the highway in whichever manner the Quality Manager may direct and to the satisfaction of the Ministry Representative.

202.30 Benkelman Beam Testing - At any time during the course of the work, when considered necessary by the Quality Manager or the Ministry Representative, Benkelman Beam testing may be undertaken.

202.31 Water Applied to the Highway - Water for compaction or dust control shall be incidental to the Contract.

202.32 Development and Cleanup of Ministry-Provided Pits and Quarries

202.32.01 Authorized clearing and grubbing of Ministry-provided pits and quarries, and construction of the access road is the responsibility of the Contractor. Removal and stockpiling of overburden and topsoil in the development of the proposed work areas, and spreading overburden to reshape the sides of a pit and spreading topsoil over a depleted pit or quarry shall be the responsibility of the Contractor and the work shall be completed to the satisfaction of the Ministry Representative.

202.32.02 Pit and quarry development work, restoration work, and construction of access road will be paid for by Order for Extra Work where, in the opinion of the Ministry Representative:

i) Not Used

ii) The gravel pits or quarries are designated subsequent to tendering.

iii) Development and restoration work is substantially different from that described in the Contract.

iv) Restoration work is required outside the current work area.

v) Not Used

202.33 Stockpile Reject Aggregate

202.33.01 Aggregate from screening or crushing operations in a Ministry-provided pit or quarry, whether:

i) Oversize under DBSS 202.09, or

ii) Rejected at the crusher in order that the product meets the requirements of DBSS 202.05,

shall be stockpiled separately according to size in accordance with DBSS 202. Stockpiles of reject aggregate shall not be contaminated by organic or other deleterious materials.

202.33.02 No payment will be made for any reject aggregate.

202.34 Blending Materials for Stabilizing Aggregates on the Highway - Blending materials, supplied, loaded, hauled, placed and mixed into the granular aggregate on the highway to correct deficiencies in aggregate stability, shall be the responsibility of the Contractor.

202.35 Not Used

202.36 Aggregates Supplied in Place

202.36.01 Not Used

202.36.02 Not Used

202.36.03 Surplus Aggregate

Surplus aggregates in stockpile on Ministry lands are the property of the Ministry, and no additional compensation will be paid.

Appendix 1

Fracture Count for Coarse Aggregate (BCH 1-13)

Purpose:

This test determines the amount of fractured material in the coarse part of an aggregate sample.

Method "A" is used for crushed granular surfacing and base aggregates.

Method "B" is used for paving aggregates.

Apparatus:

1. Drying oven, preferably forced draft, capable of maintaining a uniform temperature of $110 \pm 5^\circ \text{C}$.
2. A nest of sieves of the following sizes:
Method "A": 37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, 9.5 mm, 4.75 mm
Method "B": 19.0 mm, 13.2 mm, 9.5 mm
3. Balance with sufficient capacity and accurate within 0.1 percent of the mass of sample.

Test Sample:

The sample of aggregate to be tested shall be representative, oven-dry, and reduced to an amount suitable for testing. The mass of the sample shall conform to the following:

Maximum Nominal Size (mm)	Minimum Dry Mass (kg)
37.5	4.0
25.0	2.5
12.5	1.5
9.5	1.0

Procedure: Method "A"

1. Sieve the coarse aggregate to be tested on the 37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, 9.5 mm 4.75 mm sieves.
2. Separate each sieve size into two groups, fractured and unfractured. Each rock in the fractured group shall have at **least one** fractured face or shall be naturally angular with sharp edges. (See Discussion 1).
3. For each sieve size, count the number of fractured rocks and the total number of rocks (fractured and unfractured).
4. Calculate and record the % fracture for each sieve size and report the total % fracture for the sample using the following formulas:

FOR EACH SIEVE SIZE: (i.e. 19 mm)

$$\% \text{ Fracture (19 mm)} = \frac{\text{Number of Fractured Rocks (19 mm)}}{\text{Total No. of Rocks (19 mm)}} \times 100\%$$

FOR THE TOTAL SAMPLE:

$$\text{Total \% Fracture} = \frac{\text{Number of Fractured Rocks (All Sieve Sizes)}}{\text{Total No. of Rocks (All Sizes)}} \times 100\%$$

Procedure: Method "B"

1. Separate the coarse aggregate to be tested from the fine aggregate by sieving it over the 4.75 mm screen.
2. Separate the coarse aggregate for each sieve size into two groups, fractured and unfractured. Each rock in the fractured group shall have **two or more** fractured faces produced by a crusher or shall be naturally angular with sharp edges. Each rock in the unfractured group shall be unfractured or fractured only in one dimension.
3. Obtain the mass of the fractured group, also the mass of the total coarse aggregate (fractured + unfractured groups).
4. Calculate and report the total % fracture for the sample using the following formula:

$$\% \text{ Fracture} = \frac{\text{Mass of Fractured Rock}}{\text{Mass of Total Rocks}} \times 100 \%$$

Discussion:

- Fractured face** shall be defined as a fracture in any plane whose areas is 15% or more of the largest cross-section area in a parallel plane.
- The required sample can be conveniently obtained from the separated fractions of the Dry or Wash Sieve Test.

SECTION 204

ROCK CUTS

DESCRIPTION

204.01 Scope - This Section describes the controlled blasting techniques required to produce rock cut slopes at the locations shown on the Design or as required by the Contract. Rock shall be excavated to subgrade elevation as shown on the Design. The work shall be conducted, whether by blasting or other methods, in a manner that minimizes blast damage to the excavation backslope and minimizes the requirement for stabilization. The responsibility for the results of every blast lies with the Contractor. Nothing within this specification shall be interpreted to mean the Ministry accepts responsibility for the results of any blast.

204.02 Definitions

204.02.01 Backline Holes - A line of holes detonated or intermittently detonated along the specified excavation backslope.

204.02.02 Bench - A near-horizontal or shallow slope surface at the top of a near-vertical rock face where blast holes are collared.

204.02.03 Bench Width - The horizontal distance on the bench between the excavation backslope and the crest of the existing rock face. Generally this dimension defines the width of the rock to be removed and is perpendicular to the highway alignment.

204.02.04 Blast Crater - A local depression in rock formed by blasting.

204.02.05 Buffer Holes - The line of production holes located closest to and parallel to the backline holes.

204.02.06 Burden - The distance between the blasthole and the nearest free face.

204.02.07 Charge - A specific quantity of explosive such as a cartridge.

204.02.08 Controlled Blasting - Controlled blasting is the controlled use of explosives and accessories in carefully spaced and aligned production and backline drill holes to produce the specified excavation backslope within the specified excavation limits. The purpose of controlled blasting is to minimize damage to the rock backslope, to help ensure long-term stability and to minimize flyrock.

204.02.09 Controlled Delay Sequence - The delay sequence required for controlled blasting.

204.02.10 Cushion Blasting - A blasting method whereby the production holes are detonated before the backline holes.

204.02.11 Delay - A blast initiator with a specific delay time period before detonation.

204.02.12 Excavation Backslope or Smooth Wall - This

is the location of the free surface or shear plane in the rock produced by blasting along the backline holes.

204.02.13 Excavation Limits - This is the boundary within which rock is removed.

204.02.14 Explosive Decoupling - The separation of an explosive charge from the wall of the blast hole.

204.02.15 Flyrock - The throw of fragmented material during blasting.

204.02.16 Free Face - The rock face that provides relief for a blast.

204.02.17 Guide Holes - Those holes along the backline that are not loaded with explosive and are not stemmed.

204.02.18 Hole Deviation - Borehole misalignment distance measured in two directions, within and perpendicular to the excavation backslope. Within the plane of the excavation backslope, hole deviation is borehole misalignment as measured by the horizontal offset distance between any point in the design hole location and the point at a corresponding depth in the actual hole. Perpendicular to the plane of the excavation backslope, hole deviation is the horizontal offset distance between the plane of the design excavation backslope and the centreline of the borehole being measured.

204.02.19 Lift - The vertical distance between the top and bottom of an area to be blasted.

204.02.20 Overbreak in Rock - Overbreak in rock is any rock outside of the specified excavation limits (except slide material described in DBSS 201.42) that is excavated, displaced or loose due to the inherent character of any formation encountered or due to any other cause.

204.02.21 Overburden - This is Type B, C and/or D material (as described in DBSS 201.11) overlying rock.

204.02.22 Presplit (or Pre-Shear) Blasting - A blasting method whereby backline holes are detonated before production holes are detonated.

204.02.23 Production Blasting - Blasting of production holes detonated in a controlled delay sequence.

204.02.24 Production Holes - All holes within the specified excavation limits that are not backline holes. Production holes are often more widely spaced than backline holes.

204.02.25 Rock Excavation - Rock excavation includes drilling holes, loading holes with explosives, detonation by controlled blasting, mucking to subgrade and ditch level, and removal of material to a designated area. Rock excavation also includes secondary breakage of oversize rock.

204.02.26 Rock - Rock is Type A material as defined in DBSS 201.11.01.

204.02.27 Scaling - The removal of all loose material using scaling bars, portable hydraulic jacks, other hand tools, wire rope cables, compressed air blow pipes, blasting without the need for drilled holes and other methods authorized by the Ministry Representative.

204.02.28 Setback Distance - The setback distance is the horizontal distance between the top of the excavation backslope and the toe of the overburden material. Setback is created by removing overburden.

204.02.29 Spacing - The distance between blastholes perpendicular to the burden.

204.02.30 Stemming - Material placed on top of the explosive to provide confinement of the explosive gases.

204.02.31 Subdrill - The distance drilled below subgrade level.

204.02.32 Trimming - The removal by drilling and controlled blasting of potentially unstable rock remaining at the exposed excavation backslope. Trimming may not require backline holes.

204.03 Quality Management

204.03.01 General - Quality management shall be conducted for all blasting operations.

204.03.02 Blasting Consultant - The Contractor shall retain a specialist blasting consultant, acceptable to the Quality Manager, to provide quality control. The consultant shall not be an employee of the Contractor, explosives manufacturer or explosives distributor.

204.03.03 Vibration Specialist - The Contractor shall retain a vibration specialist to provide blast vibration monitoring if required. The specialist shall not be an employee of the Contractor, explosives manufacturer or explosives distributor.

204.03.04 Quality Management Activities For Blasting Operations - Quality management for blasting operations shall be performed for test sections, full scale blasting operations and trimming. A field report, generated by the Consultant shall be provided to the Quality Manager, and upon request to the Ministry Representative, within one day of each site visit by the Consultant.

Quality control for blasting includes, but is not limited to the following activities by the blasting consultant:

- Viewing the proposed blast area at least one (1) week before drilling operations commence.
- Preparing and submitting blast designs for production and backline holes.
- Intermittently viewing the site during drilling for each blast area.

- Intermittently observing the loading of holes with explosives and tying in to the delay system.
- Observing the blasts and reviewing the excavated areas.
- Attending on site to view the excavation backslope after each lift and reviewing excavation backslope for quality control purposes.
- Viewing the site while reviewing proposed changes to the blast design and preparing new designs.
- Attending on site at other times as are appropriate to assist the Contractor and Quality Manager in the setting up, assessment and adjustment of the various procedures to be employed for blasting.
- Preparing a field report for each site visit, including details of the progress of blasting operations, a statement whether the blast design is being complied with, any changes to the blast design, any recommendations made to the Contractor and Quality Manager and any problems encountered by the Contractor and Quality Manager.

204.04 Submittals

204.04.01 General – The Ministry will perform Quality Audit. The receipt of submittals by the Ministry shall not relieve responsibility from the Contractor for the accuracy and adequacy of the submittals. Submittals are for quality audit and record keeping purposes. Inadequate or incorrect submittals will be returned for revisions prior to acceptance. The Contractor shall submit to the Quality Manager, and upon request to the Ministry Representative, the following documentation for review.

204.04.02 Qualifications and Experience of Contractor - The Contractor shall provide a statement of the qualifications, experience and work function of all personnel assigned to drilling and blasting duties. A statement of previous work experience on similar projects shall also be provided. This statement shall include the project name, location, volume of rock, year constructed and the owner/client contact name. The company, the driller and the blaster shall each have a minimum of 5 consecutive years demonstrated experience in drilling and controlled blasting work on at least 3 projects involving rock cuts over 8 m height along transportation corridors.

204.04.03 Qualifications and Experience of Proposed Blasting Consultant - The Contractor shall provide the name of the consulting firm, and the name and qualifications of the blasting consultant's on-site representative who will be providing the quality control for rock excavation. The blasting consultant shall have a minimum of 5 consecutive years demonstrated experience in preparing successful blast designs along transportation corridors for at least 3 projects. The following information shall be included in the qualifications submitted:

- Project name, location and experience.
- Name and phone number of owner/client contact who can verify the experience of the blasting consultant's site representative.

204.04.04 Qualifications and Experience of Proposed Vibration Specialist - The Contractor shall provide the name and qualifications of the vibration specialist who will be providing the quality control for rock excavation. The vibration specialist shall have a minimum of 5 consecutive years demonstrated experience in the field of vibration monitoring for at least 3 projects. The following information shall be included in the qualifications submitted:

- Project name, location and experience.
- Name and phone number of owner/client contact who can verify the experience of the vibration specialist.

204.04.05 Proposed General Construction Plan - The Contractor shall submit a general construction plan to the Quality Manager showing proposed blasting sequence numbers defining the order of blasts for the contract. The plan shall also show the following information for each blast:

- Blast sequence number.
- The location of the blast in relation to the remaining rock on the site.
- Approximate dimension of the rock to be removed.
- Estimated volume of rock to be removed.
- Location of the disposal site.

204.04.06 Sequence of Operations - The Contractor shall adopt a logical, systematic sequence of operations to ensure blasting is conducted safely and effectively. The following general sequence of blasting operations outlines minimum requirements of the Contractor to maximize the stability of the excavation backslope and does not limit or supercede any other requirements in this specification:

- Retain a blasting consultant to perform quality control.
- Submit blast designs for quality audit purposes to the Ministry Representative.
- Accurately survey locations of proposed blast holes.
- Drill holes, load explosives, detonate blast and remove muck pile.
- Check the excavation backslope to determine hole offsets, hole angles, hole alignment and compliance with allowable tolerances.
- Review blast results and make changes to blasting operations as necessary.
- Perform backslope stabilization to the satisfaction of the Quality Manager before subsequent lifts are

detonated.

204.04.07 Blast Design - The Contractor shall provide and follow a blast design, approved and signed by the blasting consultant, not less than one week prior to commencing drilling and blasting operations and a minimum of one day before the Contractor proposes to implement any changes to the previously utilized drilling or blasting methods. The design may be prepared by the blaster, but shall be reviewed by the Contractor and forwarded to the blasting consultant for signing. The design shall contain full details of the drilling and blasting patterns and controls that the Contractor proposes to use for controlled blasting. The blast design shall contain the following minimum information:

- Date the design was prepared and proposed date of blast.
- Station limits of proposed blast.
- Plan and section views of proposed drill pattern including free face, burden, blasthole spacing, blasthole diameters, blasthole angles, lift height, hole depth, and subdrill depth.
- The location of production (including buffer) and backline holes.
- Loading diagram showing type and amount of explosives, primers, initiators, and location and depth of stemming.
- Initiation sequence of blast holes including delay times and delay system.
- Manufacturer's data sheets for all explosives, primers, delays, and initiators to be used.
- Blasting consultant's signature, printed name, and company name.
- Blaster's signature, printed name, company name, and blaster's certificate number.

204.04.08 Preblast Survey - The Contractor shall conduct a preblast survey a minimum of one day before blasting operations commence. The preblast survey shall include a complete description of the existing condition of any nearby buildings, structures, wells and utilities that potentially may be damaged by blasting operations. The survey method used shall be acceptable to the Contractor's insurance company.

204.04.09 As-Built Blast Design - Within one day after each blast, the Contractor shall submit to the Quality Manager, an as-built blast design showing all actual blast details in a format that permits direct comparison with the proposed blast design.

204.04.10 Blasting Consultant's Field Report - The Contractor shall provide the blasting consultant's field report to the Quality Manager within one day after each visit by the blasting consultant.

204.04.11 Vibration Control Records - As required, the Contractor shall provide all seismograph records of vibration monitoring and interpretation of results within one day after each blast to the Quality Manager.

204.04.12 Peak Overpressure Records - As required, the Contractor shall provide a permanent signed and dated record of the peak overpressure measurements within one day after each blast to the Quality Manager.

MATERIALS

204.11 Explosives and Related Products

204.11.01 Manufacturer - All products and materials used for any blasting operations shall be products of a company regularly engaged in the manufacture of explosives and related products.

204.11.02 Expired Explosives - Explosives with an expired shelf life shall not be used.

204.11.03 Water Resistance - Water resistant explosives may be required for the work.

CONSTRUCTION

204.31 Permits and Regulations - The Contractor shall obtain all necessary permits for and shall comply fully with the laws, rules and regulations of Municipal, Provincial and Federal agencies in connection with the use, transportation, storage and safe handling of all explosives, including those regulations contained in the Industrial Health and Safety Regulations (IHSR) published by the Worker's Compensation Board (WCB) of British Columbia.

204.32 Supervision - The Contractor shall provide at least one person thoroughly trained and experienced in the use of explosives who shall be present at all times during the execution of all blasting operations and who shall direct such work.

204.33 Personnel - The Contractor shall ensure that all persons conducting blasting operations have a valid blaster's certificate issued by the WCB or is under the direct supervision of a certificate holder.

204.34 Safety - The Contractor shall meet all WCB regulations. All work shall be performed in a manner that prevents injury or harm to any personnel employed in the rock excavation area. Warning signs shall be posted and readily recognizable audible warning signals shall be used. The perimeter of the area affected by blasting operations shall be patrolled and controlled by direct voice communication. The Quality Manager shall stop work if the safety of the public is being jeopardized by the Contractor's blasting operations.

204.35 Flyrock Control - Before the detonation of any blast in areas where flying rock or other debris may result in personal injury or damage to property, the area within the excavation limits shall be covered with suitable blasting mats, soil or other equally serviceable material to prevent

flyrock.

204.36 Other Damage - The Contractor shall be responsible for any damage resulting from blasting. Occupants of local buildings shall be notified by the Contractor, prior to the commencement of the blasting, as to the timing, size of blasts, types of warning and other signals.

204.37 Subgrade and Ditch Areas

204.37.01 General - The subgrade shall be constructed to ± 50 mm of the specified line and grade before the placement of Select Granular Sub-Base Material. Any pinnacles of intact rock protruding above the design subgrade elevation shall be removed.

204.37.02 Supporting Rock - The Contractor shall exercise care and use appropriate methods to prevent breaking, loosening or otherwise damaging supporting rock below subgrade level and ditch bottom. The Contractor shall be responsible for the methods used and for any damage to the rock structure resulting from the operations.

204.37.03 Drainage - Excavated rock areas shall be free draining. If craters formed in rock by blasting below subgrade elevation are not free draining, then the Contractor shall provide drainage by trenching to a free outlet. These blast craters and drainage trenches shall be backfilled to subgrade elevation.

204.37.04 Shatter Zone for Drainage - Drainage shall also be provided by shattering the upper portion of rock below subgrade and ditches within the entire excavation limits. The shatter zone shall be 300 mm thick. A shatter zone thickness of 900 mm may be required near cut to fill transition zones for 10 m beyond the transition.

204.37.05 Backfill Material - Backfill shall be free draining material such as clean broken rock or coarse clean granular material. All backfill shall be placed and compacted as specified.

204.37.06 Ditches - The ditches shall be formed and cleaned before any base material is placed on the subgrade.

204.38 Blasting Test Section(s)

204.38.01 General - All requirements for full scale blasting shall also apply to test sections. Prior to commencing full-scale blasting operations, the Quality Manager may require the Contractor to demonstrate the adequacy of the proposed blast design by drilling, blasting, and excavating short test sections, up to 30 m in length, to determine which combination of method, hole spacing, timing, and charge yields acceptable results. The length of the blast test section shall be as specified in the blast design.

204.38.02 Reduced Section Length - Where requested by the Quality Manager, the Contractor shall use test section lengths of less than 30 m.

204.38.03 Backline Hole Spacing - The Contractor shall begin the tests by drilling backline holes 750 mm apart

along the specified excavation backslope, then adjust if needed, until the Quality Manager authorizes the spacing to be used for full-scale blasting operations.

204.38.04 Review of Test Section Results - The Contractor shall not drill beyond the test section until it has been excavated and the results reviewed by the blasting consultant and continuation is authorized by the Quality Manager.

204.38.05 Revision of Methods - If either the blasting consultant or the Quality Manager determines that the results of the test section are unsatisfactory, then the Contractor shall adopt such revised methods as are necessary to achieve the required results.

204.38.06 Additional Test Sections - If at any time during the progress of the work the methods of drilling and blasting do not produce the required excavation backslope geometry within the tolerances specified for backline holes, then the Contractor will be required to drill, blast and excavate short sections, not exceeding 30 m in length, until a technique is achieved that will produce the desired results.

204.39 Overburden Removal and Setback - The setback distance shall be 3.0 m. The Contractor shall, before drilling the backline holes, remove all overburden within the excavation limits or 10 m beyond the limits of the production holes in a direction parallel to the backline. The overburden surface shall be sloped at 1.5:1 **204.40 Backline and Production Holes**

204.40.01 Stemming - The upper portion of all holes between the topmost charge and the hole collar shall be stemmed. Stemming materials shall be sand or other inert angular granular material with similar specific gravity passing a 9.5 mm sieve.

204.40.02 Hole Obstructions - Before placing charges, the Contractor shall determine that the hole is free of obstructions for its entire depth. All necessary precautions shall be exercised so that the placing of the charges will not cause spalling of material from the walls of the holes.

204.40.03 General Orientation - All holes shall be drilled downward unless otherwise specified in the blast design. In general, slash holes (horizontal, near horizontal or fanned out holes) shall not be drilled along the excavation backslope or on pioneering routes excavated to provide access for backline hole drilling.

204.40.04 Insertion of Explosive - Explosive materials shall not be inserted into the holes until the blast design has been reviewed by the Quality Manager.

204.41 Backline Holes

204.41.01 General - The Contractor shall control the hole layout and drilling operations using proper equipment and techniques to ensure that backline holes are located and oriented correctly. The proposed location of each backline hole shall be accurately surveyed and staked.

204.41.02 Hole Location - For each blast, the line of backline holes shall extend 10 to 20 m beyond the limits of the production holes to be detonated or to the end of the specified excavation backslope, as applicable.

204.41.03 Hole Location Tolerance - Backline holes shall be drilled within 75 mm of the staked collar location.

204.41.04 Hole Deviation - Backline holes shall not deviate from the plane of the specified excavation backslope by more than 150 mm as measured perpendicular to the slope. Backline holes shall not deviate more than 150 mm as measured within the plane of the excavation backslope

204.41.05 Hole Diameter - The backline holes shall be 50 to 75 mm in diameter, or as recommended by the blasting consultant. Trim blast holes may be as small as 25 mm diameter.

204.41.06 Hole Length - The length of backline holes for any individual lift shall not exceed 8 m unless the Contractor can demonstrate to the Quality Manager that the Contractor can stay within the tolerances and produce the required excavation backslope geometry.

204.41.07 Guide Holes - Guide Holes shall be of the same diameter and drilled in the same plane and to the same tolerance as the remaining backline holes.

204.41.08 Hole Length Increase - Upon satisfactory demonstration, the length of holes may be increased to a maximum of 12 m with written authorization of the Quality Manager. If more than 5% of the backline holes are misaligned in any one lift, then the Contractor shall reduce the height of the lifts until the 150 mm alignment tolerance is met.

204.41.09 Control of Drilling Orientation - All drilling equipment used to drill the backline holes shall have mechanical devices attached to that equipment to accurately determine the orientation of the drill steel entering the rock. Backline hole drilling will not be permitted if these devices are either missing or inoperative.

204.41.10 Offset Between Lifts - When the cut height requires more than one lift, a maximum 0.5 m offset between lifts is permitted to allow for drill equipment clearances. The Contractor shall begin the backline hole drilling at a point on the top lift which will allow for necessary offsets and shall adjust at the start of lower lifts to compensate for any drift which may have occurred in the upper lifts.

204.41.11 Length for Toe Berm Removal - Drilling 0.5 m below ditch bottom is permitted to facilitate removal of the toe berm.

204.42 Presplit Blasting

204.42.01 General - Unless otherwise specified in the blast design, presplit blasting shall be conducted for all blasting to the excavation backslope. In general, cushion blasting may proceed when the bench width is less than three times

the lift height.

204.42.02 Explosive Type and Accessories - Drill hole conditions may vary from dry to filled with water. The Contractor shall use explosives and blasting accessories appropriate for the drill hole conditions encountered to accomplish the specified results. Only standard explosives manufactured for presplit blasting shall be used in backline holes, unless otherwise specified in the blast design. Bulk ammonium nitrate and fuel oil (ANFO) shall not be loaded into the backline holes.

204.42.03 Explosive Decoupling - Explosives shall be evenly distributed and decoupled to the maximum extent possible.

204.42.04 Explosive Charges - The bottom charge of backline holes may be larger than the remaining charges but shall not be large enough to cause overbreak. The top charge of backline holes shall be placed far enough below the collar and be sufficiently small to avoid overbreak and heaving of rock beyond the excavation backslope.

204.42.05 Modified Blasting Sequence - The Contractor may detonate the backline holes before drilling production holes, provided satisfactory excavation backslopes are obtained.

204.42.06 Backline Hole Delays - If required to reduce ground vibrations or noise, backline holes may be delayed, provided the effective hole-to-hole delay time is not more than 25 ms.

204.42.07 Excavation Backslope Geometry - The excavation backslope shall not deviate more than 150 mm from a plane passing through adjacent drill holes except where the character of the rock is such that irregularities are unavoidable. The 150 mm tolerance shall be measured perpendicular to the plane of the slope. In no case shall any portion of the slope encroach on the ditch.

204.43 Cushion Blasting

204.43.01 General - Where the horizontal distance from the specified excavation backslope to the existing free face is less than 5 m, the Contractor may use cushion blasting instead of presplit blasting.

204.43.02 Delay Time - The difference in delay time between the backline holes detonated after the buffer holes shall be between 25 and 75 ms. With the exception of these criteria, requirements for presplit blasting shall also apply to cushion blasting.

204.44 Production Blasting

204.44.01 Hole Diameter - Production holes shall not exceed 150 mm in diameter, unless otherwise specified in the blast design.

204.44.02 Hole Location - Production blast holes (not including buffer holes) shall not be drilled closer than 2.0 m to the backline holes, unless otherwise specified in the blast

design. The bottom of the production holes (including buffer holes) shall not be lower than the bottom of the backline holes.

204.44.03 Delay Sequence - All sequences shall be delayed in such a manner that successive delays promote the movement of rock in the direction of a free face at all times.

204.44.04 Damage to Backslope - It is the Contractor's responsibility to take all necessary precautions during production blasting to minimize blast damage to the excavation backslope.

204.44.05 Buffer Holes - A line of buffer holes shall be drilled along a plane parallel to the backline holes. Buffer hole diameters shall be between 50 and 75 mm unless otherwise specified in the blast design. Unless otherwise specified in the blast design, the line of buffer holes shall be drilled approximately 1 m away from the backline holes and spaced 1.0 to 1.5 m centre to centre.

204.44.06 Buffer Hole Charge and Detonation - The explosive charge in buffer holes shall not exceed 50% of the full explosive load that could be placed in a 75 mm diameter production hole. Detonation of the buffer holes shall be on a delay sequence toward a free face. Ammonium nitrate and fuel oil shall not be used for buffer holes unless otherwise specified in the blast design.

204.45 Vibration Control and Monitoring

204.45.01 Vibration Control - The Contractor shall use blasting methods designed to limit the intensity of ground vibrations originating within the excavation limits. When blasting near buildings, structures, wells, utilities or other works that may be subject to damage from blast induced ground vibrations, the ground vibrations shall be controlled using properly designed delay sequences and allowable charge weights per delay.

204.45.02 Charge Weight Per Delay - Allowable charge weights per delay shall be based on vibration levels that will not cause damage. The Quality Manager may monitor vibration levels at the blast site by requesting trial blasts to determine actual vibration levels reached during blasting.

204.45.03 Monitoring - Monitoring shall meet ISRM standards. Whenever vibration damage to adjacent structures is possible, the Contractor shall monitor each blast with approved seismograph(s) located between the blast area and the closest structure(s) subject to potential blast damage. The geophone shall be placed as close as possible to the structure(s) but not directly above the structure(s). The seismograph(s) shall be set to record particle velocity, accelerations, and frequency in the range generally found with controlled blasting. The peak particle velocity shall be calculated as the maximum vector sum of three mutually perpendicular components of vibration. All components and peak particle velocity shall be recorded.

204.45.03 Vibration Limits - Peak particle velocity, accelerations and frequency shall not be allowed to exceed

the safe limits of the nearest structure subject to potential vibration damage. The Contractor shall employ a qualified vibration specialist to establish the safe vibration limits.

204.45.04 Interpretation - The vibration specialist shall interpret the seismograph records to ensure that the seismograph data is effectively used in the control of the blasting operations with respect to the existing structures.

204.46 Air Concussion and Noise Control

204.46.01 General - When requested by the Quality Manager, an air concussion monitoring system shall be installed in a representative location between the blasting area and the nearest structure subject to potential blast damage or annoyance. The equipment used to make the air concussion measurements shall be the type specifically manufactured for that purpose.

204.46.02 Monitoring - The air concussion monitoring system shall be set to record air overpressure on the linear setting. Human annoyance (A weight setting) and human ear response (C weight setting) shall also be recorded.

204.46.03 Overpressure - Peak overpressure shall be controlled using appropriate blasthole patterns, detonation systems and stemming to prevent venting of blasts, and to minimize air concussion and noise levels produced by the blasting operations. The contractor shall use a qualified

vibration specialist to establish safe overpressure limits.

204.47 Excavation Backslope Stabilization

204.47.01 Stabilization - The excavation backslope shall be stabilized by the Contractor as recommended by the Contractor's specialist Geotechnical Engineer and the Quality Manager, during or upon completion of the excavation of each lift. Drilling of the next lift shall not proceed until stabilization has been completed. Drilling of the next lift shall not proceed until all concerns about stability raised by the Contractor's geotechnical engineer, the Quality Manager and the Ministry Representative are addressed by the stabilization work, and Stabilization shall be completed before any base material is placed upon the subgrade.

204.47.02 Stabilization Methods - Stabilization methods include scaling, trimming, the application of rock bolts, shotcrete, slope mesh, drains or other stabilization techniques recommended by the Contractor's geotechnical engineer and authorized by the Quality Manager.

204.48 Special Use of Excavated Rock - Excavated rock of suitable quality required for walls, riprap, paving, or other special use shall be sorted and deposited in stockpiles if so requested by the Contract.

Stabilization shall be at the Contractor's expense.

PROPOSED BLAST DESIGN

File #: _____

PROJECT NO. _____

(TO BE SUBMITTED NOT LESS THAN 1 DAY BEFORE DRILLING)

GENERAL:

CONTRACTOR'S NAME _____
 BLASTER'S NAME _____
 BLASTER'S CERTIFICATE NUMBER _____

DATE PREPARED _____
 PROPOSED BLAST DATE _____
 BLAST # _____

HIGHWAY# _____

BLAST LOCATION AT: _____

UTILITY PROTECTION OR STANDBY REQUIRED: (CIRCLE) YES NO

SITE DETAILS:

HEIGHT ABOVE HWY _____ (m) SLOPE ANGLE _____ (°) SLOPE LENGTH _____ (m)

ROCK TYPE _____

DISTANCE TO NEAREST STRUCTURE (UTILITY) _____ (m)

ANTICIPATED DRILLING DETAILS:

PROPOSED NO. OF BACKLINE HOLES _____

PROPOSED APPROX. NO. OF HOLES _____

PROPOSED AVG. DEPTH _____ (m)

HOLE DIA. _____ (mm)

PROPOSED NO. OF ROWS _____

APPROX. HOLE SPACING _____ (m)

BURDEN _____ (m)

PROPOSED MAXIMUM DEPTH _____ (m)

PROPOSED HOLE INCL.: (CIRCLE) VERTICAL HORIZ. VARIABLE

PROPOSED TOTAL DEPTH _____ (m)

PROPOSED BLAST DETAILS:

EXPLOSIVE TYPE _____

EXPLOSIVE SIZE _____ mm by _____ mm

APPROX. NUMBER OF CARTRIDGES _____

APPROX. TOTAL WEIGHT _____ (kg)

PROPOSED NUMBER OF DELAYS _____

DELAY TYPE AND LENGTH _____ (ms)

INITIATION DEVICE: (CIRCLE) E.B. CAPS SAFETY FUSE OTHER (SPECIFY) _____

BLASTING MACHINE: TYPE _____ CAPACITY _____

APPROX. VOLUME OF ROCK TO BE BLASTED _____ (m³)**PROPOSED BLAST SKETCH:****SHOW THE FOLLOWING:**

SCALE

PLAN VIEW

CROSS-SECTION

ROCK GEOMETRY

APPROX. HOLE LOCATIONS

APPROX. HOLE DEPTH

PROPOSED TIE-IN PATTERN

ROW BY ROW DELAYS

DETONATION DIRECTION

HIGHWAY LOCATION

UTILITY LOCATION

NORTH ARROW

PLAN VIEW:

CROSS-SECTION VIEW:

BLASTING CONSULTANT NAME _____ SIGNATURE _____ COMPANY _____

BLASTER'S SIGNATURE _____ COMPANY _____

RECEIVED BY QUALITY MANAGER (SIGNATURE) _____

(Use Additional Sheets if Necessary)

AS-BUILT BLASTING RECORD

File #: _____

PROJECT NO. _____

(TO BE SUBMITTED NOT MORE THAN 1 DAY AFTER EACH BLAST)

GENERAL:

CONTRACTOR'S NAME _____
 BLASTER'S NAME _____
 BLASTER'S CERTIFICATE NUMBER _____

DATE PREPARED _____
 ACTUAL BLAST DATE _____
 BLAST # _____

HIGHWAY# _____

BLAST LOCATION AT: _____

UTILITY PROTECTION OR STANDBY USED: (CIRCLE) YES NO TYPE OF UTILITY PROTECTION _____

SITE DETAILS:

HEIGHT ABOVE HWY _____ (m) SLOPE ANGLE _____ (°) SLOPE LENGTH _____ (m)

ROCK TYPE _____

DISTANCE TO NEAREST STRUCTURE (UTILITY) _____ (m)

DRILLING DETAILS:

NUMBER OF BACKLINE HOLES _____

AVERAGE DEPTH _____ (m)

NUMBER OF ROWS _____

MAXIMUM DEPTH _____ (m)

TOTAL DEPTH _____ (m)

TOTAL NUMBER OF HOLES _____

HOLE DIAMETER _____ (mm)

HOLE SPACING _____ (m) BURDEN _____ (m)

HOLE INCLINATION: (CIRCLE) VERTICAL HORIZ. VARIABLE

BLAST DETAILS:

EXPLOSIVE TYPE _____

EXPLOSIVE SIZE _____ mm by _____ mm

TOTAL NUMBER OF CARTRIDGES _____

TOTAL WEIGHT _____ (kg)

TOTAL NUMBER OF DELAYS _____

DELAY TYPE AND LENGTH _____ (ms)

INITIATION DEVICE: (CIRCLE) E.B. CAPS SAFETY FUSE OTHER (SPECIFY) _____

BLASTING MACHINE: TYPE _____ CAPACITY _____

VOLUME OF ROCK BLASTED _____ (m³)**BLAST SKETCH:****SHOW THE FOLLOWING:**

SCALE

PLAN VIEW

CROSS-SECTION

ROCK GEOMETRY

HOLE LOCATIONS

HOLE DEPTH

TIE-IN PATTERN

ROW BY ROW DELAYS

DETONATION DIRECTION

HIGHWAY LOCATION

UTILITY LOCATION

NORTH ARROW

PLAN VIEW:

CROSS-SECTION VIEW:

BLASTER'S SIGNATURE _____ COMPANY _____

RECEIVED BY QUALITY MANAGER (SIGNATURE) _____

(Use Additional Sheets if Necessary)

SECTION 205

RIPRAP

205.01 General - This Section covers the protection by riprap of embankments and channels at the locations and of the type and class shown on the Design or required by the Contract.

Work within any watercourse shall generally be carried out in conformity with the environmental protection provisions to the satisfaction of the Designer, the Quality Manager, and the Ministry Representative.

205.02 Material - Rock shall be hard durable angular quarry rock of a quality that will not disintegrate on exposure to water or the atmosphere. The gradation of rock sizes (mass in kg) in each class of riprap, as specified or directed, shall conform to Table 205-A.

Rocks generally shall be evenly graded, approximately the stipulated sizes, and individual rocks shall have a thickness greater than one-third their length and none shall have a mass greater than five times that of the specified class mass.

For visual comprehension only, Table 205-B indicates the approximate average dimension of an angular rock for each specified rock class mass.

205.03 Preparation - Areas to receive riprap shall be trimmed to a uniform surface and to the slope(s) indicated on the Design or as directed by the Designer.

Before rock placement commences, loose material shall be removed and minor pot-holes and hollows filled with selected materials well tamped-in to the approval of the Designer and the Quality Manager.

205.04 Foundations - To provide a stable foundation and protection against any undercutting, the riprap shall be thickened at the toe, laid horizontally to form an apron and/or keyed into the bed of the watercourse, all as indicated on the Design or as directed by the Designer.

205.05 Filter Blankets - Filter blanket material and placement, where required, shall be as specified in the Design or as

directed by the Designer.

205.06 Loose Riprap - The controlled placement of rock of the class specified shall produce a rock mass of the nominal or required thickness over the area indicated. The rock shall be manipulated as necessary to provide mass stability and a regular surface with a minimum of voids.

205.07 Hand-Laid Riprap - Hand-laid riprap, normally Class 10 or 25, shall conform to the size, gradation and requirements set out in DBSS 205.02. Individual rocks too large to handle shall be manipulated for satisfactory setting and spacing.

At the toe of sloped riprap, a sufficient number of the larger rocks shall be placed to form a firm foundation

TABLE 205-A GRADATION OF ROCK SIZES IN EACH CLASS OF RIPRAP

CLASS OF RIPRAP (kg)	*NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION: PERCENTAGE LARGER THAN GIVEN ROCK MASS (kg)		
		85%	50%	15%
10	350	1	10	30
25	450	2.5	25	75
50	550	5	50	150
100	700	10	100	300
250	1000	25	250	750
500	1200	50	500	1500
1000	1500	100	1000	3000
2000	2000	200	2000	6000
4000	2500	400	4000	12000

* The minimum thickness of riprap, measured at right angles to the slope, for the class specified, shall be the nominal thickness stated.

TABLE 205-B APPROXIMATE AVERAGE DIMENSION OF AN ANGULAR ROCK FOR EACH SPECIFIED ROCK CLASS MASS

kg	10	25	50	100	250	500	1000	2000	4000
mm	200	300	350	450	600	800	1000	1200	1500

approximately 50% thicker than the required nominal riprap thickness. The remaining larger rocks shall be regularly spaced, at least one to every 2.5 m², when placing the general rock mass to the nominal or required thickness over the area indicated. Smaller rocks or spalls shall be well hammered in to fill the interstices and to form a closely massed regular surface.

Where riprap is required in two layers, the rocks shall be laid up and generally lap jointed between the

regularly spaced larger rocks placed as through headers.

205.08 Grouted Riprap - Where grouted riprap is shown or required, the surfaces of the rocks shall be cleaned and wetted and the interstices filled with cement mortar, well rodded and pounded in for a minimum mortar depth of 300 mm or as otherwise detailed or required by the Designer. The mortar shall consist of one part Portland cement to three parts well-graded clean fine aggregate mixed to a proper consistency.

SECTION 206

ROCK BOLTS

DESCRIPTION

206.01 Scope - This Section covers the installation, by appropriate rock bolting methods, of anchored steel bars tensioned and locked off against face plates in the areas designated by the Designer. Unless otherwise stated below, all rock bolts shall be installed and tensioned to the rock bolt manufacturer's specifications.

206.02 Codes And Standards

CAN/CSA G164.....Hot Dip Galvanizing of
Irregularly Shaped Articles.
CAN/CSA G30.18.....Billet Steel Bars for
Concrete Reinforcement
CAN/CSA G40.21.....Structural Quality Steels
CAN/CSA A23.2-9C.....Compressive Strength of
Cylindrical Concrete
Specimens.

206.03 Quality Control - The Contractor shall provide quality control and quality assurance for rock bolt operations.

206.04 Submittals - The Contractor shall supply the following to the Ministry Representative:

206.04.01 Proposed Rock Bolt System - Provide documentation as follows for the proposed rock bolt system:

- a) Rock Bolts** - Type, dimensions and manufacturer of the bar, centralizers, face plate, washer (where applicable), and nut.
- b) Resin** - Published specifications showing name of material, manufacturer, graph of unconfined compressive strength development versus time, gel time, viscosity, shelf life, storage and handling requirements.
- c) Grout** - Published specifications showing name of material, manufacturer, 7 and 28 day unconfined compressive strength, composition, shelf life, storage and handling requirements.
- d) Data Sheets** - Upon request by the Ministry Representative, supply the manufacturer's product data sheets.
- e) Properties of Steel** - Upon request by the Ministry Representative, supply the physical and chemical properties for each lot or heat number of the steel.
- f) Test Results** - Upon request by the Ministry Representative, submit a certified statement from an

independent testing laboratory of the physical dimensions and mechanical properties of the rock bolt bar proposed for use. This statement shall include:

- Minimum cross-sectional area of the threaded portion of the bar.
- Minimum cross-sectional area of the unthreaded portion of the bar.
- Yield strength of the bar.
- Ultimate tensile strength of the bar.
- Percent elongation of the bar at yield and ultimate strength.

g) Quick Setting Mortar - Name of material, manufacturer, 7 and 28 day unconfined compressive strength, and composition.

h) Sealing - Proposed method of sealing fractures and voids in drill holes to prevent loss of grout.

206.04.02 Calibration Certificates - Provide tensioning jack calibration certificates before commencing rock bolt installation. Calibration of jacks shall have been performed by an authorized testing agency not more than 30 days prior to rock bolt testing. The certificate shall show the relationship between gauge pressure and applied load. Pumps and jacks shall be paired for calibration.

206.04.03 Contractor's Rock Bolt Records - Provide daily rock bolt tensioning records within one day of each day's rock bolt operations. Records shall include contractor name, date of tensioning, weather, temperature, test jack identification number, pump identification number, name of person who tested the rock bolt, rock bolt location, rock bolt number, rock bolt length, resin or grout details, test start time, test end time, gauge reading for each minute of the creep test, and lock off load. For resin systems, records shall also include the start and end times of spinning the bar through the resin in the hole.

MATERIALS

206.11 Materials - Steel materials shall be hot-dip galvanized to CSA G164. All resin, grout and steel materials shall be the products of established manufacturers regularly engaged in the manufacture of rock bolt materials for at least five years. Materials shall meet the following additional requirements:

a) Rock Bolt Bars

- Steel hot-rolled Grade 517 MPa meeting CAN/CSA G30.18.
- Nominal bar diameter 22 mm unless otherwise

specified.

- Threadlike surface deformations for full length of bar and suitable for mechanical coupling.
- Cut-thread reinforcing bar not permitted.

b) Miscellaneous Hardware

- Steel hardware to be compatible in size and strength with rock bolt bars.
- Face plates to be square in plan and dome shaped in cross-section.
- Face plate size to be matched to bar size.
- Face plates to CAN/CSA G40.21 Grade 300W.
- Face plate dimensions 10 mm by 150 mm by 150 mm unless otherwise specified.
- Face plates date stamped after galvanizing on the side visible when installed with the current year (in the format YYYY) in numbers 10 mm high.
- Face plates slotted for grout tube if grout is used.

c) Resin

- Fast-set and slow-set resin in cartridge form.
- A minimum unconfined compressive strength when fully mixed and cured of 90 MPa, tested in accordance with CAN/CSA A23.2-9C.
- Encased in a plastic film that provides optimum resistance to moisture, and is easily ruptured to enable complete mixing during installation.
- Suitable thixotropic and viscous properties to permit adequate mixing of the resin components by rotation of the rock bolt bar and to contain the resin within the drill hole.
- Easily identifiable gel time and as recommended by the resin manufacturer.
- Reach 80% of its ultimate strength within a time interval equal to five times the gel time.
- Non-shrink after the gel time.
- Unaffected by mild acids or mild alkalis.
- Cartridge boxes labelled with the resin expiry date.

d) Grout

- Pre-mixed, unsanded, non-metallic, and non-shrink cementitious grout containing silica fume.
- Can be mixed to a flowable consistency, typically with a water to cement ratio of 0.35 or as specified by the grout manufacturer to achieve or exceed the required strength.
- Minimum 7 day compressive strength of 30 MPa and a minimum 28 day compressive strength of 40 MPa, tested in accordance with CAN/CSA A23.2-9C.
- Admixtures to be used according to the manufacturer's specifications and as authorized by

the Ministry Representative.

- Calcium chloride accelerator is not permitted.

e) Mortar Pads

- Portland cement based.
- Quick setting.

CONSTRUCTION

206.31 Execution

206.31.01 General - The entire rock bolt system shall be stored under cover away from deleterious materials. All grease and other deleterious material shall be removed from the steel prior to rock bolt installation.

206.31.02 Site Preparation - Where rock bolts may be adversely impacted, rock removal above and around proposed rock bolt locations shall be completed before installation of rock bolts commences. Any minor rock scaling performed in conjunction with rock bolting shall be considered incidental to rock bolting.

206.31.03 Drill Holes

a) Location, Orientation and Depth - The location, direction, angle and depth of the holes will be dependent on field conditions. Prior to construction, the location, direction and depth shall be detailed by the Designer and the information provided to the Ministry Representative.

b) Hole Diameter - The diameter of the holes shall be suitable for the rock bolt system chosen. Where grout is used, the hole size shall be according to the rock bolt manufacturer's recommendations. Where resin is used, the hole size shall be according to the resin manufacturer's recommendations.

206.31.04 Cleaning - All water, grease, oil, cuttings and other deleterious materials shall be removed from finished holes by a water and/or air jet as required.

206.31.05 Sealing The Contractor shall take measures to seal fractures and voids in drill holes where necessary to prevent anchor grout loss.

206.31.06 Installation

a) General - Rock bolts shall be inserted (or rotated) into the drill holes and fully encapsulated in resin or grout to the drill hole collar. When resin is used, the bolt shall be advanced and rotated at a rate recommended by the resin manufacturer.

b) Anchorage Length - The anchorage length or bond zone shall be the last 1000 mm of the inserted end of the bar, unless otherwise specified.

c) Centralizers - If grout is used, centralizers on 3.0 m centres shall centralize the rock bolt in the drill hole before grout is placed. Centralizers shall be suitable for holes in rock and shall be specifically manufactured for rock bolt application.

d) Resin - Resin cartridges shall be installed as follows or as specified by the resin manufacturer:

- **Fast-Set Resin** - A sufficient number of fast-setting cartridges shall be placed in the bond zone at the bottom of the hole for the anchorage.
- **Slow -Set Resin** - A sufficient number of slow-setting cartridges shall be placed in the free stressing length between the bond zone and the collar of the hole.

e) Grout - Grout shall be prepared and placed as follows unless otherwise specified by the grout manufacturer:

- **Mixing** - Grout shall be mixed in a colloidal or high shear grout mixer according to the grout manufacturer's published instructions. Mixing paddles shall be slotted and perforated. Mixing time shall be not less than two minutes.
- **Batching** - All ingredients for the grout mix shall be batched by mass. Water shall be added to the drum first and dry ingredients afterwards. Grout shall not be re-tempered after initial mixing. Grout shall be placed immediately after mixing.
- **Grout Placement** - Grout shall be pumped using a grout tube extending to the bottom of the hole. The inserted end of the tube shall remain below the level of the grout in the hole to effect a continuous air free column as the grout level rises. Grout shall be placed quickly and continuously to avoid overworking, segregation, bleeding and disturbance of initial set. Grout that has stiffened due to delay in placing shall not be used in the work and shall be disposed of at an authorized location.

f) Resin and Grout - At the Contractor's option, both resin and grout may be used to surround a rock bolt as follows. Resin cartridges may be placed in the bond zone, and grout may be used in the free-stressing length.

g) Rock Face Preparation - The bearing surface shall be prepared to allow the face plate to be oriented within the limits recommended by the anchor manufacturer. If necessary, rock shall be chipped from around the face plate contact area.

h) Mortar Pad Construction - Mortar pads shall be constructed as required to ensure the bar is within 20° of a line perpendicular to the face plate. Mortar pads shall be installed where face plates deform excessively under load. The pad shall not crack or deform when loaded. Sufficient time shall be provided to allow pads to achieve sufficient bearing capacity prior to test-tensioning.

i) End Hardware Installation

- Nuts shall bear uniformly against the faceplate.
- The bolt extension beyond the nut shall be 100 mm ± 10 mm.

206.31.07 Tensioning - All rock bolts shall be test-tensioned and locked off following set-up (or curing) of the bond zone and before set-up of the free stressing length. Prior to testing, the bond zone grout and/or resin shall meet the strength specified by the anchor manufacturer. The following procedure applies to 22 mm diameter Grade 517 MPa steel bars. An alternative procedure may be specified for different bar sizes.

a) Equipment - Equipment required for tensioning shall be supplied by the Contractor and shall be of a size adequate to provide the required tension. A torque wrench shall not be used for tensioning.

b) Test-Tensioning and Creep Test - Rock bolts shall be test-tensioned to 186 kN (42,000 lb). The test load shall be held for 10 minutes for the creep test.

c) Lock-Off Tension - Rock bolts shall be locked-off to a design tension of 140 kN (31,500 lb) after testing.

d) Acceptance Criteria - During the creep test a load loss of greater than 10% of the load applied shall be indicative of anchorage failure. Creep movement at the anchor head shall not exceed 2 mm during the creep test. A replacement rock bolt shall be installed at the Contractor's expense where these criteria are not met.

206.31.08 Rock Bolt Evaluation - The Contractor shall implement a program of evaluation of rock bolts installed. The Contractor shall perform the following test procedure on randomly selected bolts. After locking off the anchor, the load shall be re-applied to determine the lift-off load. The lift-off load shall be the tension level at which the

anchor nut can be loosened by hand. Lift-off tests shall be performed on rock bolts chosen by the Designer to a minimum of 5% of the total number of rock bolts. One additional lift-off test on a different bolt shall be performed for each bolt whose lift-off load is not within 10% of the specified lock-off load. Following lift-off testing, all bolts shall be locked off as specified.

The Contractor shall also perform the above evaluation on additional bolts identified by the Ministry Representative, as part of the Ministry's audit program, on up to 2% of the rock bolts installed

File # _____

PROJECT NO.

(TO BE SUBMITTED WITHIN 1 DAY AFTER EACH DAY'S ROCK BOLTING OPERATION)

Contractor Name _____

Bolt Type _____ Size _____

Resin/Grout Type _____ Anchorage Length _____ m

Test Jack Number(s) _____

Sample calculation for this grout:

Weight of each bag of grout (M) _____ kg

Volume of water added for each bag (V) _____ L

Actual Water / Cement Ratio (V/M) _____

Date _____

Weather _____

Temperature _____ °C

[illegible]

Certified Correct: _____
(Contractor's Superintendent)

SECTION 207

SLOPE MESH FOR ROCK CUTS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

DESCRIPTION

207.01 Scope - This Section applies to slope mesh structures which are installed to provide rockfall protection.

207.01.01 Rock slope scaling and tree removal shall be performed in conjunction with slope mesh installation. Rock slope scaling and tree removal shall be completed before the mesh support system is installed. The Designer shall detail trees to be removed.

207.01.02 Discarded mesh components, scaled rock, trees and debris generated by the slope meshing work shall be removed from the ditches and disposed of by the Contractor. Temporary storage of felled trees in ditches will not be permitted.

207.01.03 The contractor shall layout in the field all anchor and suspension cable locations for each section.

207.01.04 Field conditions may require final anchor, cable and mesh configurations to vary from the Design. All variations must be detailed by the Designer and provided to the Ministry Representative for information.

207.01.05 The area to be provided with slope mesh protection shall be divided into sections with a maximum width of 24 m. Each section shall have a separate suspension cable, end main anchors and end anchors. End main anchors of adjacent sections shall be positioned 200 mm apart. The gap between sections shall be closed with mesh.

207.01.06 The maximum mesh length shall be 80 m.

207.01.07 The maximum rock impact energies shall be as follows:

- 3 kJ above cut crest
- 30 kJ below cut crest

207.01.08 Overburden thickness may range from zero to over 1.5 m.

MATERIALS

207.11 Slope Meshing Materials - Unless otherwise

specified, preparation and installation of materials shall be according to manufacturer's recommendations.

All components shall be hot-dip galvanized conforming to ASTM A 123 or ASTM A 153 or CSA G164 where appropriate. Damaged galvanizing shall be re-galvanized.

207.11.01 Mesh - Mesh shall be 11 gauge (2.95 mm dia.) hexagonal triple twist gabion type mesh. Mesh wire shall meet federal specification QQ-W-461g, possess soft tensile strength with a finish 5 class 3 zinc coating of not less than 260 g/m². The weight of zinc coating shall be determined by ASTM A 90. The coating shall withstand four one minute dips by the preece test, ASTM A 239. Mesh opening shall be hexagonal in shape and uniform in size measuring 80 mm by 100 mm.

207.11.02 Threadbar - Threadbar shall conform to CSA G30.18, grade 400 steel, manufactured by Dywidag Systems Int. (DSI) or authorized equivalent.

207.11.03 Eye nuts - Eye nuts shall be cast or manufactured eye nuts by DSI or authorized equivalent.

207.11.04 Cables - All cables shall be fibre core conforming to CSA G4. Cables shall be unspliced.

207.11.05 Thimbles - Thimbles shall meet FF-T-276B Type III (extra heavy G-414).

207.11.06 Clips - Clips shall meet FF-C-450 Type 1, Class 1 (G450 Crosby clip or authorized equivalent).

207.12 Grout

207.12.01 Grout for main anchors shall be Celtite Anchortite. Grout for auxiliary anchors shall be Celtite Lokset cartridges, cement grout or authorized equivalent.

207.12.02 Cement grout shall be Target 1118 or Ocean Microsil anchor grout or equivalent with W/C=0.35. Grout minimum 3 day and 28 day compressive strengths shall be 20 MPa and 40 MPa respectively, tested in accordance with CSA A23.2-1B.

207.13 Conformance Documents - Prior to installation the contractor shall supply documents of conformance to project specifications of all materials upon request.

CONSTRUCTION**207.31 Anchor Installation**

207.31.01 Overburden shall be excavated to rock at anchor locations unless specified otherwise. The Contractor shall minimize disturbance of surrounding soil and rock when excavating. Cables shall not contact ground surface.

207.31.02 Anchor holes shall be a minimum of 1.5 times anchor diameter and in strong, competent rock. Anchors shall be centered in the hole and grouted. Anchors shall not be loaded within 3 days of grouting.

207.31.03 Main anchors shall be located at local high points where practicable to maximize clearance between suspension cable and ground surface. Main anchors shall be vertical and centered in the hole. Field conditions may require that the main anchor height above ground surface be reduced.

207.31.04 Auxiliary anchors shall be located to minimize potential for main anchor bending.

207.31.05 Main anchors may be substituted with a limited number of guy cables directly connected to the suspension cable where no suitable main anchor locations can be found. Guy cable anchors shall be located to maximize suspension cable elevation. See Section Y-Y, on Drawing SS SP207-02 and Detail B on Drawing SS SP207-03.

207.31.06 Auxiliary or guy anchor embedded length may require extension if weak rock conditions are encountered.

207.32 Soil Anchors - Soil anchors shall be used where required. For soil anchor details see Drawings SS SP207-04 and SS SP207-05.

Concrete requirements for soil anchors:

- minimum compressive strength at 28 days = 30 MPa
- maximum nominal size of aggregate = 28 mm
- air content = $5 \pm 1\%$
- slump = 55 ± 20 mm
- maximum w/c ratio by mass = 0.45

The contractor shall load test one overburden soil anchor to 10 kN to verify capacity.

207.33 Cable and Mesh Installation - Suspension, auxiliary, end, and guy cables shall be installed to nominal tension to remove slack before and after installing mesh.

A maximum of two horizontal mesh seams (200 mm overlap) shall be permitted along the entire mesh height. The upper mesh portion shall be between the slope and lower mesh at the overlap. The horizontal seam connections shall be similar to the vertical seams.

The mesh shall terminate 1500 mm above the highway edge of pavement elevation. The bottom of the mesh shall be evenly trimmed parallel with the highway elevation. The bottom of the mesh shall be bent to remove the curl.

SECTION 208

DRAINS FOR ROCK CUTS

DESCRIPTION

208.01 Scope - This Section covers the installation of lined drains in the designated areas to the specified depth. The exact locations of drain holes will be dependent on field conditions and will be detailed by the Designer.

MATERIALS

208.11 PVC Pipe Materials - Drain hole lining shall consist of Schedule 40 slotted PVC pipe. The outside diameter of the pipe shall not be less than 67% of the borehole diameter, and the internal diameter of the pipe shall be a minimum of 19 mm. The slots shall be along the entire length of the pipe in one row. Unless otherwise specified, the slots shall be 0.5 mm wide, spaced 6 mm apart and have a minimum length of 30% of the outside circumference of the pipe.

CONSTRUCTION

208.31 Drilling - Advancement of drilling for drain holes shall be in an upslope direction. The dip angle for drain holes shall be 5°, or as specified by the Designer. Finished holes shall be flushed with air to remove deleterious materials.

208.32 PVC Pipe Installation: PVC pipes shall be installed into the finished holes immediately after flushing. Pipes shall be coupled according to the manufacturer's specifications. The pipe shall be installed along the entire length of the holes and shall protrude 0.30 m out of the rock face. The slots shall be on top when the pipe is installed. The pipe shall be secured in the hole, using plastic or wooden wedges driven into the hole collar if necessary, so that the pipe cannot be pulled out by hand.

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SHOTCRETE FOR ROCK CUTS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

DESCRIPTION

209.01 General - Unless otherwise specified, the shotcrete standards of ACI 506.2 and the standards of good practice in ACI 506R shall apply. DBSS 211, Portland Cement Concrete, shall also apply for shotcrete, unless otherwise specified.

Shotcrete operations shall include, but not be limited to pre-construction and construction work including preparation of the mix design(s), quality control, quality assurance, surface preparation; installation of wick drains, weep holes and pipes; supply and installation of the shotcrete; preconstruction and construction testing, curing; the supply, transportation and testing of shotcrete panels; any core extraction of the in-place shotcrete, and any other testing to determine curing or protection requirements.

209.02 Quality Management

209.02.01 General - The Contractor shall provide on-site quality control and independent quality assurance for shotcrete operations.

209.02.02 Qualifications - The Contractor's QC representative shall have designed shotcrete for 3 projects over the last 5 years. The Contractor's QC representative conducting onsite shotcrete tests shall be an ACI or CSA certified concrete technician.

209.02.03 Specific Requirements - For wet and dry process shotcrete, quality control shall include, but not be limited to the following:

- Observation of surface preparation before shotcrete application.
- Observation and testing during shotcrete application.
- Observation of curing operations.

209.02.04 Other Requirements - The Contractor's QC representative shall be present at other times as are appropriate to assist the Contractor in the preparation, assessment and adjustment of the various procedures to be used for shotcrete operations.

- d) Certification of the Concrete Technician** - Provide evidence of ACI or CSA Certification for

209.02.05 Field Report - The Contractor's QC representative shall prepare a field report for each site visit, signed by the QC representative. The report shall include details of the progress of shotcrete operations, any recommendations made to the Contractor and any problems encountered by the Contractor.

209.02.05 Quality Assurance - The Contractor shall perform QA in accordance with the Contract, to assess the quality of the product, process and the effectiveness of the QC.

209.03 Submittals

209.03.01 The Contractor's Quality Management Plan shall include the following documentation;:

a) Qualifications and Experience of the Contractor - Provide a statement of the qualifications, experience and work function of all personnel assigned to shotcrete duties. A statement of previous work experience on similar projects shall also be provided. This statement shall include the project name, location, type of shotcrete, volume of shotcrete, year constructed and the owner contact name. The company, the nozzle operator and the predampener/pot operator shall each have a minimum of 5 years demonstrated experience on shotcrete work.

b) Qualifications and Experience of the Contractor's QC representative - The qualifications shall include the name of the consulting firm, and the name and qualifications of the Consultant's on-site representative who will be providing the quality control. The following information shall be included in the qualifications submitted:

- Project name, location and experience.
- Name and phone number of the owner contact who can verify the experience of the Contractor's Consultant's site representative.

c) Proposed Laboratory Testing Agency - Provide a statement of the testing agency's experience in performing laboratory tests on shotcrete. The agency shall be an independent, qualified laboratory with a proven record of performing tests on shotcrete on at least 5 previous projects. The testing agency shall be certified to CSA A283.

the concrete technician who will be providing on site shotcrete tests.

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209.03.02 The Contractor shall submit for review the following documentation at least 10 days prior to commencing shotcrete operations:

a) Materials Records - Provide records showing source and proof of conformance to project specifications of the following materials:

- Portland Cement (provide mill certificates)
- Silica Fume (provide mill certificates)
- Mix Water
- Aggregates
- Admixtures (provide supplier data sheets)
- Fibre Reinforcement (if specified), include load/deflection curves to ASTM C 1018 for the proposed mix design
- Mesh Reinforcement (if specified, provide mill certificates)

b) Previous Performance Data - Provide previous performance data for the proposed shotcrete mix design, if available.

c) Proposed Shotcrete Mix Design

(Proportions) - Provide documentation for the proposed shotcrete mix design. Include such back-up data as requested by the Ministry Representative. The proposed mix design submittal shall include:

- Mix design number.
- Batch quantities in kg/m³ based on aggregates in an SSD (Saturated Surface Dry) moisture state for wet process shotcrete and ready mix supplied dry process shotcrete. Batch quantities for dry bagged supply shall be based on mass of aggregates in a dry state.
- A total cementitious content of not less than 20% by mass of the total ingredients.
- Aggregate source, bulk density, absorption, combined gradation data and a grain size distribution graph scaled between 0.075 mm and 75 mm showing the percent passing curve for the combined aggregate.

d) Proposed Shotcrete Imprint - Provide a drawing of the proposed shotcrete imprint including content, imprinting method and materials that will be used to produce the imprint.

209.03.03 The Contractor shall submit for information the following documentation within 1 day following each day of shotcrete application:

a) Field Report - Provide original field reports signed by the Contractor's QC representative.

b) Daily Records - Provide daily shotcrete records with the following information (certified by the

Contractor's QC representative in the case of wet process shotcrete):

- Contractor Name
- Nozzleman Name
- Helper Name
- Contractor's QC Representatives Name (for wet process shotcrete)
- Date
- Weather
- Contractor's start and end time
- Shotcrete equipment type
- Temperature
- Type of shotcrete (wet or dry process)
- When is slump measured, before or after admixture and fibres

Submit the following information for each batch of shotcrete:

- Batch number
- Location of shotcrete
- Mix design number
- Batch time at plant (wet process)
- Batch arrival time on site
- Truck departure time (wet process)
- Placement start time
- Placement end time
- Quantity used
- Water/cementitious materials ratio (wet process)
- As-shot air content (wet process)
- Slump (wet process) - indicate when measurement is made (e.g.: after air entrainment is added, before superplasticizer is added and before fibre reinforcement is added)
- Percent rebound (visual estimate)
- Average thickness of shotcrete
- Test panel number
- Shotcrete delivery tickets from batch plant (wet process)
- Comments on the quality of the shotcrete and any problems that arise
- Proposed revised mix design

209.03.04 The Contractor shall submit the laboratory test results within 2 working days after testing. These test results shall compare the shotcrete performance with the requirements given in Table 209-A. Records shall include all reporting requirements outlined for construction testing. Records shall also include an original summary report of all test results, showing the sample number, sample origin, panel number, panel origin, date the panel was sprayed, panel shipping date, date panel received at the laboratory, photos of prepared test samples, test date, sample age at testing, test results for each sample, average test results of the three samples for each test at a given age, and

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acceptability of the results.

209.04 Definitions - The following definitions refer to words and terms used in this specification. For definitions not covered in this document, refer to ACI 506R and ACI 506.2.

209.04.01 Blow pipe - Air / water jet operated by nozzle operator's helper during shotcrete placement to assist in keeping rebound and overspray out of the work.

209.04.02 Dry Process Shotcrete - A process where most of the water added to the shotcrete mixture is added at the nozzle.

209.04.03 Overspray - Shotcrete material deposited away from the intended receiving surface.

209.04.04 Pot (Sometimes called Gun) - Machine used to meter the shotcrete into the hose.

209.04.05 Predampener - Device used to mix a portion of the mixing water with the shotcrete. Can also be used to mix accelerator with shotcrete.

209.04.06 Saturated Surface Dry - The state of a material in which it will neither add nor subtract moisture from other material placed in contact with it.

209.04.07 Slake - A process of deterioration of freshly exposed rock due to exposure to the atmosphere and/or water.

209.04.08 Sloughing (also called sagging) - Subsidence of shotcrete, due generally to excessive water in the mix or placing too great a thickness of

SHOTCRETE FOR ROCK CUTS

shotcrete in a single pass.

209.04.09 Weep Pipes - Plastic pipes inserted in water bearing fissures to relieve water pressure from behind the shotcrete.

209.04.10 Wet Process Shotcrete - Shotcrete in which all of the ingredients are mixed before introduction into the delivery hose. Compressed air is introduced to the material flow at the nozzle. If an accelerator is used, it is normally added at the nozzle.

MATERIALS

209.11 Materials

209.11.01 Cement - Cement shall be Type 10 or 30.

209.11.02 Silica Fume - Silica fume shall meet the requirements of CAN/CSA-A23.5-M, Supplementary Cementing Materials, Type U Silica Fume, with the following additional requirements:

- Minimum SiO₂ content - 90 percent by mass
- Maximum carbon content: 5 percent by mass

209.11.03 Pozzolan - Pozzolan shall be Type F flyash.

209.11.04 Water - Surface or ground water may be used for cleaning the slope and curing provided it is free of deleterious substances. Verification that the water intended for use is acceptable shall be made by the Designer and Quality Manager. **209.11.05**

Aggregates - Aggregate shall be normal density. The combined aggregate gradation limits shall meet the limits shown in Table 209-B.

TABLE 209-A SHOTCRETE PERFORMANCE REQUIREMENTS

TEST DESCRIPTION	TEST METHOD	AGE (DAYS)	SPECIFIED REQUIREMENT
*Maximum Water / Cementitious Materials Ratio		-	0.45
*Air Content - As Shot, %	CAN/CSA A23.2-4C	-	4 ± 1½
*Slump at discharge into shotcrete pump, mm	CAN/CSA A23.2-5C	-	80 ± 30
Minimum Compressive Strength, MPa	CAN/CSA A23.2-14C	7 28	30 40
Minimum Flexural Strength, MPa	ASTM C 1018	7	4
Minimum Toughness Performance Level (TPL)	ASTM C 1018 and this specification	7	III
Maximum Boiled Absorption, % Maximum Volume of Permeable Voids, %	ASTM C 642	7 7	8 17

Notes: * Properties apply to wet process shotcrete only.

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209.11.06 Admixtures

- a) General** - Chemical admixtures shall include air-entraining, water reducing and set retarding admixtures where appropriate.
- b) Superplasticizers** - Superplasticizers shall meet the requirements of CAN3-A266.6-M.
- c) Accelerating Admixtures in General** - Accelerating admixtures shall only be used with the written consent of the Designer
- d) Accelerating Admixture Requirements** - Accelerating admixtures:
- i) shall be non-chloride based accelerating admixtures meeting the requirements of CAN/CSA A23.1M Clause 15.1.7.1;
 - ii) shall be compatible with the cement being used when tested in accordance with ASTM C 1117;
 - iii) shall have a demonstrated ability, when used at the required proportions, to produce accelerated shotcrete meeting the performance criteria specified in Table 209-A;
 - iv) for wet process shotcrete shall be liquid, dispensed at the nozzle in closely controlled quantities;
 - v) for dry process shotcrete shall be liquid, dispensed at the nozzle in closely controlled quantities; or be powdered and either:
 - integrally mixed in the case of dry bagged material or;
 - mechanically proportioned through the predampener in the case of ready mix supply; metering of accelerators directly into the pot will not be permitted.

specified, shotcrete reinforcement shall consist of steel or polyolefin fibres. The fibres shall be capable of meeting the performance criteria specified in Table 209-A and the following requirements:

- a) Steel Fibres** - These fibres shall meet the requirements of ASTM C 1116 Type I.
- b) Polyolefin Fibres** - These fibres shall only be used in wet process shotcrete and shall meet the requirements of ASTM C 1116 Type III.

209.11.08 Mesh Reinforcement - Where specified instead of or in addition to fibre reinforcement, shotcrete shall be reinforced with mesh anchored to the surface before shotcrete application. For fibre reinforced shotcrete, additional reinforcement may be required by placing mesh panels up to 0.60 m by 0.60 m without anchors between successive shotcrete lifts where final shotcrete thicknesses are expected to exceed 300 mm in local areas.

- a) Mesh Materials** - Mesh shall consist of welded wire fabric 102 mm by 102 mm opening (4 by 4 inch) by MW13.3 / MW13.3 (8 gauge) wire meeting CSA G30.5 and hot dip galvanized meeting ASTM A 123.
- b) Mesh Anchor Materials** - Anchors shall consist of ASTM A 615 Grade 400 steel, minimum 19 mm nominal diameter. Anchorage may be resin or grout. Grout anchorage may be Ocean "Microsil Anchor Grout" or Target "Unsanded Silica Fume Grout". Resin anchorage may be Caltite Lokset or Ground Control cartridges. Face plates shall be 150 mm by 150 mm by 6 mm. Face plates, nuts and washers shall be capable of developing full anchor pullout capacity.

c) Mesh Coverage and Overlap - Mesh shall be installed over the entire area to be shotcreted, unless otherwise specified. Mesh joints shall be lapped 1.5 mesh openings in each direction (horizontally and vertically) and tied at minimum 100 mm intervals with 16 gauge tie wire to achieve full contact between mesh layers.

d) Mesh Anchor Spacing - Mesh shall be anchored on minimum 1.2 m centres in each direction or closer where required to form the mesh to within 50 mm of the slope surface. The mesh shall be in full contact with the surface where practicable. The mesh may also be anchored to any previously installed rock bolts provided the spacing is consistent with the spacing required for the above anchors.

e) Anchor Installation - Anchors shall be

TABLE 209-B COMBINED GRADATION LIMITS FOR SHOTCRETE AGGREGATE

U.S. STD SQUARE MESH	METRIC SIEVE SIZE	TOTAL PASSING EACH SIEVE SIZE, % BY MASS
3/4	20 mm	
1/2	14 mm	100
3/8	10 mm	90-100
#4	5 mm	70-85
#8	2.5 mm	50-70
#16	1.25 mm	35-55
#30	0.630 mm	20-35
#50	0.315 mm	8-20
#100	0.160 mm	2-10

209.11.07 Fibre Reinforcement - Unless otherwise

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installed as recommended by the anchor manufacturer. The minimum anchor embedment length shall be 1.0 m. Resin or grout shall be applied to full anchor embedment.

f) Mesh Anchor Testing - A total of 5% of the anchors shall be load tested to 20 kN. This load shall be held for 10 minutes. A load loss of greater than 10% of the applied load shall be indicative of anchorage failure. Any failed anchors shall be replaced.

209.11.09 Anchor Reinforcement - Where specified, additional anchor reinforcement shall be installed. Anchor materials, installation and testing shall meet the requirements for mesh anchors unless otherwise specified. Face plates for these anchors shall be "Spider Plates". These anchors and plates shall be fully embedded in the shotcrete.

209.11.10 Materials Handling and Storage

a) General - All materials shall be stored and handled in a manner that will prevent damage, deterioration or contamination.

b) Hot Weather Storage - During hot weather prebagged material shall be stored in a manner that will allow maximum cooling of the material.

c) Cold Weather Storage - During cold weather prebagged material shall be stored in a manner that will provide maximum heat retention of the material.

209.12 Performance Requirements

209.12.01 General - Shotcrete shall meet the performance requirements in Table 209-A.

209.12.02 Air Content - The air content shall be determined on wet process shotcrete sprayed into a CAN/CSA-A23.2-4C air pressure meter base or freshly applied material removed from in-place and consolidated into the air meter base by rodding.

CONSTRUCTION

209.31 Batching, Mixing and Conveyance

209.31.01 General - Shotcrete shall be batched, mixed and supplied using (one of) the following system(s):

- a)** dry bagged pre mix supply to ASTM C 928 or:
- b)** ready mix supply

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209.31.02 Mixing - Shotcrete supplied shall be uniformly mixed with no evidence of segregation or improper mixing.

209.31.03 Batching and Conveyance - Ready mix supplied shotcrete shall be batched and conveyed at a rate that allows a consistent application of shotcrete. Irregularities of conveyance that result in delays or a surplus of aged material on site shall be avoided. Shotcrete that has stiffened excessively or is more than 90 minutes old from the time of batching will not be accepted.

209.32 Preconstruction Testing

209.32.01 General - The Contractor shall perform preconstruction shotcrete tests (prior to full-scale shotcrete operations), at a shotcrete test site, to demonstrate the competence of the crew, the adequacy of the equipment and the adequacy of the shotcrete mix design. The requirement for preconstruction testing may be waived by the Ministry Representative if sufficient documentation of previous satisfactory performance on similar work is provided.

209.32.02 Previous Performance - Documentation for previous satisfactory performance shall meet the following requirements:

a) Company - The company shall have applied more than 100 m³ of shotcrete on a minimum of 3 projects in the last 5 years.

b) Nozzle Operator - The nozzle operator shall have applied more than 100 m³ of shotcrete on a minimum of 3 projects in the last 5 years.

c) Predampener/Pot Operator - The predampener/pot operator shall have mixed more than 100 m³ of shotcrete on a minimum of 3 projects in the last 5 years.

d) Contacts - The contact name and number for each project above shall be supplied upon request.

209.32.03 Application - Shotcrete applied at the shotcrete test site shall be applied in accordance with the general shotcrete provisions in these specifications.

209.32.04 Test Panel - One test panel shall be gunned and tested for the preconstruction shotcrete testing as described for construction testing.

209.32.05 Test Results - The Contractor shall not apply shotcrete outside of the shotcrete test site area until the preconstruction shotcrete test results have demonstrated that the shotcrete system employed is satisfactory and the test site information has been

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supplied to the Ministry Representative and the test site information has been signed off by the Designer.

209.32.06 Revised Methods - If the results of the shotcrete tests are unsatisfactory, the Contractor shall adopt such revised methods as are necessary to achieve the required results.

209.32.07 Additional Tests - The Contractor shall perform, at any time during the progress of the work, additional shotcrete tests at designated test sites if the shotcrete applied in the areas specified in this Contract is unsatisfactory in the opinion of the Ministry Representative.

209.33 Weather Conditions

209.33.01 Heavy Rain or High Wind - During periods of heavy rain or high wind, the Contractor shall ensure that the quality of the finished shotcrete product is not compromised. Shotcrete shall not be applied during such weather unless protective measures can be practicably taken.

209.33.02 Hot Weather - During periods of hot weather, when ambient temperatures are expected to rise over 30°C, the following requirements shall be met:

a) Curing - The Contractor shall implement curing immediately after the shotcrete has been placed.

b) Temperature at Placement - The Contractor shall take any steps necessary to ensure that the temperature of the shotcrete supplied to the site is less than 25°C at the time of placement.

209.33.03 Cold Weather - During periods of cold weather, where the minimum ambient air temperature falls below 5°C, the following requirements shall be met:

a) Temperature at Placement - The Contractor shall take whatever steps are necessary to ensure that the in-place shotcrete temperature is between 10 and 25°C at the time of placement.

b) Initial Curing Temperature - The Contractor shall ensure that, during the initial curing period (4 days), the in-place shotcrete temperature will not fall below 5°C. Shotcrete shall not be placed unless measures can be practicably taken to ensure these requirements are met.

c) Temperature at the Pot - The Contractor shall not allow the temperature of the dampened dry process shotcrete at the pot to exceed 30°C.

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d) Ice, Snow or Frozen Surfaces - Shotcrete shall not be applied to frozen surfaces, or surfaces covered with frost, ice or snow.

209.34 Surface Preparation - Surfaces to which shotcrete is applied shall be cleaned of loose rock, dirt and debris which if left in place could impair the bond of shotcrete to rock, concrete or existing shotcrete. Water or air and water jets shall be used to clean rock surfaces. Compressed air only shall be used to clean rock surfaces that have a tendency to slake from contact with water.

209.35 Drainage - Unless otherwise controlled, water seepage from slopes shall be controlled by installing weep holes, weep pipes, and wick drains. Surface runoff shall be controlled using suitable water diversion systems.

209.35.01 Weep Holes - Weep holes (and weep pipes as required) shall be installed before shotcrete is applied. These weep holes shall be on 1 to 1.5 m centres in the areas to be shotcreted in joints, fractures and faults, or at a closer spacing where required by the Designer. Holes and pipes shall be inclined to permit free drainage.

209.35.02 Weep Pipes - To prevent blockage of weep holes due to entry of shotcrete or rebound materials, weep pipes shall be secured in weep holes and temporarily plugged at the outer end of the pipe. The plugs shall be removed when shotcreting is completed. Weep pipes shall consist of 25 mm minimum outside diameter Schedule 40 plastic pipe.

209.35.03 Active Seepage Areas - Where active seepage occurs, weep holes shall be drilled approximately 150 mm or more to intercept fractures or openings wherever practicable and weep pipes shall be installed prior to the application of shotcrete. Where drilling is not practicable, the weep pipes shall be secured in the fractures by other appropriate means.

209.35.04 No Active Seepage Areas - Where no active seepage occurs, weep holes shall be installed in joints, fractures and faults by one of the following methods:

a) by securing the weep pipes by appropriate means before shotcreting;

b) by marking locations using sticks or other appropriate means before or during shotcreting and drilling at the marked locations after shotcreting. Weep holes shall be 25 mm diameter and shall be drilled to intersect the joints, fractures and faults under the shotcrete at the marked locations. Weep pipes are not required for such holes.

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209.35.05 Weep Pipe Removal or Cutting - Weep pipes shall be removed or cut level with the shotcrete surface after the shotcrete has reached initial set, within one day after application.

209.35.06 Additional Weep Holes - Additional weep holes shall be drilled after shotcreting where there are visible signs of water pressure, such as seepage and damp spots in the hardened shotcrete.

209.35.07 Wick Drains - In areas of active seepage, wick drains shall be installed before shotcreting in addition to weep holes if requested by the Designer. Wick drains shall consist of a flexible polypropylene core drain wrapped with a proven durable geotextile filter fabric. Wick drains shall be 3 mm by 100 mm size (variable length), with #120 sieve filter, 0.17 mm/s filter permeability, and 0.8 kN core grab tensile strength. They shall be able to withstand all handling, abrasion and distortion that occur during installation. Wick drains shall be secured to the surface on maximum 0.5 m centres with pneumatically driven nails, or authorized substitute fasteners. Fastener spacing shall be reduced where required to ensure wick drains are in full contact with the surface. Wick drains shall be installed and covered with shotcrete in a manner that allows gravity drainage to the toe of the slope.

209.35.08 Surface Runoff - Where the bond of shotcrete to rock may be impaired by surface water runoff, this water shall be controlled and directed away from the area to be shotcreted.

209.36 Existing Rock Bolts - Within or near areas designated for shotcrete where rock bolts were installed (not for the sole purpose of securing mesh) prior to shotcrete application, the rock bolts shall be protected or extended through the shotcrete as follows:

209.36.01 Extension of Rock Bolts - Where rock is fractured within 0.5 m of the existing rock bolts, the face plates and nuts shall be removed before shotcrete is applied. The bar shall be extended, where necessary, using a short piece of bar and a coupler. The shotcrete shall be applied up to and against the existing bar. The face plates and nuts shall then be reinstalled over the shotcrete after the shotcrete has cured. Each face plate shall be replaced to the same bar from which it was removed. The exposed bar length shall be 100 mm following reinstallation of the face plate. The bar shall be nominally tensioned (using a wrench to the nut).

209.36.02 Protection of Rock Bolts - All other rock bolts shall be protected from overspray. Where overspray was not anticipated, the affected rock bolts shall be cleaned off by appropriate means.

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209.37 Application

209.37.01 General - The Contractor shall ensure that the shotcrete operations are conducted in a satisfactory manner in accordance with these specifications.

209.37.02 Wetted Surface - Not more than one hour prior to application of shotcrete, all surfaces (except slaking ground) to be shotcreted shall be sprayed with water. Wetted surfaces shall be allowed to dry back to a saturated-surface-dry condition prior to application of shotcrete. If necessary, a blow-pipe shall be used to facilitate removal of surface water. Compressed air used in the blow pipe shall be oil-free.

209.37.03 Shotcrete Layers - Wherever possible, shotcrete shall be applied to the full thickness in a single layer, provided it does not slough or become delaminated. If multiple lifts are required, the previous shotcrete lifts shall be scraped or broomed prior to the time of set to remove any loose material, rebound, overspray, laitance or any other material that may impair bond of subsequent layers. Previous lifts shall be prevented from drying out by moist curing. Construction joints shall be to a 45° edge.

209.37.04 Rebound and Overspray - A blow pipe shall be used during the course of the work to remove accumulations of rebound and overspray from areas to be shotcreted. Rebound and overspray shall not be incorporated in the completed work.

209.37.05 Thickness and Area Covered - In general, an average thickness of 100 mm of shotcrete shall be applied over fractures, joints and faults in the areas designated for shotcrete, unless the Designer requires a greater thickness to ensure performance.. In general, shotcrete shall cover laterally to a maximum of 0.50 m beyond fractures, joints and faults over solid rock or concrete areas.

209.37.06 Access - Suitable devices shall be employed to allow access to the work for shotcreting. Access shall be such that fresh shotcrete is not damaged by hoses, equipment or personnel.

209.37.07 Surface Finish - The shotcrete surface shall be left in a natural gun state unless otherwise specified.

209.37.08 Embedments - A cover of 50 mm of shotcrete shall be applied over any reinforcing steel or other embedments. If greater total thicknesses of shotcrete are applied to encapsulate the embedments this work shall be performed at no cost to the Ministry.

209.37.09 Imprint - The plastic shotcrete surface shall be neatly imprinted with capitalized lettering 75 mm high with the following information:

- MoT
- (the shotcrete completion date, in the format MMM, YYYY)
- (the name of the Contractor)

The imprint shall be located in a small area in the bottom right corner of each continuous shotcrete area. Where practicable, the information shall be readable unaided from highway level following shotcrete curing. Imprints produced by scraping letters into the plastic shotcrete will not be acceptable.

209.38 Curing and Protection

209.38.01 Curing Compounds - Membrane curing compounds shall not be used

209.38.02 Moist Curing - The surface of the shotcrete shall be maintained in a moist condition for a minimum period of 4 days following shotcrete application or until an in-place compressive strength of 20 MPa has been reached. Wet burlap and polyethylene sheet or water sprays shall be used to provide moist curing.

209.38.03 Protection from Freezing - The shotcrete shall be protected from freezing for a minimum period of 7 days after placing or until an in-place compressive strength of 20 MPa has been reached, whichever occurs first.

209.38.04 Sampling and Testing - If compressive strength samples are used to determine curing or protection requirements, the cost for obtaining the samples, shipping the samples and performing the tests shall be the responsibility of the Contractor. Extraction of cores shall be in accordance with CAN/CSA A23.2-14C. Compressive strength testing shall be performed according to requirements for construction testing.

209.39 Construction Testing

209.39.01 On-Site Tests - For wet process shotcrete, the following on-site tests shall be conducted for each truck:

- As-placed air content.
- Slump at discharge into pump.

209.39.02 Thickness Monitoring - The Contractor shall monitor the thickness of shotcrete applied using depth gauges or probes. Thickness shall be measured on 1.0 m centres or closer as required to provide thickness control.

209.39.03 Test Panels in General - The Contractor shall produce test panels in accordance with the requirements of ASTM C 1140, but panels shall have minimum base dimensions of 500 mm x 500 mm and a

minimum depth of 125 mm. The form base shall be made from 19 mm thick sealed plywood, and side pieces shall be made from two by six timbers. The test panel molds shall have 45° sloped sides to permit escape of rebound.

209.39.04 Test Panel Frequency - One construction test panel shall be cast at the start of each day of shotcrete placement and another after each 50 m³ of shotcrete being placed that day,.

209.39.05 Test Panel Gunning and Marking - Test panels shall be gunned using the same nozzle and length of hose as the production shotcrete. The test panels shall be gunned at the location of the in-situ shotcrete. Construction test panels shall contain no reinforcement or embedments (other than fibre reinforcement). For each test panel the Contractor shall provide a record of the test panel number, date cast, date shipped and date received by the laboratory.

209.39.06 Test Panel Curing and Transportation - Test panels shall be field cured, in the forms, in the same manner as the specified shotcrete work, for a minimum period of 48 hours, prior to transport to the test laboratory. Panels shall be covered with wet burlap and plastic sheet to prevent drying. In cold weather, panels shall be protected from temperatures below 5°C by covering with thermal insulation blankets or by placing panels in a suitably heated enclosure. Test panels shall be transported in their forms and kept moist, with care being taken not to crack or damage the shotcrete.

209.39.07 Test Panels in Laboratory - The test panels shall be placed in a moist room in the laboratory, maintained at a temperature of 23 ± 2°C and relative humidity of 98 ± 2%. After age 3 days the test panels shall be removed from the forms and returned to the moist room until the time of testing.

209.39.08 Test Specimen Extraction and Storing - At specified test ages, test specimens shall be extracted from the panels using either diamond sawing or coring. Test specimens shall be maintained in a moist state in the moist room in the laboratory or in a lime-saturated water bath maintained at 23 ± 2°C until the time of testing.

209.39.09 Compressive Strength Test Specimens - Compressive strength test specimens shall preferably be 75 mm diameter cores. Length/diameter ratios shall not exceed 2:1 and shall not be less than 1:1.

209.39.10 Compressive Strength Testing - For each panel, three specimens shall be tested for compressive strength at each specified age. Compressive strength tests shall be conducted in accordance with CSA/CAN-

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A23.2-14C. Measured compressive strengths shall be corrected to equivalent 2:1 length:diameter cores, using the core correction factors given in CSA/CAN-A23.2-14C (Table 1). Reporting of results shall be according to Section 5 (Reporting) in CSA/CAN-A23.2-14C.

209.39.11 Flexural Strength and Toughness Test

Specimens - Flexural strength test specimens shall have dimensions of 100 mm x 100 mm x 350 mm. Reporting of results shall be according to "11. Report" in ASTM C 1018 and shall include all load - deflection graphs.

209.39.12 Flexural Strength and Toughness Testing

- For each panel, three specimens shall be tested for flexural strength and toughness at the specified age. Flexural strength and toughness tests shall be conducted in accordance with ASTM C 1018 with the following additional requirements:

a) Measuring System - A "Japanese Yoke" or other measuring system that precludes any extraneous deflection measurements shall be used. An automatic data acquisition system or equivalent shall also be used during the tests.

b) Accuracy of Measurement - The accuracy of the first crack deflection shall be verified by comparing the measured value with the theoretically calculated value by using the formula:

$$\delta = \frac{23 PL^3}{1296 EI} \times \left[1 + \frac{216 H^2 (1 + \mu)}{115 L^2} \right]$$

Where:

δ = mid-span deflection in mm
 P = load at first crack in kN
 L = load span in mm
 E = modulus of elasticity (for convenience usually based on an estimated compression modulus of elasticity) in GPa
 I = moment of inertia in mm⁴
 H = height of specimen in mm
 μ = Poisson's Ratio (for convenience usually based on an assumed compression Poisson's Ratio of 0.2)

For a 100x100x350 mm beam tested on a 300 mm span the first crack deflection for typical fibre reinforced shotcrete will have first crack deflection in the range of about 0.03 to 0.05 mm. Extraneous deflections have been eliminated if first crack deflections are within this range.

c) Recording of Deflections - An LVDT

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connected to an x-y plotter or digital recording shall be used to capture load vs. deflection response. Dial gauges shall not be used for recording deflections. Bending Load shall be plotted against Net Midspan Deflection.

d) Testing Machine - A deflection-control testing machine shall be used, but shall not be of the closed-loop or soft testing type.

e) Total Deflection - Deflection measurements shall continue until a total deflection of 2 mm is reached.

209.39.13 Toughness Performance Level Data

Analysis - Toughness Performance Level of flexural strength specimens shall be obtained by the following analysis:

a) Template - A template shall be created using the percent of design flexural strength shown in Table 209-C, but expressed in load equivalent units. The following formula shall be used:

$$P_d = \frac{\sigma \times B \times H^2}{L} \times \frac{1}{1000}$$

to determine load equivalent units, where:

P_d = design flexural load in kN
 σ = design flexural strength in MPa
 B = beam width in mm
 H = beam depth in mm
 L = load span in mm

TABLE 209-C TOUGHNESS PERFORMANCE LEVEL

TOUGHNESS PERFORMANCE LEVEL	RESIDUAL FLEXURAL STRENGTH BY % OF DESIGN FLEXURAL STRENGTH	
	1/600 Span (0.5 mm)	1/150 Span (2.0 mm)
III	50%	30%

b) Master Template - A master template shall be produced to the same scale as the load vs. deflection data recorded from the toughness test. The master template shall be superimposed over the actual load deflection curves and compared with the recorded data.

c) Acceptability Criterion - To conform to a given Toughness Performance Level the recorded data shall meet the specified flexural strength and fall above the line representing the given

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Toughness Performance Level at both the 0.5 mm and 2 mm net midspan deflection.

209.39.14 Boiled Absorption and Permeable Voids

Test Specimens - Specimens for boiled absorption and permeable voids testing shall be 75 mm cubes cut from the broken ends of flexural test prisms, or extracted 75 mm diameter cores at least 100 mm long.

209.39.15 Boiled Absorption and Permeable Voids

Testing - For each panel, three specimens shall be tested for boiled absorption and permeable voids at the specified age. Boiled absorption and permeable voids tests shall be conducted in accordance with ASTM C 642. The report of results shall include all information recorded for 6.1 Calculation in ASTM C 642.

209.39.16 Laboratory Test Results - For each type of test, test results shall be considered acceptable if the average of three (3) specimens tested at a given age meets or exceeds the criteria specified in Table 209-A. The test results for an individual specimen shall not be less than 80% of the criteria specified for compressive strength, and not more than 120% of the criteria specified for boiled absorption and permeable voids.

209.40 Shotcrete Deficiencies and Repair

209.40.01 General - The Contractor shall, whenever possible, correct deficiencies while the shotcrete is still plastic. For any proposed changes to the initial mix design, a solid volume calculation shall be performed and submitted upon request. The calculation shall include the mass, density and volume of each constituent material, the total yield, and a comparison between measured (ASTM C 138) and the calculated plastic density.

209.40.02 Deficiency Types - Shotcrete deficiencies other than failure to meet the performance requirements include, but are not limited to, the following:

a) Improper consolidation of the shotcrete because of incorrect spraying angles or improper distance of the nozzle from the receiving surface.

b) Improper control and removal of overspray and rebound material.

c) Excessive shotcrete or fibre rebound.

d) Any evidence of excessive plastic or drying shrinkage cracking.

e) Segregation, incorporation of sand lenses, excessive voids, tears, sags, sloughs or delaminations in the work.

f) Inadequate thickness.

209.40.03 Shotcrete Repair - Shotcrete with deficiencies as defined above shall be removed and replaced to these specifications.

209.41 Shotcrete Evaluation – The Designer and Quality Manager will evaluate and report on the quality of the in place shotcrete. The Ministry Representative will audit in-place shotcrete.

209.41.01 Core Extraction - Cores shall be extracted from the in-place shotcrete in accordance with CAN/CSA A23.2-14C, at locations detailed by the Quality Manager, and tested for compliance to the project specifications. Six (6) cores shall be extracted from every 200 m² of shotcreted surface.

Up to an additional 2 cores per 200 m², from locations chosen by the Ministry Representative, shall be extracted by the Contractor for the Ministry's quality audit program.

209.41.02 Non-Destructive Testing - The shotcrete will be checked for delaminations, voids or other deficiencies using appropriate non-destructive testing procedures.

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DAILY SHOTCRETE RECORD

File #: _____

PROJECT NAME _____

PROJECT NO. _____

(TO BE SUBMITTED WITHIN 1 DAY AFTER EACH DAY'S OPERATION)

Contractor Name _____ Date _____

Nozzleman Name _____ Weather _____

Helper Name _____ Temperature _____ °C

Contractor's Start _____ End _____ Time

Contractor's QC Representative _____ Shotcrete Equipment Type _____

Shotcrete Type: (circle) WET DRY Process

For wet process, when is slump measured (circle) BEFORE AFTER Air entrainment added

BEFORE AFTER Superplasticizer added

BEFORE AFTER Fibre Reinforcement added

On-Site Details and Tests for Shotcrete:

Batch #	Location		Mix Design #	Batch Times:			Spray Start Time	Spray End Time	Quantity Used m ³	Water/Cement Ratio	Sample (As-Shot) Air Content	Slump (wet mix) (mm)	Re-bound est. (%)	Average Thickness of In-Place Shotcrete (mm)	Test Panel No.
	Zone	Area		From Plant	On Site From	To									

Comments: _____

Certified Correct: _____

(Contractor's QC Representative) (Title)

(Use Additional Sheets if Necessary)

SECTION 211

PORTLAND CEMENT CONCRETE

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

211.01 General. This Section describes the requirements for Portland Cement Concrete. Requirements include quality control and quality assurance, constituent

TABLE 211-A APPLICABLE STANDARDS

CAN/CSA -A23.1	Concrete materials and methods of concrete construction
CAN/CSA -A23.2	Methods of test and standard practices for concrete
CAN/CSA -A3000	Cementitious Materials Compendium
CAN/CSA -S269.3	Concrete Formwork
CAN/CSA -A283	Qualification Code for Concrete Testing Laboratories

211.03 Concrete Mix Designs and Submission Requirements.

211.03.01 General. The Contractor shall be responsible for quality control and quality assurance of all components of the concrete operation, including but not limited to, aggregate and component quality, proportioning, test batching, batching, mixing, transporting, placing, consolidating, finishing, curing, and all necessary quality control, quality assurance and verification testing of the components and the fresh and hardened concrete.

211.03.02 Proportioning. The Designer shall be responsible for proportioning and designing all concrete in full compliance with the stated mix specifications. All mix designs shall use the “Absolute-Volume Method” for mix proportioning.

211.03.03 Alkali-Aggregate Reactivity (AAR) Preventative Requirements. Contrary to CSA A23.2 27A, the total alkali content (Na_2O equivalent) contributed by the Portland cement to the concrete mix shall not exceed 2.0 kg/m^3 . The Ministry Representative reserves the right to alter this limit or to redefine the concrete mix design parameters based on the review of the mix design submittal.

211.03.04 Mix Design Submittals. The Designer shall

BC - MOT

materials, mix design proportioning, sampling and testing of the materials and concrete, batching, mixing, transporting, placement, finishing and curing. The Contractor shall supply all necessary materials.

211.02 Applicable Standards. The standards listed in Table 211-A shall apply unless specified otherwise herein. All referenced standards shall be to the current editions at time of Award.

submit a report outlining the proposed mix design for each classification of concrete to the Ministry Representative for review at least 2 weeks in advance of when concrete production is scheduled to commence. Review of the mix design by the Ministry does not constitute acceptance of the concrete. Acceptance of the concrete will be based on the test results and the performance and quality of the concrete and concrete components placed on the project. No concrete shall be placed prior to receiving Ministry review comments of the mix design. Each mix design submittal shall include all of the following:

Project Specifics

- Name and location of the proposed supplier.
- Distance and expected travel time from batch plant location to Site.
- Expected method of batching, transporting and placing concrete.
- Specified mix parameter requirements.
- Name and contact information of certified quality control testing laboratory and certified testing personnel. Certification shall be in accordance with the requirements of CSA A23.1.
- Name and contact information of certified quality assurance testing laboratory and certified testing personnel. Certification shall be in accordance with the requirements of CSA A23.1.

Materials

All materials shall comply with the requirements as listed in DBSS 211.04.

- Cementitious Materials – Types and source of each material including mill test reports and manufacturer’s certificates of compliance.
- Aggregates – Type and source of all individual aggregate products including individual gradations and all other aggregate quality testing as described in Table 211-D for each product and each aggregate source.
- Admixtures – Type and source of all admixtures,

including expected dosage rates, point of addition to the mix, compatibility documentation, and individual technical data sheets.

- Water – The source of mixing water. (depending on the source, the Ministry Representative may request additional test documentation).
- Miscellaneous – Documentation for all other materials proposed for the mix, showing conformance with applicable Ministry requirements and manufacturer/industry guidelines and standards.

Proportioning

- The concrete proportions expressed in terms of quantity of each component.
- Fresh and hardened concrete properties.
- The mass of materials in kilograms (kg) and the absolute volume in cubic metre (m^3) contributed by each material in the mixture.
- The quantity of each individual cementitious material added in a powder state shall be expressed as kilograms per cubic metre (kg/m^3).
- Pozzolans that are added in slurry shall have their respective solid and water contents expressed as kilograms per cubic metre (kg/m^3).
- The quantity of each separately batched size of coarse aggregate and fine aggregate shall be expressed as kilograms per cubic metre in a saturated-surface-dry (SSD) condition.
- The quantity of water shall be the maximum amount allowed based on the maximum specified water-to-cementitious material ratio (W/C_m), corrected to account for any additional water that may be contributed by other materials used in the proposed mix.
- The quantity of water shall be expressed as kilograms (or Litres) per cubic metre. If ice is used for temperature control, it shall be expressed in incremental units (sacks, bags, or pails, etc.) and kilograms per cubic metre and shall be included in the maximum allowable water quantity.
- Admixtures dispensed as liquids shall be expressed as Litres per cubic metre and where applicable, expected dosage range stated.
- The quantity of any pre-measured, pre-packaged additives, such as fibres, shall be expressed in incremental units (sacks, bags, or pails, etc.) and kilograms per cubic metre.
- The absolute volume of each material, air content and the total sum of the absolute volumes of all materials shall be provided in cubic metres (m^3).

- Slump, unit weight, air content, strength characteristics, and any other specified characteristic shall be reported for each set of mixture proportions intended for use.

Incomplete submittals by the Designer may result in rejection of the mix design submittal.

211.03.05 Trial Mixes. The Contractor shall produce test batches of 4.0 m^3 volumes on all proposed bridge deck mix designs. The Contractor shall produce test batches of 4.0 m^3 volumes on other mix designs where deemed necessary by the Ministry Representative. Point of discharge sampling and testing shall be carried out by the Contractor to verify the pertinent parameters of the proposed mix design. If placement is by pump, concrete shall be sampled and fully tested at both the truck chute discharge and at the pump discharge locations. Sampling and testing shall be in accordance with DBSS 211.09, Table 211-J and Table 211-K. Test parameters include all required properties of the fresh and hardened concrete, workability and finishability of the mix, strength gain characteristics, including 7 and 28-day compressive strengths, and any other additional testing of the hardened concrete that may be required by the Ministry Representative. Batching, haul times and conveyance procedures used for the test batch must emulate the procedures expected during the actual concrete placement. The Contractor shall be fully responsible for all costs associated with the test batches. Test batch trials that do not meet the specified requirements shall be repeated.

211.03.06 Adjustments to Mix Designs. If, during the progress of the work, the mix design is found to be unsatisfactory, the Designer shall make the necessary adjustments. Adjustments shall be submitted to the Ministry Representative for review prior to subsequent concrete placement. Notwithstanding the Ministry Representative's review of the proposed mix design, it remains the Contractor's responsibility to ensure that the concrete meets all Contract and Design requirements.

211.04 Materials.

211.04.01 General. All material properties used in concrete production shall conform to CSA A23.1, unless otherwise specified in these specifications. Laboratory testing shall be carried out by a testing laboratory certified in accordance with the requirements of CSA Standard A283. Field test procedures shall be undertaken by personnel certified under an industry-recognized program.

211.04.02 Cementitious Material. The Contractor shall obtain from the supplier, a mill test report and a manufacturer's certificate of compliance representing each delivered shipment and type of cementitious material. .

211.04.02.01 Portland Cement. Unless otherwise specified, the Contractor shall use Type GU (General Use) Portland Cement in all concrete. Cement shall conform to the requirements of CSA Standard A3001, Cementitious Materials for use in Concrete.

The total alkali content [Na_2O equivalent, $(\text{Na}_2\text{O} + (0.658 \times \text{K}_2\text{O}))$] of the Type GU Portland Cement shall not exceed 0.60% by mass.

211.04.02.02 Silica Fume. Dry condensed silica fume shall conform to CSA Standard A3001 Type SF, with a SiO_2 content of at least 85%, a maximum of 10% ignition loss, and maximum SO_3 content of 1.0%. Silica Fume application rates shall be 8% maximum by mass of Portland Cement.

211.04.02.03 Fly Ash. Fly ash shall conform to CSA Standard A3001, Type F or C1, with a maximum CaO content of 8%, a maximum SO_3 content of 5%, a maximum 8.0% ignition loss for Type F and a maximum 6% ignition loss for Type C1. Fly ash application rates shall be limited to a maximum of 25% by mass of Portland Cement in substructure concrete. Fly ash shall not be used in bridge deck concrete without the acceptance of the Designer and Ministry Representative. Upon such acceptance the maximum application rate shall be 15% by mass of Portland Cement.

211.04.02.04 Blended Hydraulic Cement. Blended Hydraulic Cement shall not be used without the acceptance of the Designer and Ministry Representative.

211.04.03 Water. Water to be used for mixing concrete or mortar and for curing shall conform to the requirements of CSA Standard A23.1 and shall be free from contamination by oil, acid, alkali, organic matter, sediment or other deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources.

211.04.04 Admixtures. Admixtures shall not be incorporated into the mix design and/or added to the concrete without the acceptance of the Designer and Ministry Representative.

Unless otherwise specified, all concrete shall contain Air-Entraining Admixtures.

Air-Entraining Admixtures shall conform to ASTM C260.

Chemical admixtures shall conform to ASTM C494.

Type F High Range Water Reducer (superplasticizer) shall be used when concrete contains silica fume.

All accepted admixtures shall be compatible with all other admixtures and constituents used in the mix.

Type B, Retarding or Type D, Water-Reducing and Retarding (Hydration Stabilizing) Admixtures shall not be incorporated into the mix design and/or added to the concrete without the acceptance of the Designer and Ministry Representative. When accepted by the Designer and Ministry Representative, the guidelines given in DBSS 211.08.02 shall apply.

Calcium chloride or any admixture containing chloride ions shall not be used. If requested, a written statement from the manufacturer stating that the admixture contains no intentionally added calcium chloride shall be provided to the Quality Manager and Ministry Representative.

211.04.05 Aggregates. All aggregates are to be natural, processed or manufactured granular material composed of hard, sound and durable particles, free of adherent coatings, shale, clay, organic materials and other soft or disintegrated pieces.

211.04.05.01 Coarse Aggregate. All coarse aggregate materials shall conform to the following requirements:

- Sampling shall be according to CSA Test Method A23.2-1A.
- Gradation shall be determined in accordance with CSA Test Method A23.2-2A and 5A. (All gradations shall be based on a washed sieve analysis, see Table 211-D footnotes).
- Gradation of the coarse aggregate shall be within the limits shown in Table 211-B for the particular size range or nominal maximum size of coarse aggregate specified.

NOTE: The gradation of coarse aggregates used shall be such that the percentage passing any one sieve does not vary more than 5% from the initially approved coarse aggregates used in the mix design.

- The maximum Petrographic Number (PN) of coarse aggregate shall not exceed 125, and shall be determined in accordance with CSA A23.2 15A.
- The amount of deleterious substances in coarse aggregate shall not exceed the limits prescribed in Table 211-E.
- Other specified physical properties measuring aggregate quality referenced in Table 211-D shall not exceed the limits prescribed in Table 211-E.

Table 211-B GRADATION REQUIREMENTS FOR COURSE AGGREGATES

NMSA (1) mm	Product Size, mm	Total Passing Each Sieve, Percentage by Mass								
		56 mm	40 mm	28 mm	20 mm	14 mm	10 mm	5 mm	2.5 mm	1.25 mm
40	40-5 ⁽²⁾	100	95-100	—	35-70	—	10-30	0-5	—	—
28	28-5 ⁽²⁾	—	100	95-100	63-83	30-65	—	0-10	0-5	—
20	20-5	—	—	100	90-100	50-90	25-60	0-10	0-5	—
14	14-5	—	—	—	100	90-100	45-75	0-15	0-5	—
10	10-2.5	—	—	—	—	100	85-100	10-30	0-10	0-5

(1) NMSA – nominal maximum size of course aggregate. Definition: The standard Sieve size opening immediately smaller than the smallest through which all of the aggregate must pass.

(2) To prevent segregation, aggregates that make up the above gradings shall stockpiled and batched in two or more separate sizes as per CSA A23.1

211.04.05.02 Fine Aggregate. Fine aggregate shall conform to the following requirements:

- Sampling shall be according to CSA Test Method A23.2-1A.
- Grading shall be within the limits given in Table 211-C when tested in accordance with CSA Test Method A23.2-2A and 5A. (All gradations shall be based on a washed sieve analysis)
- Fineness modulus shall be between 2.3 and 3.1
- Fineness modulus tolerance shall be ± 0.2 (except that the above sentence shall apply) from the fineness modulus of the initially approved fine aggregate used in the design mix.
- A maximum 45% shall be retained between any two consecutive sieves.

- The amount of deleterious substances in fine aggregate shall not exceed the limits prescribed in Table 211-E.
- Other specified physical properties measuring aggregate quality referenced in Table 211-D shall not exceed the limits prescribed in Table 211-E.

211.04.06 Steel Fibres. Steel fibres shall meet the requirements of ASTM Standard A820 Type 1 Cold Drawn High Tensile Deformed Steel Fibres. A mill certificate showing compliance with ASTM Standard A820 shall accompany each delivered lot. Steel Fibres shall be Xerox 1 or Novotex or an alternate acceptable to the Ministry Representative. Concrete where steel fibres are used shall contain 50 kg of 30 mm or 50 mm length fibres per cubic metre of concrete.

TABLE 211-C GRADATION REQUIREMENTS FOR FINE AGGREGATES

SIZE mm	TOTAL CUMULATIVE PASSING EACH SIEVE, PERCENTAGE BY MASS	SIEVE SIZE mm	TOTAL CUMULATIVE PASSING EACH SIEVE, PERCENTAGE BY MASS
10	100	0.630	25-65
5	95-100	0.315	10-35
2.5	80-100	0.160	2-10
1.25	50-90		

TABLE 211-D REQUIRED AGGREGATE TESTING FOR NORMAL DENSITY COARSE AND FINE AGGREGATE (PER INDIVIDUAL PRODUCT & AGGREGATE SOURCE)

Test Method	Test Description	Test Data Validity ⁽⁵⁾
CSA A23.2-2A ⁽¹⁾ CSA A23.2-5A ⁽¹⁾	Sieve Analysis of Fine and Coarse Aggregate Amount of Material finer than 80 µm in Aggregate	Within 90 days ⁽⁶⁾ Within 90 days ⁽⁶⁾
CSA A23.2-3A	Clay Lumps in Natural Aggregate	Within 3 years
CSA A23.2-4A	Low Density Granular Material in Aggregate	Within 3 years
CSA A23.2-6A, 12A	Relative Density and Absorption of Fine and Coarse Aggregate	Within 1 year
CSA A23.2-7A	Test for Organic Impurities in Fine Aggregates for Concrete	Within 2 years
CSA A23.2-8A ⁽³⁾	Measuring Mortar-Strength Properties of Fine Aggregate	Within 2 years
CSA A23.2-9A ⁽²⁾	Soundness of Aggregate by Use of Magnesium Sulphate	Within 4 years
CSA A23.2-14A	Potential Expansivity of Aggregates (Procedure for Length Change Due to Alkali-Aggregate Reaction in Concrete Prisms)	Within 5 years
CSA A23.2-13A	Flat and Elongated Particles in Coarse Aggregate - Procedure A (Length to Width Ratio 4:1)	Within 3 years ⁽⁶⁾
CSA A23.2-16A ⁽⁷⁾	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine	Within 4 years
CSA A23.2-23A ⁽²⁾	Test Method for the Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	Within 4 years
CSA A23.2-29A ⁽²⁾	Test Method for the Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	Within 4 years
CSA A23.2-15A ⁽⁴⁾	Petrographic Analysis of Coarse & Fine Aggregate specific for use as concrete aggregate; and Determination of the Petrographic Number	See Note 4

- (1) Each aggregate product that may be used as a component of the proposed mix must have a washed sieved analysis performed showing the cumulative percent passing for each of the following sieve sizes; 56, 40, 28, 20, 14, 10, 5, 2.5, 1.25, 0.630, 0.315, 0.160 and 0.080 mm. Sieve analysis reports are to include all relevant sampling information (date/sampled by/location/field sample size) and include the actual test specimen sample mass.
- (2) Test Method A23.2-9A can be performed as an alternative to performing Test Method A23.2-23A and A23.2-29A. Refer to CSA A23.1, Section 4.2, Table 12 for further information.
- (3) Test Method A23.2-8A is required only if the aggregate fails to meet the requirements of Test Method A23.2-7A as described in CSA A23.1 Section 4.2.3.3.2
- (4) Petrographic Assessment of Aggregates

The Contractor shall submit the results of the Petrographic Analysis, certified by a qualified professional registered with the Association of Professional Engineers and Geoscientists of B.C. and indicating the aggregate's suitability for its intended use.

The petrographic analysis shall not be used to forfeit the requirement of performing other necessary aggregate quality testing.

- (5) Test data validity requirements are based on time periods prior to the expected initial date of concrete production. It is only applicable to aggregate sources proven to be materially consistent, based solely on historical test data. The Ministry Representative, based on submitted test data and/or visual observations, may reduce the above listed time periods.
- (6) Quality control during aggregate production shall include the following test methods at the specified test frequencies: CSA A23.2-2A & A23.2-5A (1 per 500 tonnes), and A23.2-13A (1 per 1000 tonnes).
- (7) Test Method CSA A23.2-16A can be waived if CSA A23.2-29A test results meet the specified criteria.

TABLE 211-E LIMITS FOR DELETERIOUS SUBSTANCES IN AND PHYSICAL PROPERTIES OF AGGREGATES

Test Method	Substance or Property	Maximum Percentage by Mass of Total Sample	
		Coarse Aggregate	Fine Aggregate
CSA A23.2-3A	Clay Lumps	0.25	1.0
CSA A23.2-4A	Low-Density Granular Materials	0.5	0.5
CSA A23.2-5A	Material Finer than 0.08 mm for Concrete Subject to Wear	1.0	3.0
	Material Finer than 0.08 mm for Other Concrete	1.0	5.0
CSA A23.2-9A	Magnesium Sulphate Soundness Loss	12	16
CSA A23.2-16A,	Los Angeles Abrasion Loss for Concrete Subject to Wear	35	N/A
CSA A23.2-23A-29A	Micro-Deval Abrasion Loss	17	20
CSA A23.2-12A	Absorption Percentage	2.0	N/A
CSA A23.2-7A	Organic Impurities in Fine Aggregate	N/A	Standard colour or lighter ⁽¹⁾
CSA A23.2-13A	Flat and Elongated Particles in Coarse Aggregate - Procedure A (Length to Width Ratio 4:1)	20	N/A
CSA A23.2-14A	Alkali-Reactivity Expansion in Concrete Prisms	0.040 ⁽²⁾	0.040 ⁽²⁾

(1) Standard Colour is defined as Organic Plate No. 3

(2) Expansion measured at 1 year

211.05 Storage and Handling of Materials - General.

The storage and handling of all materials used in the production of concrete shall conform to CSA A23.1, unless otherwise specified herein. All materials shall be stored and handled in a manner that will prevent contamination or deterioration, otherwise they shall be rejected. Access shall be provided to the storage facilities to allow for inspection and sampling. Where applicable, materials shall be identified by MSD sheets.

211.05.01 Cementitious Material. All cementitious materials shall be stored in a suitable weather-tight structure capable of protecting the materials from dampness, hydration and contamination, otherwise they shall be rejected. Materials shall be free of lumps at all times during their use in the work and shall have a maximum temperature of 50°C.

211.05.02 Tanks. Tanks used for storing and/or hauling, concrete mixing and curing water shall be free

from contamination by oil, acid, alkali, organic matter, sediment, rust or other deleterious substances.

211.05.03 Admixtures. All admixtures shall be stored in manufacturers' original labelled containers with clearly legible labels and be kept above freezing at all times and in accordance with the manufacturers' technical data sheets. Admixtures damaged by any cause shall be rejected.

211.05.04 Other Materials. Other materials, such as steel fibres, etc. shall be stored and handled in accordance with the manufacturer's recommendations and instructions.

211.05.05 Aggregates. Each nominal size of aggregate, including coarse and fine shall be separately stockpiled, stored and handled in a manner that will prevent contamination, intermixing and segregation. A minimum of 10 m³ of each aggregate size, in excess of the

- Aggregate transfer over stockpiles or storage bins of other sized aggregates should be avoided.
- Storage bins should be filled only to 150 mm from the top unless a suitable extension rim is provided to prevent contamination.
- Front-end loader buckets should be filled by raising them vertically up the face of the stockpile, not by thrusting into the stockpile in one place.
- Depositing aggregates into the batch plant storage bins should be made directly over the bins' outlet.
- Storage bins should be kept as full as possible during batching to minimize segregation as the aggregates are withdrawn from the bins.

Acceptable and uniform aggregate moisture content shall be obtained and maintained by necessary means to include the following:

- Washed or wetted aggregates should remain in stockpiles for a minimum of 12 hours to permit a uniform moisture content throughout the stockpile to be reached before aggregate transfer to batch plant storage bins.
- After each day's concrete production during wet weather, fine aggregate bins should be either emptied or covered with a suitable waterproof covering.

211.06 Batching

211.06.01 Batching Equipment

Batching equipment shall comply with the requirements of CSA A23.1.

Equipment specifications in DBSS 211.06.01 (i) to (vi) below are guidelines only, and as such, are not mandatory.

i) General - Batching equipment, such as weighing

requirements of the daily concrete operations, shall be maintained in identifiable stockpiles at the batch site in order to ensure proper continuity of the work with approved aggregates.

NOTE: Stockpiled aggregate, which has segregated, contaminated or intermixed with foreign matter of any kind, shall be rejected. Separate batch plant storage bins shall be provided for each size of aggregate to be batched.

Precautions shall be taken when moving, handling and transferring aggregates to prevent contamination, segregation or degradation in accordance with the following recommendations:

- Aggregate blanket 150 mm thick should be left on the ground as stockpiles are depleted.

mechanisms, gates, water lines and dispensing systems, to be maintained in good working order. Batching bins to be completely emptied of all material before the first and succeeding batches are measured.

Batching equipment to have the following capabilities and facilities:

- bins or silos for storage of aggregates, silos for storage of cement and pozzolan
- free movement of each type or size of material to discharge openings without contamination
- design of storage and hauling facilities to prevent:
 - loss or intermingling of different sizes and types of materials
 - contamination by deleterious substances
 - harmful segregation and breakage
- covers to stockpiles of fine aggregates to ensure constant moisture content
- all fulcrums, clevises and similar working parts maintained in clean condition
- provision made, in remote control plants and/or where batch cycles are timed, for the complete filling and discharge of the measuring unit for each batch.

ii) Batch Charging Mechanism - Batch Charging Mechanism requirements to be as follows:

- material flow control within the specified tolerances
- hopper construction to eliminate material accumulation and to permit the complete discharge of every batch
- cement weighing hopper:
 - self-cleaning and properly ventilated to allow air to

escape

- accessible for inspection
- dust sealed between the charging mechanism and the hopper to maintain weighing accuracy.

iii) Scales and Dispensing Mechanism - Scales and Dispensing Mechanisms to conform to the following requirements:

- beam type or springless dial type
- other methods of weighing (electric, hydraulic, load cells, etc.) are acceptable provided the specified weighing tolerances and accuracy requirements are met
- all accurate to $\pm 0.4\%$ of the total capacity of the scale when static load tested
- zero balance adjustment capability
- unaffected by binding or vibration due to vibrators or other appurtenances
- working range between 10% and 90% of the scale reading
- equipped with prominent markers with individual batch weight setting capabilities for dial scales
- calibration facilities including an adequate number of standard test masses
- beam type scales with provision for indicating to the operator that the required load in the hopper is being approached; the device shall indicate at least the last 100 kg of the load.
- all weighing and indicating devices shall be in full view of the operator while charging the hopper, and the operator shall have convenient access to all controls.

iv) Volumetric Devices for Water Measurement - Volumetric devices for water measurement to be:

- fitted with such valves and connections as are necessary to divert the water measured for a batch to easily verify the accuracy of measurement
- arranged so that measurements will be unaffected by variable pressures in the water supply line
- calibrated to an accuracy of 2% of the batch volume.

v) Dispensing Systems for Liquid Admixtures -

Dispensing systems for liquid admixtures, other than weigh systems, to have the following capabilities:

- visual, volumetric measuring or readout units located as close as possible to eye level for easy reading by the operator

- positioned in such a manner that discharge into the batch is observed by the operator from a normal working position
- volumetric measuring unit for periodic check of dispenser accuracy where a positive displacement system is used
- visual measuring unit for an accurate visual check of increments of 30 mL of air entraining agent or of chemical required to treat a maximum of 25 kg of cement

vi) Certificate or Report of Inspection - A certificate or report of inspection, from a Weights and Measures approved, independent testing authority, and which is not more than one year old for the plant in its present position, shall be on display in the plant at all times. The certificate or report will be accepted as proof of accuracy of the scales or weighing devices. Where there is reasonable doubt concerning the accuracy of the scales or weighing devices the Quality Manager or Ministry Representative may require their recalibration and recertification, at the Contractor's expense, during progress of the work. Plant relocation or major alterations shall require such recalibration and recertification.

211.06.02 Batching of Materials. Material may be weigh-batched separately or cumulatively.

Aggregates shall be batched by mass, cement and mineral admixtures in the powder form by mass or bag.

The mass of any ingredient to be batched shall not be less than 10% nor greater than 90% of the scale capacity.

When batched by 40 kg bags, only full and sealed bags of cement shall be used with no fractional bags permitted. Cement batched by mass shall be to an accuracy of $\pm 1\%$ for batch quantities between 30% and 90% of the scale capacity. When the mass of cement being batched is between 10% and 30% of the scale capacity, the mass of cement batched shall not be less than the required mass nor more than 4% in excess. Intermediate bulk cement shall be weighed to an accuracy of $\pm 1\%$.

When aggregates are measured by mass, batch masses shall be based on the required mass of saturated surface dry aggregate corrected for the moisture conditions of the aggregate at the time of batching. Field determination of free moisture in the aggregates shall be made by any proven method such as CSA A23.2-11A or by the use of a device such as the "Speedy Moisture" gauge. Where doubt exists as to the accuracy of such methods, total moisture in the aggregate shall be determined in accordance with ASTM C566. The minimum test frequency shall be once per each day's production. When individual aggregate weigh batchers are used, the scale reading for each material shall be within 2% of the specified mass. In a cumulative aggregate weigh batcher,

the cumulative mass after each measurement shall be within 1% of the required cumulative amount when the scale is used in excess of 30% of its capacity. For cumulative measurement less than 30% of scale capacity, the allowable variation shall be $\pm 0.3\%$ of scale capacity or $\pm 3.0\%$ of the required cumulative mass, whichever is less.

Mixing water shall be measured by mass or volume to an accuracy of $\pm 1\%$. Adjustments for free water contained in batched materials, such as free water in the aggregates, water contained in admixture solutions, shall be made to the quantity of water to be batched. The total amount of mixing water in the batch obtained from all sources shall be within $\pm 3\%$ of the specified quantity and shall not vary the designed water-to-cementitious material ratio of the mix by more than ± 0.02 . Mixers shall be completely emptied of all water prior to the loading of a concrete batch.

Admixtures shall be batched in liquid form by either mass or volume; in powdered form by mass or bag. Volumetric measurements of admixtures or air entraining agents shall be to an accuracy of $\pm 3\%$ of the required amount or 30 mL, whichever is greater. Measurement by mass shall be to an accuracy of $\pm 3\%$ of the required amount.

The addition of cement to a fully-batched load of aggregates will not be accepted.

211.07 Mixing.

211.07.01 General - Sufficient plant capacity and transporting equipment shall be provided by the Contractor to ensure continuous delivery of concrete at the rate required with the necessary intervals between batches, for the proper placing and finishing of the concrete without the formation of cold joints in the finished concrete.

211.07.02 Concrete Mixers.

i) General - Concrete mixers shall conform to the following requirements:

- manufacturer's rating plate carried in a prominent position, indicating rated mixing capacity, and recommended speed of mixing which must be in the range of not less than 4 nor more than 18 rpm
- demonstrated capability of operating satisfactorily at the recommended mixing speed
- number of revolutions of the drum or blades registered with a counter in working condition
- charge and discharge openings and chute free from appreciable accumulations of cement or concrete, and hopper and chute surfaces clean and smooth
- batch water measuring equipment in good operating condition.

ii) Volumetric Mobile Mixers. - Volumetric mobile

mixers shall conform to the following requirements:

- Shall be auger type mixers
- The mobile mixers shall be calibrated with the actual cement and aggregate products used in the concrete mix. Calibration tables and curves shall be submitted to the Quality Manager and Ministry Representative. The volume of the concrete produced shall be confirmed and shall be within 2%.
- Mobile mixers shall have separate flow controlled supply hoppers for each individual aggregate gradation and cementitious constituent material to be added volumetrically.
- May be used provided that the accuracy of batching and uniformity of concrete is as required by CSA A23.1.
- Cement flow rates shall be checked before (during if required) each placing operation.
- The scale being used to calibrate the mobiles shall have a minimum capacity of 50 kg.
- The water tank shall have a stand pipe showing the amount of water in the tank.
- The mobiles shall have individual flow meters and admixture tanks for each admixture to be used as part of an admixture injection system.
- The mobiles shall be able to advance backwards and forwards from controls located at the back of the mobile.
- The mixer auger shall be maintained at minimum of a 25° angle from horizontal when mixing and discharging, unless otherwise indicated by the manufacturer.

211.07.03 Mixing Concrete. Mixing drums shall be clean and empty before being charged. The drum shall be rotated at the manufacturers' recommended mixing speed during charging and mixing. Concrete shall be mixed to the uniformity requirements of CSA A23.1, Section 5.2.3.5. When a satisfactory mixing time is established it shall be maintained for all batches of the same design, mixed with the same equipment.

211.08 Delivery.

211.08.01 General - Off-site mixed concrete shall, after being mixed, be transported to the Site in either truck agitators or truck mixers operating at the speed designated by the manufacturer of the equipment as agitating speed.

When concrete is being mixed in mixer trucks while in transit, the speed of the mixing drum shall be reduced to agitating speed once the mixing time has elapsed. Delivery of mixed concrete in non-agitating equipment

will not be permitted.

211.08.02 Time of Placement

Time of placement guidelines for bridge decks including diaphragms, bridge parapets, bridge medians, bridge sidewalks and approach slabs are given in DBSS 413, Bridge Decks and Concrete Overlays.

All other concrete shall be fully discharged and placed within 90 minutes after water and cement have been combined. Under conditions contributing to rapid stiffening of concrete the Contractor shall adjust its placing operations to suit the reduced handling time.

Time of placement extensions will be considered on a case by case basis and may require the use of Hydration Stabilizing Admixtures (HSA's) conforming to the requirements of ASTM C494 Type B, Retarding or Type D, Water-Reducing and Retarding Admixtures. If accepted by the Designer and the Ministry Representative, guidelines for the use of HSA's shall be as follows:

- Concrete shall be fully discharged and placed within 3 hours after water and cement have been combined.
- When HSA's are used, these time extensions are subject to preconstruction trials being conducted by the Contractor to establish the appropriate HSA dosage to provide suitable extended slump life of concrete without increasing the water/cementitious ratio of the concrete above that which would be required if HSA's were not used. The use of HSA's shall in no instance modify the maximum concrete temperature required at time of placement. A one time only addition of HSA will be allowed, this will be during initial batching of the concrete or immediately at completion of batching as recommended by the admixture manufacturer. Addition of HSA at any other time will be cause for rejection of the concrete.

211.08.03 Temperature Control - Temperature control guidelines for bridge decks including diaphragms, bridge parapets, bridge medians, bridge sidewalks and approach slabs are given in DBSS 413, Bridge Decks and Concrete Overlays.

The temperature of all other concrete, from the time of batching to complete discharge shall remain between 10° C and 25° C. Any concrete containing silica fume shall not have a maximum temperature in excess of 17°C at time of placement. Concrete used in elements having a minimum section thickness greater than 1000 mm shall have temperature controls as per CSA A23.1 Clause 5.2.4.4. Methods used for maintaining temperature controls shall not diminish the quality of the concrete, and shall not alter nor exceed the specified maximum W/C_m ratio.

When the atmospheric temperature is 20°C or higher, DBSS 211.18 – Hot Weather Concreting shall apply.

211.08.04 Addition of Water - No water shall be added after the initial introduction of the mixing water for the mix, except at the start of discharge within the initial 10% of the total load volume, and when:

- the specified water-to-cementitious materials ratio is not exceeded
- the measured slump is less than that specified
- no more than 60 minutes have elapsed after water and cement have been combined
- the concrete is in a mixer or truck mixer.

An amount not exceeding 16 L of water per cubic metre of concrete or 10% of the mix design water whichever is less may be added. After addition of water, the drum or blades shall be turned an additional 30 revolutions or more if necessary at mixing speed. The amount of water added shall be recorded on the delivery ticket. Water shall not be added to the batch at any later time. The Contractor assumes full responsibility for the on-site addition of water and its subsequent effect on the quality of the concrete.

211.08.05 Addition of Superplasticizer (HRWR) – When superplasticized concrete falls below the designated slump due to delay, it shall be re-tempered with superplasticizing admixtures only, not water, and shall only receive a maximum of one re-tempering. The amount of superplasticizer added shall be recorded on the delivery ticket. The Contractor assumes full responsibility for the on-site addition of superplasticizer and its subsequent effect on the quality of the concrete. The use of superplasticizers shall not be used for extending the time of placement requirements described in DBSS 211.08.02.

211.08.06 Control of Air Content on the Job Site – The air content of the concrete shall, if necessary, be brought up to the specified range by the addition of an air-entraining agent in the field. Mixing shall follow to ensure proper dispersion and upon completion of mixing, the air content shall be retested. The amount of admixture added shall be recorded on the delivery ticket. The Contractor assumes full responsibility for the on-site addition of the air entraining agent and its subsequent effect on the quality of the concrete.

211.08.07 Delivery Ticket - Concrete delivered to the job site shall be accompanied by a ticket providing the Contractor, Quality Manager and Ministry Representative with legible information, as follows:

- serial number of ticket
- date, name and location of concrete supplier
- name of the Contractor

- specific job designation (name and location)
- specific designation of concrete mix design
- truck number and volume of concrete in cubic metres
- addition of any materials added at the job site, at the request of the Contractor including but not limited to water and all chemical admixtures.
- time concrete was batched, arrived at job site, and completely discharged.
- amount of water added during batching including free moisture in aggregate, the maximum allowable amount of water that can be added at the site to maintain the specified maximum W/C_m ratio.

211.09 Quality Control and Quality Assurance Inspections, Testing and Acceptance.

211.09.01 General. The Contractor shall be fully responsible for hiring, scheduling, overseeing, performing and documenting all quality control and quality assurance testing and inspection in full compliance with the Contract.

The Ministry may perform on-site sampling and testing as a function of the Ministry's quality audit. Any Ministry quality testing shall not relieve the Contractor of responsibility for providing quality control and quality assurance.

211.09.02 Sampling and Testing. Laboratory testing shall be carried out by a testing laboratory certified in accordance with the requirements of CSA Standard A283. Field test procedures shall be undertaken by personnel certified under an industry-recognized program. Field inspectors shall have extensive experience in on-site quality control testing of concrete, with the applicable admixtures being used, and with on-site batch adjustments. Quality control testing personnel shall be on-site and available to test concrete for the complete duration of any concrete placement operation. Sampling and testing shall be in accordance with the test methods and minimum frequency levels as listed in Table 211-J and Table 211-K. Any test outside the specified range shall be immediately reported to the Contractor, Quality Manager and Ministry Representative. Copies of all test results shall be received by the Quality Manager and Ministry Representative

within 1 day of the test date.

211.09.03 Sampling - Point of Acceptance.

Determination of concrete properties for acceptance will be made based on samples taken at the final discharge end of the placement system. The Quality Manager and Ministry Representative may accept sampling at the truck discharge end provided that testing during the test batches confirm that the concrete mix parameters are within the stated specification requirements at the actual placement point. The Quality Manager or Ministry Representative may require additional testing to be performed at the point of placement at a predetermined frequency throughout the placement period. Such additional testing, including all costs, shall be deemed as part of the Contractor's quality control program.

211.09.04 Strength Tests. Unless otherwise specified in the Contract, a strength test shall be the average 28-day strength of three standard 100 mm x 200 mm test cylinders, sampled, cast, cured, transported, and tested in accordance with CSA A23.2- 3C and 9C. The cylinder size shall however, meet the aggregate size limitations specified in Clause 6.2 of CSA Test Method A23.2-3C. For each strength test, a fourth cylinder shall be cast for a 7-day strength determination. If one specimen in a strength test, in the opinion of the testing agency shows evidence of improper sampling, casting, or testing, including damage from improper handling and transporting (and if agreed to by the Ministry Representative), it shall be discarded and the remaining two specimen strengths averaged. Additional cylinders may be cast, at the discretion of the Ministry Representative or Quality Manager.

The strength of each classification of concrete shall be considered satisfactory if:

- the averages of all sets of three consecutive strength tests equal or exceed the specified strength
- no individual test shows strengths less than 90% of the specified strength

Each "classification of concrete" will be specified in the Design. Where fewer than three strength tests are taken, the results of one test or the average of two will be used.

TABLE 211-J STANDARD TEST METHODS FOR SAMPLING AND TESTING

Test Methodology	Test Description	Minimum Test Frequency
CSA A23.2-1C	Sampling Plastic Concrete	As stated below
CSA A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens	One set for every 35 m ³ or portion thereafter for each classification of concrete placed within an individual structural element or component, and placed on any one-calendar day from a single supplier. The Quality Manager or Ministry Representative may request additional sets.
CSA A23.2-9C	Compressive Strength of Cylindrical Concrete Specimens	
CSA A23.2-4C	Air Content of Plastic Concrete by the Pressure Method	Every individual load unless approved otherwise by the Quality Manager and Ministry Representative
CSA A23.2-5C	Slump and slump flow of Concrete	Retests shall be performed following any load adjustments.
ASTM C1064	Temperature of Fresh Concrete	
CSA A23.2-6C	Density, Yield, and Cementing Materials Factor of Plastic Concrete	Density and Yield tests shall be performed with every air test and strength test.

TABLE 211-K ADDITIONAL TEST METHODS FOR CONCRETE CONTAINING HIGH RANGE WATER REDUCERS (SUPERPLASTICIZERS)

Test Methodology	Test Description / Sample Requirements	Minimum Test Frequency
ASTM C457 *	Microscopic Determination of Parameters of the Air-Void System in Hardened Concrete	One test per individual test batch for each classification of concrete. Acceptance criteria shall be in accordance with CSAA23.1 Section 4.3.3.2 and 4.3.3.3. Further testing, during scheduled concrete pours may be required, as directed by the Quality Manager and Ministry Representative
ASTM C1202	Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (Test age at 56 days)	One test per individual test batch for each classification of concrete Acceptance criteria shall be a coulomb rating not exceeding 1500 coulombs Each test set includes two 100 mm x 200 mm [4" x 8"] cylinders, sampled at the final placement discharge point. Casting, transporting and curing shall be in accordance with DBSS 211.09.05.

* for superplasticized concrete only

211.09.05 Test Cylinders. Making and curing concrete test cylinders shall be carried out in accordance with CSA A23.2-3C, except that the time for cylinders to reach the

testing laboratory shall be between 20 and 48 hours from initial time of casting. The test cylinders shall be cast by the Contractor using standard CSA approved moulds. The

Contractor shall provide properly designed temperature-controlled storage boxes for test cylinder storage, as specified in CSA A23.2-3C Clause 7.3.2.1, for a period of at least 20 hours, and further protection from adverse weather and mishandling before and during delivery to the testing laboratory for curing and testing. The Contractor shall provide a maximum-minimum thermometer for each storage box.

The Contractor shall deliver the test cylinders to a CSA certified testing laboratory. Handling and transporting of the cylinders shall be in accordance with CSA A23.2-3C. No extra laboratory curing time will be allowed for cylinders that are delivered late to the laboratory. A copy of the test results shall be forwarded to the Quality Manager and Ministry Representative within 2 days of each individual strength test date. Test results shall include all information as described in CSA A23.2, Annex B, Form for Reporting Compressive Strength of Concrete Test Cylinders.

211.09.06 Field Cured Test Cylinders. The Quality Manager or Ministry Representative may require field cured test cylinders be cast to check the adequacy of the Contractor's curing or cold weather protection. The Contractor may also cast field cured test cylinders for determining interim strengths that may be required for further work progress approval such as opening to traffic, formwork removal and/or erection, etc.

Casting, handling, transporting and testing shall be in accordance with CSA A23.2-3C and 9C.

Test cylinders shall be stored as near as possible to the point in the structure that the test cylinders represent, and shall be afforded the same temperature protection and moisture environment as the structure.

At the end of the curing period the test cylinders shall be left in place, exposed to the weather in the same manner as the structure.

All test cylinders shall be removed from the field storage and stored in lime water at $23 \pm 2^\circ\text{C}$ for $24 \pm 4\text{h}$ immediately before time of testing to ensure uniform moisture conditions from cylinder to cylinder.

Test results on field cured test cylinders shall not be used as a basis for acceptance or rejection of the concrete.

211.09.07 Failure to Meet Minimum Strength Specifications.

i) Understrength Concrete - where the strength of concrete is not satisfactory as specified in DBSS 211.09.04, the Designer shall prepare a plan for remedial measures and the plan shall be submitted to the Ministry Representative for review. If the proposed plan is not acceptable to the Ministry Representative then the Ministry Representative may order replacement or

reinforcing or other remedial measures, at the Contractor's expense, of portions of the structure. Alternatively, at the Ministry Representative's discretion, the understrength concrete may be accepted at a reduced price.

ii) Coring - the coring of concrete, to verify its strength, will be allowed only for concrete, which is otherwise to be replaced or reinforced. Coring will not be allowed for concrete for which reduced payment is to be made for understrength. When coring is allowed, cores shall be taken at locations directed by the Ministry Representative, who shall be present during the coring.

Where coring is allowed, it shall be carried out by an independent qualified testing firm. Three cores shall be obtained and tested in accordance with CSA A23.2-14C "Obtaining and Testing Drilled Cores for Compressive Strength Testing" at each test location. Concrete in the area represented by the core tests may be considered structurally adequate if:

- the average strength test result of each set of three cores from the portion of the structure in question is equal to at least 100% of the specified strength
- the strength test result of any single core is not less than 80% of the specified strength

Notwithstanding the final result, the Contractor will be responsible for all costs associated with the coring operation and testing, and shall not be reimbursed for inconvenience or other associated costs.

211.09.08 Failure to Meet Slump or Air Content Specifications. In the event that the slump and/or air content are outside the specified limits, the Ministry Representative may accept adjustments to correct the deficient condition as an alternative to rejection. In such cases, adjustments must be completed within the maximum time allowed as specified in DBSS 211.08.02 and additional testing shall be required to verify specification compliance. If compliance is not achieved, the concrete shall be rejected.

211.10 Placing of Concrete.

211.10.01 General - Equipment for conveying concrete at the job site, such as buggies, buckets, hoppers, chutes, belts and pumps, shall be of such design, size and condition to deposit a continuous and adequate supply of concrete of the specified mix and consistency without segregation at the required locations.

The equipment specifications in DBSS 211.10.02 to DBSS 211.10.06 inclusive are guidelines only, and as such, are not mandatory. DBSS 211.10.07 is mandatory. Placing of concrete shall also comply with the requirements of CSA A23.1

211.10.02 Buggies. Buggies shall have inflatable rubber tires. Inner surfaces of the bucket shall be smooth with filleted corners, mortar-tight and free of any excessive accumulation of hardened concrete, obstructions or deterioration interfering with the proper discharge of concrete. Grade and ramp-way surfaces shall be sufficiently smooth to prevent segregation of concrete being carried in buggies.

211.10.03 Bottom-dump Buckets and Hoppers.

Bottom-dump buckets and hoppers shall have side slopes not less than 60° from the horizontal and shall be equipped with wide free-working and tight-closing discharge gates. The discharge gates shall be constructed to regulate the concrete flow, spring loaded to ensure complete closure and be capable of immediate closure at any time during discharge. Buckets and hoppers shall be cleaned of any accumulation of partially hardened or hardened concrete before and during concrete placement. Gate control mechanisms shall be cleaned and lubricated before being used.

In the use of crane and bucket, segregation of concrete from jarring or shaking shall be prevented. Side-dump buckets shall be used whenever necessary to avoid conflict with extended reinforcing steel or formwork.

211.10.04 Chutes. Chutes shall be of rounded cross section to avoid the accumulation of concrete in corners; be capable of slope adjustment sufficiently steep to permit flow without requiring a slump greater than that specified or required for placement (slope normally required is 1 vertical to 2 or 2½ horizontal).

Baffles and changes in direction may be used to control flow, but not vibration, paddling or water spray.

Chutes or belts shall be rigidly supported but sufficiently mobile to permit discharge as close as possible to the placement location as it progresses. Any long line of chutes or belts shall be covered during hot, dry or windy weather to prevent drying of concrete and excessive slump loss.

211.10.05 Conveyor Operation Rate. Conveyor operation rate shall be dependent on the proper placement and consolidation of the concrete with the belt inclination such that no segregation occurs from any sliding or roll-back of the concrete.

211.10.06 Hoppers. Hoppers, set approximately level, shall be supported on specially framed bearers transmitting only vertical loads to the top of the formwork.

211.10.07 Pumps - Pumps shall be of sufficient capacity to supply un-segregated concrete, using the design mix proportions at the design slump, to meet the required placement volume at the forms. Satisfactory operation and performance of the proposed pumping equipment with the concrete materials and mixes otherwise suitable and appropriate for the job, along with

the line layout and grate size opening, shall be demonstrated to the Quality Manager and Ministry Representative's satisfaction and acceptance.

Any necessary priming of the concrete pump shall be done with a water/cement or water/cement/sand slurry. The prime slurry followed by approximately 0.25 cubic meters of concrete shall not be included in the concrete placement. No other pump aid type admixtures will be permitted.

211.11 Falsework and Formwork.

211.11.01 General. Formwork and falsework shall be designed, supplied, installed and removed in accordance with CAN/CSA-S269.3-M92, CAN/CSA-S269.1-1975 and the requirements for concrete formwork and falsework given in the British Columbia Workers Compensation Act, Occupational Health and Safety Regulations unless otherwise noted.

Formwork and falsework support accessories shall not be welded to the permanent structural steelwork.

Where required, formwork and associated temporary falsework design and drawings shall be prepared and sealed by a professional engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia and experienced in the design and construction of falsework and formwork structures similar to those required to construct this project. No load shall be placed on the formwork or falsework until the professional engineer responsible for the design has inspected and certified, in writing, that the work has been carried out in accordance with the formwork drawings and specifications and a copy of the formwork design engineers' certification has been provided to the Quality Manager and, when requested, to the Ministry Representative.

Bridge deck formwork design shall include a check for the lateral stability of the girders during the placement of deck concrete. Stringers shall be temporarily braced, if necessary, to facilitate deck concreting operations.

Detailed falsework and formwork drawings shall be submitted to the Designer and Ministry Representative for review. The drawings shall be submitted a minimum of two weeks before the start of installation.

211.11.02 Design. All forms shall be designed and built mortar-tight and of sufficient rigidity to prevent distortion due to the pressure of vibrated concrete and other loads incidental to the construction operation. The forms shall be substantial and unyielding, and shall be designed so that finished concrete will conform to the design dimensions and contours. The shape, strength, rigidity, water tightness and surface smoothness of re-used forms shall be maintained at all times. Forms which are unsatisfactory in any respect shall not be used.

All formwork and falsework shall be designed to be completely removable, no stay in place formwork will be permitted.

No dry ties shall be permitted; form tie rods shall remain embedded and terminate not less than 50 mm from the formed face of the concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of a regular shape for reaming and filling.

For narrow walls and columns, where the bottom of the form is inaccessible, removable panels shall be provided in the bottom form panel to enable cleaning out of extraneous material immediately before placing the concrete.

211.11.03 Forms for Exposed Surfaces. All forms for exposed surfaces shall be mortar-tight. All exposed edges shall be chamfered by use of a chamfer strip and return corners filleted. Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 50mm from the concrete surface. Break-back type form ties shall have all spacing washers removed and the tie shall be broken back a distance of at least 50 mm from the concrete surface. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size. Torch cutting of steel hangers and ties will not be permitted. Formwork hangers for exterior surfaces of decks and curbs shall be an acceptable break-back type with surface cone, or removable threaded type. Cavities shall be filled with cement mortar and the surface left sound, smooth, even and uniform in color. See DBSSS 211.17 for details on finishes, mortar mixes and other relevant information.

211.11.04 Deck Formwork. Formwork for decks, curbs, sidewalks and parapets shall be fabricated so that the lines and grades shown on the Design are achieved. For suspended slab bridge decks the formwork shall be designed to allow for an adjustable haunch to facilitate the casting of a constant depth deck slab as shown on the Design. Girders will be erected to normally accepted standards of tolerance; it shall be necessary to adjust the formwork to compensate for camber, variances in girder dimensions, positioning, and sweep.

Prior to commencing deck formwork and subsequent to the completion of the erection of girders, with the girders in a thermally neutral condition and with no dead load other than the dead load of the girders and necessary fall protection, the Contractor shall profile all the girders. Camber elevations are to be taken at 1000 mm centres maximum (or as indicated on the Design), centrelines of all bearings and ends of girders. The camber elevation locations are to be laid out to an accuracy of 25 mm horizontally and camber elevations taken to the nearest 1 mm vertically. The Contractor shall supply the camber elevations to the Designer. The Designer shall calculate and provide the Contractor with the haunch heights for

setting the deck slab soffit, and the design finished grade elevations for the deck, complete with anticipated dead load deflections at 1000 mm stations along the centreline of roadway.

In the event that actual girder camber values vary significantly from the design values, the Contractor will be required to modify the original design finished grade as directed by the Designer.

211.11.05 Removal of Falsework and Formwork.

Where formwork and associated falsework have been engineered by a professional engineer, forms and their supports shall not be removed without the approval of the professional engineer responsible for the formwork and falsework design and without the acceptance of the Designer. In determining the time for the removal of falsework and formwork, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the curing of the concrete, and the materials used in the mix.

Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight together with any construction loads likely to be imposed. All formwork must be removed from the completed structure.

211.12 Construction Joints.

211.12.01 General - Definition. Joints between adjacent or successive lifts of concrete where the previously cast concrete cannot be plasticized with a vibrator, or any joint required by the Contractor's method of construction. Construction joints generally shall be in accordance with the following requirements:

- kept to a minimum
- concealed by a natural break or line in the structure
- provided for by the formwork design and placing techniques.

Emergency construction joints shall conform as nearly as possible to planned joints. In any case, concrete must be levelled as well as possible and, if lifts are partial, a vertical bulkhead shall be installed. Permission from the Designer and Ministry Representative shall be required to complete the cast following any emergency joint installation.

211.12.02 Joint Edges. Joint edges shall be preformed whenever possible for a true line upon form removal. Pour-strip shall be positioned relative to form ties so as to minimize form bulge at the bottom of the subsequent cast, but concrete may be cast to the top of a form instead of the pour-strip. Concrete surfaces outside of the reinforcing steel shall be steel trowelled to a true line.

211.12.03 Surfaces Preparation. Joint surfaces of the hardened concrete shall be thoroughly cleaned of foreign

matter and laitance to present clean, sound surfaces with the coarse aggregate partially exposed and achieved by:

- brushing immediately following initial set
- treatment with a surface set retardant, followed by green cutting
- sand blasting
- water blasting.

Where roughening of the hardened concrete is specified, the surface shall be roughened to a full amplitude of at least 5mm.

211.12.04 Bonding of Joints. Bonding of joints shall be achieved through the use of a water-cement slurry or, if specified, an epoxy-type bonding agent conforming with ASTM C 881M applied in strict accordance with the manufacturer's specifications. Slurry, when used, shall have a water-cement ratio equal to that of the concrete being placed and be brush applied to a 3 to 5 mm thickness for 100% coverage on to the cleaned existing concrete surface within five minutes of placing concrete.

211.13 Consolidation.

The equipment specifications in DBSS 211.13.01 to DBSS 211.13.02 inclusive are guidelines only, and as such, are not mandatory. DBSS 211.10.03 is mandatory. Consolidation shall also meet the requirements of CSA A23.1.

211.13.01 Vibrators – General. The number, type, design and operation of vibrators will be subject to the acceptance of the Designer and Ministry Representative.

Vibrators to have the following capabilities and requirements:

- diameter and frequency of vibrators to conform to Table 211-L
- vibration transmission to the concrete at frequencies not less than 130 Hz
- vibration intensity sufficient to be visually observed on concrete with not more than 25 mm slump over a radius of at least 450 mm
- sufficient number of vibrators available to properly compact each 8 m³ batch within 15 minutes after it is placed in forms, with at least two vibrators provided for each concrete placing unit
- stand-by vibrator and generator available on the job at all times in case of breakdown.

211.13.02 Mechanical Vibrators. Mechanical vibrators to thoroughly consolidate concrete immediately after placing.

Vibrator usage to be as follows:

- not inserted between reinforcing steel and formwork nor directly on to the reinforcing steel
- inserted vertically at a rate of 75 mm per second and penetrating into the preceding layer at least 50 mm
- withdrawn at a rate of 150 mm per second
- grid pattern movement starting 100 mm from a formed surface and at a maximum spacing of 300 mm thereafter.

211.13.03 Form Vibrators. Form vibrators may be permitted at the discretion of the Designer and Ministry Representative where rebar configuration would prohibit the use of internal vibrators.

TABLE 211-L REQUIREMENTS FOR DIAMETER AND FREQUENCY OF VIBRATORS

DIAMETER (mm)	FREQUENCY (Hz)	RATE OF PLACEMENT OF CONCRETE PER VIBRATOR (m ³ /h)	APPLICATION
20-40	170-250	1-4	very thin members
30-60	150-225	2-8	walls and slabs 200 mm - 300 mm
50-90	130-200	5-15	larger members

211.14 Finishing.

211.14.01 Finishing Top Surfaces - Plastic concrete, struck off immediately following casting and before the accumulation of bleed water, shall be finished by hand or mechanical floating with the least possible disturbance. Water, cement or proprietary topping material shall not be added to the surface during finishing.

No steel floats or trowels shall be used on exposed surfaces.

211.14.02 Strike-off and Finishing Machines -

Strike-off and finishing machines for surfacing concrete such as slabs on grade, pavements, etc. shall conform to the following:

- capable of accurately finishing concrete surfaces to the grade and elevation shown on the Design
- surface finish production free of open texturing, plucked aggregates or projections
- maintained in good mechanical repair and free of hydraulic fluid leaks, oil leaks, excessive grease and other contaminants.

211.14.03 Trowel Finishing - Trowel finishing where required:

- by the Design,
- for unformed surfaces exposed to view from a close distance,
- by close tolerance requirements (such as bearing surfaces),

shall be commenced after bleed waters have disappeared to reduce the texture of the concrete surface and produce a smooth blemish-free surface.

211.14.04 Other Textured Finishes - Other textured finishes shall be applied as and where specified.

211.14.05 Damage or Scaling - Any damage to or scaling of surfaces shall be repaired to the satisfaction of the Quality Manager and Ministry Representative.

211.15 Curing.

211.15.01 General. Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, excessive moisture, moisture loss, heavy shocks, excessive vibrations and high stresses, for the period of time necessary to develop the desired properties of the concrete.

The curing period will begin following the placement of the concrete in the section cast. It shall be the responsibility of the Contractor to ensure that the system of curing and protection is properly planned, constructed

and maintained throughout the entire curing period.

211.15.02 Acceptable Methods and Procedures.

Acceptable curing methods and procedures shall include the following:

- concrete surfaces shall be cured for a period of seven consecutive uninterrupted twenty-four hour periods, however, if the Designer has accepted the use of high-early strength cement(HE), this period may be reduced as recommended by the Designer and as permitted by the Ministry Representative.
- surface temperature maintained between 10°C and 35°C, unless high-temperature curing (i.e., by hot blankets or steam) is acceptable to the Designer and Ministry Representative.
- hot weather and cold weather special requirements are covered by DBSS 211.18 and DBSS 211.19. The determination and recording of air and concrete temperatures to verify compliance with the requirements for hot and cold weather concreting shall be the responsibility of the Contractor. The location and methodology for the determination and recording of temperatures shall be acceptable to the Quality Manager and Ministry Representative.
- formed concrete protection, with form-work left in place during the curing period (usually seven days), is generally not necessary except during extremes of hot or cold weather temperatures. Where formwork is removed before the end of the curing period, the concrete shall be protected in the manner specified below for unformed surfaces during the remainder of the curing period
- unformed surface protection using burlap and water or where permitted, other moisture-retaining methods considered adequate to promote curing, shall include the following common methods and requirements:

i) Burlap - Soaking wet burlap of acceptable quality shall be carefully laid on the surface of the concrete as soon as the concrete has set sufficiently to support the burlap without marring the surface. Strips shall be overlapped 150 mm, adequately held down and maintained in place in a thoroughly wet condition throughout the curing period (usually seven days). Wetness of burlap shall be maintained at all times.

ii) Vapour Barrier - Vapour barrier of acceptable quality of opaque white-pigmental 0.10 mm thick ("4 mil") polyethylene sheet, white upper surfaced paper or other permitted material shall be of such size and placement to minimize the number of laps. The material shall be laid, lapped and held down around the edges and at the laps:

- to prevent displacement

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- to provide and maintain an effective vapour barrier
- prevent any flow of air between the vapour barrier material and the concrete
- kept in place throughout the curing period (usually seven days).

However, the barrier material shall not be pulled tight against the fresh concrete surface so as to smooth the required surface texture.

211.15.03 Removal of Protective Materials. Protective materials shall be removed entirely from all concrete surfaces at the end of the curing period and the surfaces left clean.

211.16 Dimensional Tolerances. Dimensional tolerances shall be as shown in Table 211-M.

NOTE: The tolerances listed in Table 211-M are acceptable only in so far as they do not prevent the proper fit of structural members.

Table 211-M DIMENSIONAL TOLERANCES

Trueness of bearing surfaces	such that there is no gap over 1 mm under a 1 m straight edge
Trueness of bridge deck surfaces	such that there is no gap over 3 mm under a 3 m straight edge
Trueness of slope pavement surfaces	such that there is no gap over 12 mm under a 3 m straight edge
Trueness of other surfaces exposed to view	such that there is no gap over 12 mm under a 3 m straight edge
Curbs and parapets	such that there is no gap over 3 mm under a 3 m straight edge
Horizontal distance to concrete surfaces	±50 mm
Elevations of concrete surfaces except bearings and decks	±25 mm
Elevations of bridge deck surfaces	±15 mm
Elevations of bearing surfaces	±5 mm
Variation from plumb	1:400, but not more than 30 mm
Dimensions of members over 10 m	±25 mm
Dimensions of members under 10 m	-6 mm, +15 mm
Location of anchor bolts	± 6 mm
Projections of anchor bolts, other embedments	±13 mm

211.17 Finishing Formed Surfaces.

211.17.01 Class 1 Finish. Class 1 Finish is the basic finish to be produced on all formed surfaces not exposed to view unless a better finish is specified or required by the Design.

In order to produce a Class 1 finish, the formwork shall be mortar tight. Panel marks and texture are of no importance.

All ties, bolts, nails and other metal specifically required for construction purposes shall be removed or cut back to a depth of 50 mm from the surfaces of the concrete and the resulting holes filled.

No dry ties shall be permitted; form tie rods shall remain embedded and terminate not less than 50 mm from the formed face of the concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of a regular shape for reaming and filling.

Honeycombs and voids over 500 mm² in area shall be filled. Honeycombs and voids shall not be repaired until inspected by the Quality Manager and Ministry Representative as special methods of repair may be required where occurring in structural elements. Otherwise, concrete surfaces shall be repaired as follows:

- remove all porous concrete by cutting 20 mm into sound concrete
- thoroughly clean reinforcing steel without damaging same
- cut edges of cavities as nearly perpendicular to the concrete surface as possible and deep enough to hold the patching mortar
- keep surrounding concrete saturated for 30 minutes before patching
- after the sheet of free water has disappeared from the concrete surfaces, apply a latex bonding agent, in strict accordance with the manufacturer's instructions,
- patch with mortar, proportioned as specified in DBSS 211.17.05 and mixed with the minimum amount of water necessary to make a workable paste: for voids deeper than 10 mm, multiple layers of mortar each with a maximum thickness of 10 mm shall be used with 30 minute intervals allowed between layers
- trowel the surface of the patch flush with the surface of the surrounding concrete.

211.17.02 Class 2 Finish. Class 2 Finish is to be produced on all formed surfaces exposed to view from a moderate distance, such as surfaces of abutments and

piers, and to any surfaces for which a Class 2 finish is specified or required by the Design. A Class 2 finish shall provide surfaces of uniform colour and texture as viewed from 25 m.

In order to produce a Class 2 finish, formwork shall be mortar tight and shall render a true surface. Fins 3 mm wide (maximum) shall be allowed at the panel joints; however, sheathing joints must be mortar tight. Irregularities of 3 mm in height with areas of 50 mm x 75 mm shall be allowed to a maximum of four such areas per 3 m² of formwork. Patches of dissimilar material will not be permitted. Horizontal and vertical joints shall be aligned.

All ties, bolts, nails and other metal specifically required for construction purposes shall be removed or cut back to a depth of 50 mm from the surfaces of the concrete and the resulting holes filled.

No dry ties shall be permitted; form tie rods shall remain embedded and terminate not less than 50 mm from the formed face of the concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of a regular shape for reaming and filling.

Honeycombs and voids over 25 mm diameter shall be filled, and all bugholes over 5 mm diameter shall be pointed. All fins and projections shall be removed with a hand stone or power grinder. The use of a power grinder shall be kept to a minimum and confined to the areas required.

When a rubbed finish is not called for, patches shall be textured with a mortar float or lightly brushed after trowelling smooth.

Where more than 50 voids or bugholes over 5 mm diameter occur per square metre, or if the surfaces are not acceptably uniform in colour or texture, the entire area affected shall be given a rubbed finish, as follows:

- allow patches to attain an initial set
- keep surfaces saturated with water for 60 minutes before applying mortar
- remove free water from surfaces
- apply mortar, proportioned as specified in DBSS 211.17.05 and mixed at least 60 minutes before application, to the concrete surfaces with a sponge, float or a hand carborundum stone, and work mortar well into the surfaces
- allow mortar to dry 30 - 60 minutes
- remove residues from the surfaces by rubbing with clean dry burlap but with no addition of neat cement to the surface during the "sacking" operation and finally cure the surfaces as specified in DBSS 211.15.

211.17.03 Class 3 Finish. Class 3 Finish is to be produced on all formed surfaces exposed to view from close distances, such as surfaces of curbs and parapets, and to any surfaces for which a Class 3 finish is specified or required by the Design. A Class 3 finish shall provide surfaces of uniform colour and texture when viewed from less than 15 m.

In order to produce a Class 3 finish, the formwork shall render a true smooth surface, free from fins and projections. New plywood or steel is necessary to produce the required finish. Re-use of plywood forms will be permitted only if in an "as new" condition. Repairs to the forms shall be with full panels of sheathing only.

All ties, bolts, nails and other metal specifically required for construction purposes shall be removed or cut back to a depth of 50 mm from the surfaces of the concrete and the resulting holes filled.

No dry ties shall be permitted; form tie rods shall remain embedded and terminate not less than 50 mm from the formed face of the concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of a regular shape for reaming and filling.

Patching shall be:

- patch installation projecting slightly from the surrounding concrete surface
- after 24 hours, saturated and carefully finished to render the surfaces of the patch true to the surrounding concrete, but any grinding using a hand carborundum stone kept to a minimum

When a rubbed finish is required, the applied mortar shall be carefully worked into the surface area being finished and, using a hand carborundum stone manipulated in a circular motion, the entire surface rendered true and smooth with all excess mortar removed.

211.17.04 Class 3 Finish Alternative Procedures.

Class 3 Finish alternative procedures may be used when, in the opinion of the Ministry Representative, the formwork may safely be removed at an early age and the concrete finished while still partly plastic. Procedures shall include the following:

- careful removal of the formwork when the concrete has sufficiently hardened so as to hold its shape
- finishing the surfaces immediately (within 4 to 8 hours of casting, depending upon weather)
- careful rubbing of the concrete surfaces with a carborundum stone, occasionally wetting same to produce a paste from the surface of the concrete
- rubbing continued, adding necessary sand-cement mortar in small quantities to fill voids, until all voids and form marks are removed

- surface curing as specified.

Modifications to the surface texture shall be achieved by grinding or other means.

211.17.05 Patching Mortar. Patching mortar where specified above shall be constituted as follows:

Cement:	60% Normal Portland
	40% White Normal Portland
Liquid:	70% Water
	30% Latex Bonding Agent
Sand:	Passing a 1.25 mm sieve

NOTE: Cement blend above may be adjusted to provide close match to the concrete colour.

211. 18 Hot Weather Concreting.

When ambient air temperature is 25°C or higher or there is a probability of it rising to 25°C during the placing period (as forecast by the nearest official meteorological office), hot weather concreting procedures as outlined below, shall be used, for all concrete other than deck concrete.

Additional requirements for hot weather concreting for bridge decks including diaphragms, bridge parapets, bridge medians, bridge sidewalks and approach slabs are given in DBSS 413, Bridge Decks and Concrete Overlays.

Prior to the placement of concrete, the Contractor shall submit to the Quality Manager and Ministry Representative for acceptance, the proposed placing operations complying with the requirements for hot weather concreting.

Curing shall be accomplished by water spray or by using saturated absorptive material, such as burlap.

Formwork, reinforcement and concreting equipment shall be protected from the direct rays of the sun or cooled by fogging and evaporation.

Concrete for piers, abutments and footings of bridges shall not have a temperature greater than 25°C at any time prior to placement and curing.

The initial temperature of concrete prior to placement may be estimated from the temperatures of its ingredients by using the following equation:

$$T = \frac{0.22(T_a M_a + T_c M_c) + T_w M_w + T_{wa} M_{wa}}{0.22(M_a + M_c) + M_w + M_{wa}}$$

where T_a , T_c , T_w and T_{wa}

= temperature in °C of aggregates, cementing materials, added mixing water, and free water on aggregates, respectively

where M_a , M_c , M_w and M_{wa}

= mass in kilograms of aggregates, cementing materials, added mixing water, and free water on aggregates, respectively

If deemed necessary, the Contractor shall employ the following hot weather concreting procedures to reduce the concrete temperature:

a) Mixing Water

- Shading of storage tanks and water supply lines;
- Refrigeration of mixing water; and/or
- Adding cubed, shaved or chipped ice directly to the concrete mixer drum, and ensuring ice is of a particle size to be completely melted before the concrete is discharged from the mixer drum for placement.

b) Aggregate

- Shading of coarse and fine aggregate stockpiles; and/or
- Wetting of coarse aggregate and allowing time for drainage of free water.
- Note that wetting down of stockpiles of fine aggregate is not permitted.

c) Mixing: Mixing time should be kept to a minimum, allowing adequate time for complete mixing of the concrete. The external surface of the mixing drum should be frequently wetted down.

d) Placing: Production of concrete during hot weather shall be scheduled for a continuous supply of concrete at the Site.

Adequate manpower, equipment and standby provisions shall be provided in order to place and consolidate the delivered concrete within 45 minutes after initial mixing. Further, the time interval between placing batches shall not exceed 30 minutes.

Time of placement extensions during hot weather concreting may be considered by the Ministry Representative and may require the use of Hydration Stabilizing Admixtures (HSA's) conforming to the requirements of ASTM C494 Type B, Retarding or Type D, Water-Reducing and Retarding Admixtures. Use of HSA's shall be in accordance with DBSS 211.08.02.

For large unformed surfaces, the quantity and rate of placing of concrete shall be dependent upon the rate of finishing and climatic condition.

When the rate of evaporation from unformed surfaces as estimated from Drawing SP211-01 "Surface Evaporation Rate" exceeds 1.0 kg/m²/hr, either concrete operations shall cease or, upon acceptance of the Quality Manager and Ministry Representative, necessary precautions taken to prevent plastic shrinkage as detailed in CSA A23.1 Section 7.4.2.2.

e) Curing during hot weather shall be commenced as soon

as possible.

Forms shall be kept moist and loosened as soon as this can be done without structural damage, with a flow of water introduced and allowed to run down inside.

Newly exposed concrete surfaces shall be protected from premature drying by the application of pre-wetted curing materials or a continuous water spray as the forms are removed.

Large exposures of concrete require special precautions as follows:

- burlap application commenced as soon as the surface will support the mass without excessive deformation, with this surface kept continuously wet by fog spraying until a waterproof barrier is securely in place
- concrete under the curing blanket is not allowed to dry out for a minimum of seven days from the time of initial covering, necessitating frequent checking and soaking by the addition of water under the top evaporation barrier
- wet curing followed by the removal of the evaporation barrier only under such conditions that the wetted burlap is permitted to dry slowly before removal and the surface is exposed to prevent excessive thermal shock.

211.19 Cold Weather Concreting. Cold weather concreting procedures shall be used when the ambient temperature is, or is forecast to be, below 4°C during placement, and/or is forecast to fall below 4°C during the first seven days after placing. The Contractor shall be fully responsible for the protection of concrete during cold and adverse weather conditions and shall maintain a minimum concrete temperature of 10°C for a minimum of seven continuous days. Prior to the placement of concrete, the Contractor shall submit to the Quality Manager and Ministry Representative for acceptance, the proposed placing operations complying with the requirements for cold weather concreting. The following provisions for cold weather concreting shall apply:

a) All aggregate and mixing water shall be heated to a temperature of at least 20°C but not more 65°C. However, the temperature of the combined water and aggregates shall not exceed 40°C when combined with the cement. The temperature of the concrete shall be between 10°C and 25°C at the time of placement.

b) Aggregates shall be heated to eliminate frozen lumps, ice and snow without overheating or excessive drying. Aggregates shall not be heated above 65°C, and all lumps of frozen aggregate shall be excluded from the mix.

c) Formwork, Reinforcing Steel: Before any concrete is placed, all ice, snow or frost shall be completely removed from the forms and the temperature of contact surfaces

raised to a minimum of 5°C, with such minimum established and maintained for at least one hour prior to placement.

Heat shall be applied uniformly and at a rate which will not induce excessive thermal stresses in the section being heated. Ambient air temperatures shall not exceed concrete temperatures by more than 13°C and shall be raised at a maximum rate of 2°C/hr.

Projecting reinforcing steel shall be insulated when temperatures are between 0°C and -10°C for a minimum of 300 mm away from the fresh concrete and for a minimum of 600 mm when temperatures are below -10°C.

d) Other Contact Surfaces: Concrete shall not be placed on frozen surfaces except in pile founded footings where a minimum layer of 25 mm rigid insulation shall be installed. Rock surfaces shall be heated by forced air. Heating shall continue until all standing frost crystals are dissolved. Frozen embankment shall be thawed and recompacted prior to placing concrete thereon. The temperature of existing concrete work shall be raised to a minimum of 5°C and maintained at this temperature for a time sufficient to raise the entire mass of concrete to this temperature.

e) Curing and Protection necessary to maintain a minimum concrete temperature (10°C) shall be provided throughout the curing period.

Heated enclosures shall be kept at 95% minimum relative humidity. Concrete surfaces shall be protected by formwork or impermeable membranes from direct exposure to the combustion gases of heating. The use of salamanders, coke stoves, oil or gas burners and similar spot heaters which have an open flame and intense local heat is prohibited without the Quality Manager and Ministry Representative's acceptance. The enclosed air temperature shall not be less than 10°C nor more than 26°C.

Where practical, insulated forms, capable of maintaining the surface of the concrete at not less than 10°C for a period of seven days, may be used instead of enclosures and heating. If forms are insulated, exposed horizontal surfaces shall be protected with a similar layer of the insulating material securely fastened in place. If the insulated forms do not maintain the proper temperature at the concrete surface, auxiliary protection shall be used to provide additional heat as described above.

The determination and recording of air and concrete temperatures to verify compliance with the requirements for cold weather concreting shall be the responsibility of the Contractor.

The Contractor is responsible for furnishing and using a 24-hour minimum/maximum or continuous temperature recording thermometer to record the air temperature within the enclosure and/or insulated forms. Daily records shall

be submitted to the Quality Manager and to the Ministry Representative upon request.

At the end of the curing period, heating and protection shall be withdrawn in such a manner so as not to induce thermal shock stresses in the concrete. The temperature of the concrete shall be gradually reduced at a rate not exceeding 10°C per day to that of the surrounding air. To achieve this, in a heated housing, the heat shall be slowly reduced and then shut off, and the whole housing allowed to cool to air temperature before the housing itself is removed. However, the protection shall not be removed until the temperature of the concrete has fallen to within 10°C of the temperature of the outside air.

211.20 Underwater Concreting. Underwater concreting procedures shall be used when structures, or parts of structures, are to be constructed under water. The concrete, methods of placement either by pumping or tremie pipes, and equipment shall be in accordance with the following, or as otherwise directed by the Designer and Ministry Representative:

a) Proposals outlining procedures shall be submitted for review to the Designer and Ministry Representative 3 weeks prior to placement of concrete. Placement shall comply with the provisions of the proposal.

b) Materials shall conform to the requirements of DBSS 211.04, except that coarse aggregates shall contain not more than 25% angular particles by mass.

c) Mix proportions shall be as specified in DBSS 211.03, except:

- cement content not less than 400 kg/m³
- water-cement ratio no greater than 0.40
- slump of 150 mm \pm 20 mm
- admixtures used to achieve plastic, cohesive and flowable concrete if acceptable to the Quality Manager and Ministry Representative
- retarding type admixture if accepted by the Quality Manager and Ministry Representative shall be used to prevent the formation of cold joints with the lift method of placement or where the concrete surface area is large.

d) Heating of water or aggregates or both, to obtain a suitable placing temperature, shall be done in accordance with DBSS 211.19. Concrete, when mixed, shall have a temperature of between 15°C and 25°C and shall not be placed in water having a temperature less than 2°C.

e) Cofferdams or forms into which concrete is to be placed shall be sufficiently tight to prevent the loss of mortar and, if in running water, reduce the velocity of flow within the cofferdam or forms to not more than 3 m per minute. Dewatering will not be permitted until at least 24

hours after concreting has been completed.

f) Pumping and tremie pipe requirements shall be as follows:

- length sufficient to reach the lowest point of deposit but held 150 mm to 250 mm above the bottom of the placement
- submerged into the placed concrete and held in a near vertical position at all times
- supported in such a manner to allow vertical movement
- discharge at locations not farther apart than 7 m
- discharge end fitted with a 3 m section of steel pipe
- fed by either chutes or pumps with a continuous flow of concrete.

g) Priming of tremie pipes shall be by inserting a plug of burlap, 25 mm less in diameter than the tremie pipe, in the top of the pipe and carefully controlling concrete flow as the plug passes through the pipe. Where priming is lost, the priming procedure shall be repeated.

h) Concrete flow, once begun, shall be continuous through the pipe, at a minimum of 15 m³ of concrete supplied to each tremie or pump per hour, but controlled so as not to overflow the feed hopper. The flow of concrete shall be continuous to the end of the batch and the pipe lowered in the placed concrete to maintain its prime.

i) Placement of concrete underwater shall be either to the full depth of placement or in lifts and shall conform to the following requirements:

- seals shall be placed by beginning at one end and continuing until final grade is achieved
- point of placement shall be relocated by approximately 3 m, either laterally or longitudinally and placement continued to grade
- above procedures repeated to the completion of the seal or when the lift method of placement is used
- flow of concrete shall be regulated to produce approximately horizontal surfaces
- each lift placed before the preceding lift has taken initial set
- depth and area of each lift dependent upon the rate of placement.

Concrete in its plastic state shall not be disturbed either directly or indirectly by puddling or vibration.

Should interrupted placement be sufficient for the concrete to take initial set, the laitance shall be removed from the concrete surface before concreting is resumed, but with the resumption of concreting delayed indefinitely, laitance shall be removed not later than 36 hours after the interruption.

SECTION 213

TIMBER BRIDGES - CONSTRUCTION

Note: Timber bridges may be used only when explicitly identified in the Contract as an acceptable product.

213.01 Materials - All materials shall be of the quality, grade and finish as shown on the Design and shall conform to the requirements of the DBSS 903, DBSS 904, DBSS 905 and DBSS 908 that are relevant.

213.02 Logs for Cribbs and Log Stringers - Logs for cribs shall be cut from live trees and shall be peeled before use.

Stringers shall be cut from live trees not less than 30 days before use and shall be seasoned with the bark on. Immediately before use in the work, all bark shall be peeled and the log trimmed smooth of all knots and projections.

213.03 Work Practice - The standard of work shall be first-class throughout and in accordance with the best modern practice.

213.04 Handling and Storing Materials - All materials shall be handled with reasonable care. Timber shall not be bashed, cut or punctured or otherwise damaged.

Dogs, hooks, peavies or other equipment shall not be used on the side surfaces of treated timber. All handling of treated timber with pointed tools shall be confined to end grain and shall be such as to avoid damage of the original pressure-treated surface.

Subject to the approval of the Quality Manager and Ministry Representative, the Contractor shall make good any superficial damage of treated timber by the methods outlined in the current edition of C.S.A. 080 Specification for Wood Preservation. Timber which, in the opinion of the Quality Manager and Ministry Representative, cannot be made good by such methods will be rejected.

Minor damage to untreated timber shall be repaired and severely damaged pieces will be rejected.

When unloading at the site of the work, the various pieces shall be sorted and stacked in such a manner as to require a minimum of rehandling before being placed in the structure.

Level ground cleared of snow, brush and weeds shall be provided for stacking the timber. The timber shall be placed on blocking to raise it above the ground.

213.05 Framing - Framing shall be first class in every respect and performed by skilled workers only. No open joints, blocking or shimming of joints will be allowed. Daps, gains and dove-tails in trestles, culverts, cribs, etc. may be finished with an adze, but all joints shall go together without pounding or excessive cramping up and have full bearing in contact.

Holes shall be bored with an auger to the sizes shown in Table 213-A.

Spikes that are likely to crack or unnecessarily damage the timber shall have holes bored 1/16" small.

213.06 Field Treatment - Unless so specified, treated timber shall not be cut or dapped except for cutting to length. Cut ends and specified cuts and daps of treated timber (except piles) shall be given three coats of the same preservative used in the treatment; creosote, if used, shall be hot.

The heads of all treated piles, after cut-off, shall be covered with alternate layers of hot roofing pitch and loosely woven fabric using four applications of pitch and three layers of fabric.

The fabric shall measure at least six inches more in dimension than the diameter of the pile and shall be neatly folded down and secured by large-headed galvanized roofing nails or by binding with not less than seven complete turns of galvanized wire securely held in place by large-headed galvanized roofing nails or staples. The edges of the fabric projecting below the fastening shall be neatly trimmed.

The heads of all untreated piles, after cut-off, shall be thoroughly swabbed with three coats of hot creosote oil and if they are to be capped, they shall also be coated with hot roofing pitch.

TABLE 213-A HOLE SIZES

	FIR AND HARD-WOODS	CEDAR AND SOFT-WOODS
BOLTS	1/16" Large	Same size as bolt
DRIFT BOLTS	Same size as bolt	1/16" Small
DOWELS	1/16" Large for ends of posts, but in sills make same size as dowel	1/16" Large for ends of posts, but in sills make same size as dowel

All bolt holes drilled in the field in treated timber shall be treated with hot creosote oil applied with an approved pressure bolt hole treater.

All surfaces in contact and all bolt holes in untreated timber shall be swabbed with a water-borne preservative.

213.07 Preparation of Laminated Decks for Wearing Surface

213.07.01 For Asphalt Plank - Depressions in laminated decks shall be levelled by placing and compacting a fine sand levelling course.

The levelling course shall consist of a mixture of fine durable sand conforming to the gradation shown in Table 213-B.

The sand shall be thoroughly mixed with asphalt emulsion, Type SS-1 which shall conform to the

requirements of DBSS 951.17. The asphalt emulsion content shall be such that an air void content of 5% to 8% in the compacted mixture is obtained. This will normally require an asphalt emulsion of 15% to 25% by weight of the total mixture.

Before laying and nailing asphalt plank, laminated decks shall be swabbed with oxidized mopping asphalt Type 2 conforming to the requirements of Table 213-C.

213.07.02 For Asphalt - Prior to placing asphalt wearing surface, creosote-treated laminated decks shall be lime-scrubbed where creosote oil has "bled" to the surface.

To prevent "bleeding" of the creosote oil, the mix temperature of hot-mix asphalt placed on these decks shall be as low as is practicable.

213.08 Not Used

TABLE 213-B CONSISTENCY OF THE LEVELLING COURSE

U.S. STANDARD AND ASTM SIEVE SIZES	PERCENTAGE PASSING BY WEIGHT (%)
#8	100
#16	100 - 60
#30	80 - 46
#50	62 - 35
#100	46 - 25
#200	35 - 18

TABLE 213-C REQUIREMENTS FOR OXIDIZED MOPPING ASPHALT TYPE 2

TEST DESCRIPTION	ASTM TEST METHOD	TYPE 2	
		MINIMUM	MAXIMUM
Softening Point (R & B), °F	D36	165	175
Flash Point, C.O.C., °F	D96	450	---
Penetration @ 32°F	D5	12	20
Penetration @ 77°F	D5	20	35
Penetration @ 115°F	D5	---	70
A.P.I. Gravity @ 60°F	D71	4.6	5.8
Ductility @ 77°F, 5 cm minimum	D113	3	---
Loss on Heating to 325°F, 5 hr., %	D6	---	0.3
Penetration of Residue, % of original	D5	80	0
Total Bitumen (soluble in CS ₂) %: Mineral Stabilized Asphalt	D4	80	---
Total Bitumen (soluble in CS ₂) %: Asphalt Without Mineral Stabilizer	D4	99	---
Proportion of Bitumen Soluble in CCl ₄		99.5	---

SECTION 214

TIMBER PILING CONSTRUCTION

Note: Timber piles may be used only when explicitly identified in the Contract as an acceptable material.

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

214.01 Materials - All piling shall conform to requirements of DBSS 906, Round Timber Piles, and where specified to DBSS 908, Preservative Treatment.

214.02 Pile Lengths - Piles shall have minimum lengths in accordance with those listed on the Design. Allowances will be made for such additional lengths of pile as may be required to provide fresh heading and to suit the method of operation.

Pile lengths determined by the Design, are those expected to remain in the completed structure plus 600 mm for cut-off, except for end bearing piles where the allowance for cut-off and bearing depth irregularity is as determined by the Designer.

214.03 Handling of Piles - The use of dogs, hooks, peavies or any other equipment which may damage the round surface of a treated pile will not be permitted.

Pointed tools used in the handling of treated piles shall be confined to end grain.

During lifting, long piles shall be supported at a sufficient number of points, properly located, to prevent damage due to excessive bending.

Subject to the approval of the Quality Manager and Ministry Representative, the Contractor shall make good any superficial damage of treated piles by the methods outlined in the current edition of CSA 080 Specifications for Wood Preservation. Piles damaged by the Contractor, which, in the opinion of the Quality Manager and the Ministry Representative, cannot be made good by such methods, will be rejected and replaced.

214.04 Hammer - Piles may be driven with a drop hammer or a mechanical hammer. Drop hammers shall weigh not less than 1,400 kg for piles less than 15 m long and not less than 1,600 kg for piles 15 m and over in length, and in no case shall the weight of the hammer be less than the combined weight of driving head and pile. Mechanical hammers shall develop a total energy not less than 3,900 kg per blow.

214.05 Leads - Pile drivers with fixed leads or with hanging or swinging leads that can be held in a fixed position during driving shall be used to drive all piles.

Batter piles shall be driven using leads adaptable to their driving.

When driving treated timber piles, the use of spuds and chocks in the leads shall be kept to a minimum in order that the protective treatment will not become bruised or broken.

214.06 Preparation for Driving

214.06.01 Driving Caps and Bands - The heads of timber piles, when driving is such as to unduly damage them, shall be protected by driving caps acceptable to the Designer, preferably having a rope or other suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block. Alternatively, the pile head may be banded with a pile ring and covered with a steel wire mat. When driving treated piles, a driving cap shall be used.

214.06.02 Pointing - Where soil conditions, in the opinion of the Designer, require the pointing of piles, the Contractor shall fit the piles with steel points.

Steel points fabricated in accordance with SS Drawing SP214-01, or as detailed by the Designer, shall be supplied by the Contractor.

214.06.03 Excavation - Footing excavation and seal excavation, where applicable, shall be completed with any necessary allowance made for upheaval before the driving of footing piles. Should too great an allowance be made, backfilling with gravel will, in general, be permitted to raise the bottom of the excavation to the correct elevation. Any material forced up between the piles to above the footing level shall be removed to the correct elevation.

214.07 Driving - Unless otherwise specified by the Design, all piles shall be driven with the small end downward. The fall of a drop hammer shall be regulated to avoid damage to the piles and under no circumstances shall exceed 3 m.

Each pile shall be square-headed, properly pointed, and set fair in the leads; if it becomes split or broomed on the top it shall be fresh headed.

For drop hammers:

$$s = \frac{wh}{6p} - 0.03$$

For mechanical hammers:

$$s = \frac{wh}{6p} - 0.003$$

Where: s = average penetration per blow in metres under last 10 blows

w = weight of moving part of hammer in newtons

h = effective fall of hammer in metres

p = allowable load capacity of pile in newtons

Piles shall be driven to the minimum depth indicated on the Design and unless otherwise ordered by the Designer, to practical refusal, which shall be to the depth at which the piles have a load carrying capacity of 20 tonnes and an average penetration per blow determined by the above formulae:

Where it is required by the Designer to penetrate a thin stratum (which may show practical refusal in driving) to obtain greater depth in a less resistant formation, driving shall be continued through the stratum regardless of the definition laid down for practical refusal.

Any pile which, in the opinion of the Designer or Ministry Representative, is so damaged in driving as to be unfit for the use for which it is intended, or is so far out of position, or off vertical or designated batter, as to require excessive force or manipulation to restore it to its proper position, shall be withdrawn and replaced by a new pile. If this is not possible, a new pile shall be driven adjacent to the defective pile.

Where boulders or other large obstructions make it impossible to drive piles in the location shown on the Design, the Designer may direct the Contractor to drive an additional pile, or piles.

214.08 Additional Equipment - Where, in the opinion of the Designer or Ministry Representative, the bounce of the hammer is excessive or where the required depth or resistance is not obtained by the use of a hammer complying with the above minimum requirements the Contractor shall provide a heavier hammer to complete the work.

214.09 Accuracy of Driving - All piles shall be driven in such manner that any variation from the vertical, or batter as shown on the Design, shall not exceed 20 mm/m. Piles in trestle bents shall be so driven that the cap may be placed in its proper location without including excessive stresses in the piles. Cutting, springing, dapping or facing-off for placing bracings and planking on piles will not be permitted.

After driving, footing piles shall not be more than 75 mm out of the position shown on the Design.

214.10 Pile Heads - The tops of all piling shall be cut off to a true plane as shown on the Design or as established by the Designer. Piles shall show a solid head at the plane of cutoff.

Pile heads not encased in concrete shall be protected as follows:

214.10.01 Treated Piles - After cut-off, the pile heads shall be covered with alternate layers of hot roofing asphalt and loosely woven glass fabric, using four applications of asphalt and three layers of fabric.

The fabric shall measure at least 150 mm more in dimension than the diameter of the pile and shall be neatly folded down and secured by large headed galvanized roofing nails or by binding with not less than seven complete turns of galvanized wire securely held in place by large-headed galvanized roofing nails or staples. The edges of the fabric projecting below the fastening shall be neatly trimmed.

214.10.02 Untreated Piles - After cut-off, the pile head shall be thoroughly swabbed with three coats of hot creosote oil and if they are to be capped, they shall also be coated with hot roofing asphalt.

214.11 Not used

214.12 Not used

SECTION 215

BRIDGES

215.01 General - Bridges shall be designed in accordance with the current Canadian Highway Bridge Design Code and the current Ministry standards and practices unless otherwise specified in the Contract. Unless otherwise specified in the Contract, fabrication and erection shall be in accordance with the current Ministry standards and practices and the Design prepared for the particular structure.

SECTION 216

COATING OF STEELWORK

216.1 Scope - This Section covers the operations required for shop, field and/or maintenance coating of structural and miscellaneous steel surfaces. The coating process includes pre-cleaning, surface preparation, coating, and curing of coatings.

216.2 Definitions

216.2.1 Good Painting Practice - The application of generally accepted methods and equipment to clean, contain and coat industrial structures in a safe, practical, environmentally sensitive manner resulting in a long lasting quality protective coating system. These principals are laid out in this Section. Many of the points are drawn from the SSPC (Society for Protective Coatings) publication Steel Structures Painting Manual Volume 1, Good Painting Practice. References are to the current edition unless otherwise stated. These practices are based on experience in the United States and where they conflict with Canadian or British Columbia laws, regulations or guidelines the local regulations shall prevail.

216.2.2 Shop, Field and Maintenance Coating - The series of operations that include the surface preparation, pre-treatment (if required) and application of coatings to structural steel surfaces either in the shop or in field. It also includes the supplying of all labour, equipment and materials. In addition, it encompasses the protection of newly coated surfaces during curing, transport and erection as well as the protection of traffic, property and the environment. Additionally, it also includes the disposal of waste material in accordance with all applicable environmental, fisheries and local regulations and bylaws.

216.2.3 Painting / Coating - The terms painting and coating are considered synonymous for the purposes of this document. Techniques such as metallizing or galvanizing while not typically thought of as painting, are considered here to be painting or coating since they form part or all of a protective system.

216.2.4 Shop Coating - The coating of steel or other components in a shop or plant before shipment to the site of erection. This may include part of a coating system or the whole system including the topcoat.

216.2.5 Field Coating - The coating of steel or components at the place of erection.

216.2.6 Maintenance Coating - The coating of structures in service that have previously been partially or completely coated. The maintenance coating may be one of four general types:

216.2.6.1 Touchup - The cleaning and coating of small selected areas on a structure. Typically, this is used to repair damaged or failed areas of coating. For repairs, sufficient coats are added to bring the new coating up to the level of the existing coating surrounding the repairs. It may also be used as an interim maintenance strategy to extend the lifetime of a coating system overall.

216.2.6.2 Zone Coating - The coating process where specific whole parts of a structure are coated and others are deliberately left. This deals with larger portions of a structure than touchup coating. For example an above deck arch portion of a bridge would be zone coated, but the edges of the flanges would be touched up. Zone coating may use touchup, overcoat, or recoat strategies to meet its objectives. Zone coating also includes coating new steel added to old structures for example steel added for seismic upgrades.

216.2.6.3 Overcoating - The coating of portions of a structure where the structure is touched up, then coated with a topcoat overall. It may include top coating part or all of the structure.

216.2.6.4 Recoating - The coating process where larger portions of old coating on a structure are removed to bare metal and a completely new coating system is applied over the entire area.

216.2.7 Surface Profile - The surface profile is a measure of the roughness of the prepared surface. The profile is normally measured from surface peak to surface valley and expressed as a range (for example 50 to 75 μm or 2 to 3 mils). Besides the depth, the surface profile is dependant on the grit type used to create it. Mineral abrasives such as sand, slag, garnet, etc. produce a 'sharp' profile. Steel shot produces a rounded profile unless mixed with 15% steel grit. Normally the surface profile is specified by both a depth and sharpness parameter.

216.2.8 Containment / Hoarding - The process of encapsulating the work site so that hazardous or nuisance materials cannot escape to the

surrounding environment. SSPC Guide 6 Guide for Containing Debris Generated During Paint Removal Operations specifies types and levels of containment necessary for various cleaning operations.

216.2.9 Ambient Conditions - Ambient conditions refer to such things as wind, relative humidity, dew point, air temperature, substrate temperature etc. that affect the cleaning, application, and curing of coatings. They are very important in obtaining a properly adhered, long lived coating. All coating works shall be within the specified parameters as given in DBSS 216.8.4, DBSS 216.8.5 and DBSS 216.8.9. Where ambient environmental conditions do not fall within these conditions, coating work may continue if the conditions are being met within the containment. This may mean extra hoarding, dehumidification, ventilation and/or temperature control for the duration of cleaning, application and curing of the coating system.

It is worthy of note that some coatings are designed to apply in conditions outside those mentioned above. These coatings and their conditions of use will be individually considered for use.

216.3 Reference Standards - It is recognized that standards are changed or amended from time to time. All specifications mentioned shall be the current editions at the date and time of contract signing unless a specific edition of a reference or standard is stated here or in the Design or Contract.

216.3.1 British Columbia Ministry of Transportation

216.3.1.1 Recognized Products List (RPL) - The Ministry publishes a Recognized Products List of products. This is available on the Ministry website at:

http://www.th.gov.bc.ca/publications/eng_publications/geotech/Recognized_Products_Book.pdf

Only those coating systems listed in DBSS 308 and under the heading of "Coating Systems" in the RPL or as otherwise specified in the Contract shall be used on Ministry Projects. The Ministry may, at its sole discretion, accept alternative materials to fit a unique situation.

216.3.2 SSPC - Society for Protective Coatings - The SSPC publishes two volumes: SSPC

Painting Manual Volume 1, Good Painting Practice and SSPC Painting Manual Volume 2, Systems and Specifications, which lay out the basics for painting steel structures. The following SSPC standards and guidelines shall apply unless noted otherwise in the Contract.

216.3.2.1 Surface Preparation Standards

216.3.2.1.1 General - SSPC-SP COM Surface Preparation Commentary for Steel and Concrete Substrates.

216.3.2.1.2 Visual Standards:

Guide to SSPC-VIS 1, Visual Standard for Abrasive Blast Cleaned Steel

Guide to SSPC-VIS 2 Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces

Guide to SSPC-VIS 3 Visual Standard for Power and Hand Tool Cleaned Steel

Guide to SSPC-VIS 4/NACE No. 7 Guide and Visual Reference Photographs for Steel Cleaned by Water Jetting

SSPC-VIS 5/NACE VIS 9 Guide and Reference Photographs for Steel Surfaces Prepared by Wet Abrasive Blast Cleaning

216.3.2.1.3 Surface Cleaning Standards:

SSPC-SP 1 Solvent Cleaning

SSPC-SP 2 Hand Tool Cleaning

SSPC-SP 3 Power Tool Cleaning

SSPC-SP 5/NACE No. 1 White Metal Blast Cleaning

SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning

SSPC-SP 7/NACE No. 4 Brush-off Blast Cleaning

SSPC-SP 10/NACE No. 2 Near-White Blast Cleaning

SSPC-SP 11 Power Tool Cleaning to Bare Metal

SSCP SP 12/NACE No. 5 Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Recoating

SSPC-SP 13/NACE No. 6 Surface Preparation of Concrete

SSPC-SP 14/ NACE No. 8 Industrial Blast Cleaning

SSPC-SP 15 Commercial Grade Power Tool Cleaning

216.3.2.2 Abrasive Specifications:

SSPC-AB 1 Mineral and Slag Abrasives

SSPC-AB 2 Cleanliness of Recycled Ferrous Metallic Abrasives

SSPC-AB 3 Newly Manufactured or Remanufactured Steel Abrasives

216.3.2.3 Paint Application Standards, Guides and Specifications:

SSPC-PA COM Commentary on Paint Application

SSPC-PA 1 Shop, Field and Maintenance Painting of Steel

SSPC-TU 3 Overcoating

SSPC-PA 2 Measurement of Dry Film Coating Thickness with Magnetic Gauges

216.3.2.4 Guides:

SSPC - Guide 6 Guide for Containing Debris Generated During Paint Removal Operations

SSPC – Guide 12 Guide for Illumination of Industrial Painting Projects

216.3.2.5 Technical Updates:

SSPC-TU 4 Field Methods for Retrieval and Analysis of Soluble Salts on Substrates

SSPC-TU 6 Chemical Stripping of Organic Coatings from Steel Surfaces

SSPC-TU 7 Conducting Ambient Air, Soil, and Water Sampling During Surface Preparation and Paint Disturbance Activities

216.3.2.6 Qualification Procedures - These requirements will be laid out specifically in the Contract for each project and will depend primarily on the work to be done. Contractors may require current certification in one or more of the following levels to perform Work as called for in the Contract.

SSPC-QP COM Commentary on Qualification Procedures

SSPC-QP 1 Standard Procedure for Evaluating Painting Contractors

SSPC-QP 2 Standard Procedure for Evaluation Painting Contractors to Remove Hazardous Paint

SSPC-QP 3 Standard Procedure for Evaluating the Qualifications of Shop Painting Contractors

NACE Coating Inspection Program Level 2 with Peer Review

2.16.3.3 Hot Dip Galvanizing

CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles

216.3.4 Metallizing

CAN/CSA-G189 Sprayed Metal Coatings for Atmospheric Corrosion Protection

216.3.5 Colour Standards - Refer to US Federal Specification 595B Colors. Topcoat colours shall be in accordance with the Design or as determined by the Ministry Representative.

216.4 Environmental Considerations

216.4.1 General - All coating works including preparation shall comply with DBSS 165, Protection of the Environment.

216.4.2 Environmental Agencies Affected - Depending on the Work, some or all of the following Environmental Agencies and other affected parties have interests and may need to be contacted for their input to the Work. The list below is not exhaustive.

216.4.2.1 Federal:

Fisheries and Oceans Canada

Environment Canada

Transport Canada

Port Authorities

216.4.2.2 British Columbia:

Ministry of Water Land and Air Protection (WLAP)

Provincial, Municipal or Private Utilities if Affected

Railways if Affected

Aboriginal Bands if Affected

Water User Groups if Affected

Other Affected Parties, as necessary

The various parties' interests vary from legislated involvement to public or private interest in the

portion of the environment potentially affected by the coating project. It is the Contractor's responsibility to liaise with all the affected parties and to meet the requirements of the relevant authorities.

216.5 Containment of Coating Operations

216.5.1 General - Full containment shall be provided to prevent contamination of the environment. This enables work to be accomplished by physically limiting the spread of debris and facilitates cleanup. Current containment technology is able to contain virtually all debris generated by washing, water jetting, hand, power tool, or abrasive blasting, and coating operations.

216.5.2 SSPC - Guide 6 - Containment shall be provided in accordance with SSPC - Guide 6, Guide for Containing Debris Generated During Paint Removal Operations. In general, the Ministry wishes to minimize the environmental impact of all Ministry coating work. To this end, all coating works shall be fully enclosed to prevent contamination of the environment. The coating specification will contain specific language to exactly determine the desired containment end performance requirements. Containment shall be approved by the pertinent WCB, Environment and Fisheries Authorities.

216.5.3 Containment of Debris and Disposal of Debris - All debris from cleaning and coating operations must be contained in such a way as not to contaminate the environment. All debris shall be contained, tested and disposed of in accordance with current environmental, fisheries and local regulations. The Contractor shall provide written proof of disposal of all materials including way-bills and transport logs.

216.6 Construction Site Safety

216.6.1 General - General site safety is governed primarily by DBSS 135 Construction Site Safety. Contractor shall also meet all WCB regulation requirements for work undertaken.

216.6.2 Specific Safety Issues Relating to Bridges and Coating Work

216.6.2.1 Working at Height - All work occurring at height shall conform to all WCB regulation requirements.

216.6.2.2 Lead Paint - Many of the Ministry structures are painted with paint containing lead. While the Ministry will attempt to indicate the presence of paint containing lead, it is the responsibility of the Contractor to ascertain the presence and extent of lead containing paint if any; and to conform to all regulations for work undertaken. This includes but is not necessarily limited to WCB and WLAP regulation requirements for working with, storing, transporting, disposing of and documenting any work process involving lead paint.

216.6.2.3 Enclosed Spaces - Many of the Ministry structures contain enclosed spaces or spaces that the WCB defines as enclosed spaces. In some instances the hoarding or containment is considered an enclosed space. It is the responsibility of the Contractor to ascertain whether or not a space is defined as an enclosed space and to adjust their work procedures to meet all regulation requirements.

216.7 Surface Preparation

216.7.1 General - The useful lifetime of a coating is extended by appropriate surface preparation prior to coating. The surface preparation shall be in accordance with the Contract requirements. The Designer will define the quality of surface preparation for a given area to be coated. Where this surface preparation differs from the coating manufacturer's recommended surface preparation, the Design shall be considered correct. However, in the case where the coating manufacturer's specification requires more stringent surface preparation, then the coating manufacturer's specification shall apply unless otherwise approved by the Ministry Representative.

Where surface preparation is not defined in the Contract or in the Design, the manufacturer's specifications shall be used.

216.7.2 Washing

216.7.2.1 General - Washing is a procedure for removing surface contaminants including oil, grease, drawing and cutting compounds, soil, salts, etc. from either steel or coated surfaces. Removal of the contaminants shall be accomplished by the use of any one or a combination of the following: potable water, alkaline cleaners, solvents, emulsion cleaners, steam cleaning (with detergents), high pressure

water, scrubbing (with detergent) or other approved method.

Alkaline cleaners, detergents, solvents, etc. shall not be used over streams, lakes, rivers, etc. or agricultural land without first obtaining approval from the Ministry of Water, Land and Air Protection (WLAP) as well as Fisheries and Oceans Canada and Transport Canada.

The washing procedure shall be conducted so that any part of the structure which has already been cleaned, or newly coated, shall not be contaminated with the cleaning chemicals or solvents.

Immediately after treatment with cleaning chemicals, the surfaces shall be thoroughly washed with clean water to remove detrimental residues.

216.7.2.2 Residual Ion Levels - One main reason for washing is to remove residual anions such as chloride and sulphate as well as the ferrous cation and other non-visible contaminants. Currently, low risk levels for most of the ions are not well defined, however chloride levels are. Generally levels shall be at or below the SSPC-SP12 NV-2 level, less than 7 µg/cm² chloride ion, 10 µg/cm² soluble ferrous ion, and 17 µg/cm² sulfate, immediately prior to application of coatings when tested by SSPC-TU 4 swabbing extraction method.

Chloride levels shall be measured using one of the methods in SSPC-TU 4, and calculated using the formula in Appendix C of that specification. Verification of NV-2 level shall be done prior to surface preparation operations and prior to primer application.

216.7.3 Water Cleaning/Jetting - Water jetting encompasses low pressure water cleaning (LP WC), high pressure water cleaning (HP WC), high pressure water jetting (HP WJ), and ultrahigh pressure water jetting (UHP WJ).

SSPC-SP12/NACE No. 5, Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh- Pressure Water Jetting Prior to Recoating defines specifications for visual and non-visual surface preparation by water jetting.

Water jetting is inherently dangerous and safety precautions as listed in SSPC-SP 12 and in SSPC Steel Structures Painting Manual, Volume 1,

Good Painting Practice, shall be followed. Where current WCB regulations conflict with SSPC-SP12/NACE No. 5, the WCB regulations shall prevail. Water used in water jetting units shall be clean and free of contaminants that may leave deposits on the surface being cleaned or affect the adhesion of subsequent coatings applied. Water supply to the water jetting units must meet regulations for water taken from streams if on-site water from streams is used.

All waste water and coating debris shall be contained and disposed of in accordance with Environmental and Fisheries Agencies or other applicable regulations.

Wastewater must meet regulations for disposal on-site if it is to be disposed of on-site. These regulations are typically those of Fisheries and Oceans and WLAP, but may not be limited to those governmental agencies. As well, DBSS 165 Protection of the Environment, lays out the Contractor Responsibilities.

216.7.4 Manual and Power Tool Cleaning - Manual cleaning is a procedure for removing loose mill scale, loose rust, loose coating and other detrimental foreign matter by chipping, scraping, grinding, and wire brushing, etc. The tools used for this method of cleaning may be either hand or power tools; they shall be of high quality, and maintained in good repair.

The standard of cleaning obtained by this method shall be SSPC-SP 2, SP 3, SP 11 or SP 15 as specified in the Design. Where surface preparation is not defined in the Design, the manufacturer's specifications shall be used.

In specific circumstances the methods available may be limited by the Design.

In all four preparation methods listed above, the surface shall be cleaned of dirt, grease and soluble salts prior to treatment. Heavier layers of rust shall be removed by chipping, before any of the other cleaning tools are used.

Finally, all traces of dust shall be removed prior to coating.

216.7.5 Abrasive Blast Cleaning - Abrasive blast cleaning is a procedure for removing mill scale, rust, rust scale, paint or other foreign matter by use of abrasives propelled through nozzles or by centrifugal wheels. It is also used to roughen the surface of the substrate to enhance adhesion.

If compressed air blasting is employed, proper line filters and dryers, which remove all oil and water from the air, shall be used. Compressed air shall be periodically tested for presence of these contaminants.

The standard of cleaning obtained by this method shall be SSPC SP 5, SP 6, SP 7, SP 10, or SP 14

In all preparation standards, it is assumed that prior to treatment the surface has been cleaned of dirt, oil, grease and soluble salts etc. If necessary, heavier layers of rust shall be removed by chipping before the blast cleaning operation commences.

A cleaned and blasted surface shall be coated within a maximum of 8 hours of cleaning and before the surface shows evidence of rust blooming. If either of these criteria is not met, then the surface shall be re-prepared to specification. If a prepared surface is contaminated before coating, it shall be re-cleaned and/or re-blasted in accordance with the Design or manufacture's specifications before coating is applied.

Finally, all traces of dust and sand, etc. shall be removed prior to coating.

216.7.6 Abrasive Materials - Abrasive materials, unless specified, must be accepted by the Quality Manager and Ministry Representative.

216.7.7 Recycled Steel Abrasive - Recycled steel abrasives are permitted, however the working material must meet SSPC-AB 2 requirements and must contain a minimum 15% steel grit to produce an angular/sharp profile.

216.7.8 Containment of Debris and Disposal of Debris - All debris from cleaning and coating operations must be contained in such a way as not to contaminate the environment. All debris shall be contained, tested and disposed of in accordance with current environmental, fisheries and local regulations. The Contractor shall provide written proof of disposal of all materials including way-bills and transport logs.

216.8 Application of Coating Materials

216.8.1 Pretreatment - Newly cleaned surfaces may require pretreatment other than washing or abrasive blasting prior to the application of the prime coat of paint. The application of the pretreatment shall be strictly in accordance with the manufacturer's directions. When

pretreatments are used, particular care shall be taken to prevent contamination of adjacent surfaces.

216.8.2 General - In general, Contractors shall follow SSPC-PA 1 Shop, Field, and Maintenance Painting of Steel when applying coatings. Where DBSS 216 and SSPC-PA 1 disagree, DBSS 216 shall be taken as applicable.

216.8.3 Materials Storage and Handling - Materials handling and use shall be as per SSPC-PA 1, 5.1. Coatings shall be stored in a secure building on-site, but not on the structure itself. Coatings taken onto the structure in cans, pails or totes shall be contained so that should they spill, no coating will escape to contaminate the adjacent area or environment.

216.8.4 Temperature - Coatings shall only be applied when the ambient, surface or coating temperature is within the range indicated by the Manufacturer's written instructions. Coating shall not be applied when the substrate temperature is less than 3°C above the Dew point. Winter or quick dry catalysts or coating formulations shall not be used. Some coatings are designed for use in marginal conditions. Their use shall be as specified by the Designer and shall be acceptable to the Ministry Representative. In unique situations where coatings must be used outside these limits, they shall only be used as specified by the Designer and when permitted by the Ministry Representative. Lack of permission may necessitate removal, re-cleaning and reapplication by the Contractor.

216.8.5 Humidity - Coatings shall not be applied in wet weather, fog, mist, rain, snow and/or relative humidity in excess of 85%. Coatings shall not be applied to wet or damp or icy surfaces and care shall be taken to ensure that any overnight dew has completely evaporated before coating commences in the morning. Some coatings are designed to cure in higher humidity environments and may be specified on the Design.

216.8.6 Mixing and Thinning - All ingredients in any container of paint shall be thoroughly mixed before use and shall be agitated often enough during application to keep the paint in uniform condition. In all cases of heavily pigmented paints (e.g. "Zinc Rich" paints) the material shall be continuously agitated during application.

Mixing shall be done in accordance with the manufacturer's instructions and in accordance with good painting practice as outlined in SSPC Steel Structures Painting Manual, Volume 1, Good Painting Practice and SSPC-PA 1.

Thinner shall only be added with the written consent of the Manufacturer and only after it is shown that satisfactory application cannot be obtained with proper adjustment of the spray equipment and air pressures. In no case shall more than 12.5% of thinner by volume be added to a paint.

Only thinner specified and supplied by the Manufacturer for that product shall be added to a product. Thinners used for cleanup shall not be recycled as thinning agents. Paint shall be mixed by mechanical methods. Paint shall be mixed in a manner that will ensure breaking up of all lumps, complete dispersion of settled pigment and a uniform composition. After mixing, all paint shall be strained to remove skins and other undesirable matter; the strainer shall not be so fine as to remove any pigment.

Thinner, when approved, shall be added after initial mixing is completed. The quantity of thinner added shall be measured in and thoroughly mixed until the paint is again of uniform consistency.

216.8.7 Induction Time - Manufacturers' induction times shall be strictly observed before the coating is applied. Since induction times are a function of temperature, temperatures outside the normal range may necessitate changing the induction period. Revised times if necessary shall be provided by the Coating Manufacturer in writing and subject to acceptance by the Quality Manager and Ministry Representative.

216.8.8 Pot Life - Manufacturer's estimates of pot life shall be adhered to and no coating shall be used after the recommended pot life has expired.

Since pot life is a function of temperature, in hot or cold conditions the pot life may have to be modified reflect that temperature. Revised pot life times if necessary shall be provided by the Coating Manufacturer in writing and subject to acceptance by the Quality Manager and Ministry Representative.

216.8.9 Wind - Paint shall not be sprayed when the wind speed is over 15 km per hour. This includes gusts. Wind speed shall be measured

where the work is taking place, for example within the containment.

216.8.10 Curing Conditions - Coating lifetime may be affected by curing conditions. Coatings shall be protected from rain during their curing. Coatings shall be cured under the Coating Manufacturer's stated conditions. This may require heating, cooling, humidity or ventilation adjustments to bring the ambient conditions into line with the Coating Manufacturer's recommended conditions for curing. In enclosed spaces, ventilation must be provided to remove evaporating vehicle from the coating.

Failure to achieve proper curing or curing conditions may necessitate removal, re-cleaning, reapplication or repair of the coating by the Contractor.

216.9 Inspection

216.9.1 General - The Contractor shall provide the quality control and quality assurance functions for the Work. Quality audit will be done by the Ministry. The Contractor shall produce a quality plan for all work to be done and submit this plan for the Ministry's acceptance. The Ministry will audit the quality process via the Ministry Representative.

216.9.2 Quality Control and Quality Assurance Inspection - Quality Control and Quality Assurance inspectors shall be qualified NACE Level 2 plus peer review, i.e. NACE Certified Coating Inspectors. Inspection records produced shall be quickly forwarded to the Quality Manager and Ministry Representative. The records shall be electronic files, preferably Microsoft Excel files, and shall be forwarded to the Quality Manager and Ministry Representative in that format to speed dissemination and aid any data manipulation required for the quality audit. Where this is not possible due to lack of communication technology, the records may be hard copy or hand delivered electronic files. The Quality Control and Quality Assurance inspector(s) shall follow the quality plan as developed by the Quality Manager and accepted by the Ministry.

All washing and cleaning work shall be inspected by the Contractor before any coating is applied. Each coat of paint shall be inspected by the Contractor and passed before the succeeding coat is applied.

Coated surfaces rejected shall be made to comply with all requirements of this specification.

216.9.2.1 Hold points for inspection shall include, but may not be limited to:

Installation of scaffolding and other accesses
 Installation of containment
 Surface after washing
 Surface after cleaning prior to coating application
 Surface after Prime coat
 Surface after Penetrating Sealer if any
 Surface after Stripe Coat
 Surface after each midcoat
 Surface after caulking
 Surface after topcoat
 Removal of containment
 Removal of scaffolding and other accesses

216.9.2.2 Accessibility for Inspection - The Contractor shall provide the Quality Manager and Ministry Representative safe access to the specific areas of the jobsite under inspection. In order to limit the work disruption, the Contractor shall notify the Quality Manager and Ministry Representative of upcoming hold points at least 24 hours prior to the hold point. The Ministry Representative may perform quality audit inspections in conjunction with or subsequent to the Contractor's quality control and quality assurance inspections. The Ministry Representative will attempt to limit delays to the Contractor as much as possible, but retains the right to obtain as much information from the quality audit inspections as needed to justify acceptance or rejection of the work.

The Contractor shall maintain a minimum 200 foot-candles illumination at all areas of the work to be inspected. This may include adding lighting to augment natural light. Lighting if added shall be according to SSPC Guide 12, Guide for Illumination of Industrial Painting Projects.

216.9.3 Thickness Measurement - Large areas amenable to the application of SSPC-PA 2 Measurement of Dry Paint Thickness with Magnetic Gauges shall be measured by this method. The use of PA 2 is not considered to limit the number of measurements should additional readings be needed for any reason.

The Contractor shall set aside a suitable area of steel on the structure to be coated and dry abrasive blast clean the area with the Contractor's equipment and blast abrasive to the standard required by the coating specification. This area shall be protected from moisture and shall be used as a standard for acceptable surface cleanliness and anchor profile. A portion of the area shall also be used as an area to verify the calibration of dry film thickness (DFT) gauges. It is recognized that the magnetic plane on the blast cleaned surface is above the bottom of the profile. The Contractor shall fill that difference with coating. If requested by the Quality Manager or Ministry Representative, the Contractor shall produce and calibrate a secondary, portable calibration standard for dry film thickness gauges. The dry film thickness of small and/or more complex areas shall be measured as agreed upon by the Contractor's Inspector and the Ministry Representative. Gauges are to be calibrated according to SSPC-PA 2 at the beginning and end of each work shift.

216.9.4 Tinting Multilayer Systems - Each separate coat, penetrant, stripe, midcoat(s) and topcoat shall be coloured or tinted to differentiate it visually from the coats above and below. This is an aid to application and inspection and also serves as an indicator of wear for the life of the coating.

216.9.5 Coating Systems - DBSS 308 lists coating systems used or identified by the Ministry and suggests situations where the systems are best applied. Coating systems meeting DBSS 308 requirements are listed in the Recognized Products List. Only specified coating systems from the Recognized Products List shall be used.

Occasionally, special requirements mandate the use of coating materials not already listed in DBSS 308. These requirements will be specified in the Contract or will be shown on the Design. Approval from the Ministry Representative is required for the use of coating systems that are not listed on the Recognized Products List.

216.9.6 Coatings from Different Manufacturers - The Contractor shall not mix or interchange coatings or solvents from different manufacturers.

216.9.7 Coating Flaws - A coat of paint will only be accepted if none of the following faults are apparent:

- Coatings showing sags, runs, holidays, pinholes, orange peel, dry spray, shadowing or other application defects.
- Poor coverage at rivet heads, bolts, threads, plate edges, crevices, pockets, corners or re-entrant angles.
- Surfaces damaged mechanically by moving scaffolding, equipment, etc. or damage by rain, flying dust, etc. or damage from any other cause.

Sags and runs may be repaired or treated as per SSPC-PA 1, Section 7.4.5

Coatings shall be applied as per SSPC-PA 1, except where directed otherwise by this specification.

216.9.8 Rejection - Areas not meeting specification shall be repaired by the Contractor. At the discretion of the Quality Manager and the Ministry Representative, small areas may be spot repaired. Larger areas shall be re-cleaned to specification and the coating built up again to specification.

216.10 Application Methods (Excluding metallizing and Hot Dip Galvanizing)

216.10.1 General - Coatings are designed to be applied by specific application techniques. These techniques are specified by the Manufacturer to ensure that the risk of failure is minimized. Manufacturer's product application sheets shall be followed when applying coatings.

Where an application method is not possible due to circumstances at a particular structure, the Contractor shall obtain written instructions from the Manufacturer for a new application method. The Quality Manager and Ministry Representative must accept such methods before they are used.

216.10.2 Brush or Roller Application - Brushes or rollers shall be of high quality and of a style and material that will enable proper coating application. The paint shall be brushed or rolled so that there are no runs or sags, minimum brush marks and a uniform thickness. Achieving the specified thickness for a coating may require more than one coat with brush or roller. The Contractor is responsible for achieving the specified thickness.

216.10.3 Air Spray Application - The equipment shall be capable of properly atomizing

the paint to be applied. The equipment shall be kept clean and maintained in excellent condition. Equipment that has dirty or malfunctioning parts shall not be used until the parts are cleaned, repaired or replaced as necessary, to the satisfaction of the Quality Manager and Ministry Representative.

Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray pattern shall be adjusted so that the paint is deposited uniformly. During application, the gun shall be held perpendicular to the surface and at a distance that will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun shall be released at the end of each stroke.

All runs and sags shall be brushed out immediately, or the paint shall be removed and the surface repainted.

Areas inaccessible by spray such as cracks and crevices and the blind sides of rivets and bolts shall be painted by brush. Stripe coat material may be applied by spray to speed up the transfer of material to the surface, but all stripe coating must be brushed in to ensure complete wetting and coverage.

The air caps, nozzles and needles shall be those recommended by the manufacturers of both the material being sprayed and the equipment being used.

Proper air line filters and dryers shall be provided to remove oil and condensed water from the air. The air from the spray gun impinging against the surface shall show no condensed water or oils.

The pressure on the material in the pot and of the atomizing air shall be adjusted for optimum spraying effectiveness. Both material and atomization pressures shall be controlled by suitable pressure regulators with gauges. The atomizing air pressure shall be high enough to properly atomize the paint, but not so high as to cause excessive fogging of paint, excessive evaporation of solvent or loss by overspray.

The air compressor used shall be of sufficient size to maintain the regulated air pressures constant at all times, irrespective of the amount of equipment that is being operated from the compressor.

216.10.4 Airless Spray Application - The equipment shall be capable of properly atomizing the paint to be applied. The equipment shall be

kept clean and maintained in excellent condition. Equipment that has dirty or malfunctioning parts shall not be used until the parts are cleaned, repaired or replaced as necessary, to the satisfaction of the Quality Manager and Ministry Representative.

Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray pattern shall be adjusted so that the paint is deposited uniformly. During application, the gun shall be held perpendicular to the surface and at a distance that will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun shall be released at the end of each stroke.

All runs and sags shall be brushed out immediately, or the paint shall be removed and the surface repainted.

Areas inaccessible by spray such as cracks and crevices and the blind sides of rivets and bolts shall be painted by brush. Stripe coat material may be applied by spray, to speed up the transfer of material to the surface, but all stripe coating must be brushed in to ensure complete coverage.

Fluid tips shall be of proper orifice size and fan angle, and fluid control gun of proper construction as recommended by the manufacturers of both the material being sprayed and the equipment being used.

The air pressure to the paint pump shall be adjusted so that the paint pressure to the gun is proper for optimum spraying effectiveness. The pump pressure shall be controlled by a suitable regulator with working gauges.

Pressures higher than that necessary to properly atomize the paint shall not be used.

The air compressor used shall be of sufficient size to maintain the regulated air pressure to the pump constant at all times irrespective of the amount of equipment being operated from the compressor.

Proper filters shall be provided in the high pressure line so that dirt, dry paint or other foreign materials are not deposited on the paint film.

The trigger of the gun shall be pulled fully open and held fully open during all spraying to ensure proper application of paint. The trigger shall be released at the end of each stroke.

216.10.5 Mitt and Dauber Application - Mitt and Dauber application shall be limited to situations where other coating application

methods are poorly suited. Their use shall be as specified by the Designer and only with prior acceptance by the Ministry Representative.

Coating thickness shall be uniform over the entire surface of the object coated. Coating shall be free of pinholes or other holidays, sags, etc.

216.10.6 Powder Coatings - Powder coatings are finely ground coatings that are electrostatically sprayed onto the substrate, then melted into a consolidated layer by heat. Coatings may be thermoplastic or thermosetting. Cleaning is typically in a series of chemical baths.

Substrates contaminated with soluble salts shall be washed to remove those salts before being cleaned to meet specification. Acceptable levels of soluble salts shall be at the NV 2 level as stated in SSPC-SP 12.

The substrate to be coated shall be cleaned to the coating manufacturer's specifications. The water test shall show a clean surface.

If required for adhesion, a conversion coating shall be applied to the substrate before powder coating.

Fresh and reclaimed powder shall be dry, free flowing, and free of lumps and contaminants.

Soaking oven temperatures and residence times shall be sufficient to completely melt the powder, but not enough to oxidize or discolour the coating.

Coating thickness and gloss shall be uniform over the entire surface of the object coated. Coating shall be free of pinholes or other holidays.

216.11 Application Methods (Metallizing and Hot Dip Galvanizing)

216.11.1 Metallizing - Metallizing shall be applied in accordance with CSA-G189

Metallizing includes the thermal spraying of zinc or Zn:Al/85:15 alloy onto a properly prepared metal substrate.

The method of heating the spray metal is either by flame or by plasma arc. Spray metal may be in wire or powder form to fit the apparatus used to spray the metal. The application method shall ensure that a uniform, clean, well adhered, film of metal is applied to the steel surface.

Surface preparation shall be SSPC SP5 white metal blast. Profile shall be sharp, 50 to 75 µm.

Metallizing shall be applied by qualified personnel with documented field experience metallizing steel structures such as bridges.

Metallizing shall be applied in a uniform layer at a thickness of 150 to 200 µm thickness. For special applications, the thickness may be specified outside this range.

When the metallizing is to be overcoated to form a duplex system, the newly metallized surface shall be protected from contamination until coated. If the metallized surface becomes contaminated, the steel substrate shall be re-cleaned to SSPC SP5/NACE No. 1 as above and re-metallized.

Metallizing is porous, and application of a coating over the surface may require a mist coat or other special procedures to avoid bubbling and subsequent problems caused by the interaction of the porous coat with the coating being applied.

Metallizing may be applied over a much wider range of ambient conditions than normal paint. When application conditions may deviate outside normal coating conditions, the Contractor shall consult the Quality Manager and Ministry Representative for acceptance before proceeding.

216.11.2 Hot Dip Galvanizing - Hot dip galvanizing shall be applied per CAN/ CSA-G164.

216.12 Application of Coatings

216.12.1 General - Application of coatings on steelwork specified to be painted as part of the Contract or the Design shall meet the following requirements.

216.12.1.1 Welding Requirements - Areas to be field welded shall have no paint applied for a distance of at least 100 mm back from the weld area.

If inorganic zinc primer is used, the set-back shall be a minimum 25 mm.

All welds shall be cleaned of weld residue including weld spatter and roughness on the welds. Sharp edges shall be rounded to a minimum radius of 1 mm.

All welds shall receive a stripe coat of midcoat material over the primer prior to the midcoat.

Welding done on existing coated surfaces shall have the coating removed, past the heat affected zone or 100 mm from the weld whichever is more,

down to bare metal. Surface profile of the cleaned area shall be at least 25 µm (1mil).

216.12.1.2 Faying Surfaces - Unless specified otherwise in the Design, the faying surfaces of weathering steel shall be blast cleaned but not coated.

When faying surfaces are specified to be coated, faying or friction connections shall be coated with only a prime coat of a Class B certified coating. A copy of the Class B test certificate shall be supplied to the Quality Manager and the Ministry Representative for each coating used on a faying surface. The class of coating is as defined in CSA/CAN S6-00.

Coating and curing conditions shall strictly follow all application parameters listed on the Class B Certificate. Failure to do so will require re-cleaning and recoating according to the Class B parameters for that coating.

216.12.1.3. Surfaces Inaccessible After

Erection - Surfaces inaccessible after erection shall receive the field coats of paint in the shop, before shipment to the erection site. Prior to erection, handling damage shall be repaired to the satisfaction of the Quality Manager and Ministry Representative.

216.12.1.4 Application and Curing of

Successive Coats of Paint - Each coat of paint shall be in a proper state of cure or dryness before the application of the succeeding coat. Unless otherwise specified by the Designer a minimum of overnight drying shall be required. Under poor drying and curing conditions, this period will be extended.

Curing conditions shall be those given by the Coating Manufacturer in the product application instructions. Curing time will vary according to temperature and in some cases humidity. The required curing time is estimated at the ambient conditions during curing. This will normally be done from data supplied by the Coating Manufacturer.

Coatings that have a maximum overcoating window shall not be overcoated after that time without appropriate surface preparation as provided in writing by the Coating Manufacturer. The overcoat window will be calculated from data supplied by the Coating Manufacturer using the ambient conditions at the site.

216.12.1.5 Primer - Primer shall not be applied until the cleaned steel surface meets specification requirements. Once specification requirements are met for a substrate, the primer must be applied within 8 hours. The substrate if protected will be assumed to continue to meet the specification for 8 hours unless obvious contamination has occurred. This will be at the discretion of the Quality Manager and the Ministry Representative.

Primer shall be applied to specification requirements. Should the specification requirements be different than the Coating Manufacturer's application instructions then the more stringent specification shall apply unless otherwise approved by the Ministry Representative.

216.12.1.6 Penetrating Sealers - Penetrating sealers or low viscosity products designed to wick into seams and seal them shall be applied according to the Coating Manufacturer's product data sheets unless the Design calls for specific application parameters. Should that be the case, the sealer shall be applied to the Design requirements.

Current industry thinking has these products applied on top of a single primer coat and under stripe and midcoats.

Under certain circumstances it may be necessary to use a penetrating sealer as a primer or as a first coat. This will be specified by the Designer and subject to acceptance by the Ministry Representative.

216.12.1.7 Stripe Coat - All areas such as crevices, corners, rivets, bolts, nuts, welds, edges and other protrusions shall be given a stripe coat to ensure that there is sufficient coating dry film thickness. Coating may be applied by spray, but it shall be brushed into all areas to be striped.

The stripe coat is a separate coat and shall be applied at the thicknesses given for the midcoat coating.

The stripe coat shall be applied to the area and at least 25 mm out from the area to be striped.

The stripe coat shall be a contrasting colour to the coats above and below it.

The stripe coat shall be cured before being overcoated.

216.12.1.8 Midcoat - Midcoat shall be applied as a full coat onto clean, cured, primer, sealer, and

stripe coats. The stripe coat and or sealer shall be cured before being coated.

216.12.1.9 Caulking - Caulking shall be applied after the midcoat and prior to the topcoat.

Caulking shall be compatible with the coating system used.

Silicone Caulking shall not be used.

Suitable caulking materials are listed in DBSS 308 under the sub heading System PCM Paint Caulking Materials.

Caulking shall be applied as specified in the Contract.

Caulking shall not be topcoated until it cures according to the Manufacturer's product data sheets. Lower temperatures may increase this time.

If there is a time window for top coating, the caulking shall be topcoated before the window expires.

216.12.1.10 Topcoat - Once the undercoat and caulking if any have cured, the topcoat shall be applied.

216.12.1.11 Lapping Existing Coatings - Primer if applied shall not overlap existing coatings by more than 10-20 mm. Ministry preference is that it just contacts the existing feathered coating or overlaps very slightly to seal the join.

Midcoat shall overlap existing coatings by a minimum 50 mm.

Topcoat shall overlap existing coatings by a minimum 50 mm and shall hide all newly added midcoat material.

216.12.2 Shop Coating

216.12.2.1 General - Unless otherwise specified the following procedure shall apply to all new steel prior to shipment to the site of erection:

Before blast cleaning, the steel shall be checked for contamination of non-visible salts and the surface shall meet SSPC-SP12/NACE No. 5, NV-2.

Before coating, the steel shall be blast cleaned to SSPC-SP 10/NACE No.2 Near white. Abrasive blast cleaning will be permitted prior to fabrication provided that any contamination incurred during fabrication is removed prior to coating, leaving an SSPC-SP 10/NACE No.2

surface. Small areas of contamination occurring during fabrication shall be cleaned by manual cleaning to SSPC-SP 3 Power tool cleaning and/or SSPC SP-12/NACE No. 5 LPWC as necessary to remove contamination. Large areas of contamination occurring during fabrication shall be dry abrasive blast cleaned again to SSPC-SP 10/NACE No.2 Near-white blast.

Surface profile for primers shall be 50 to 75 µm and sharp.

Prior to dry abrasive blasting, all welding slag, spatter and alkaline deposits in the vicinity of the welds shall be removed. Surfaces shall then be blast cleaned to SSPC-SP 10/NACE No.2 Near-white blast.

When fabrication is completed and the surfaces cleaned as required, they shall be inspected by the Quality Manager and Ministry Representative prior to the application of paint.

After passing inspection and before any contamination has occurred, prime all steel surfaces with one coat of the selected shop coat primer from DBSS 308. Primer shall be applied to specification requirements. Should the specification requirements be different than the Coating Manufacturer's application instructions then the more stringent specification shall apply unless otherwise approved by the Ministry Representative.

A dry abrasive blast cleaned surface shall be coated within 8 hours of cleaning and before rust blooming becomes apparent. If either condition is exceeded then the area must be re-blasted to specification.

Clean or partially coated steel shall be protected from contamination including, but not limited to dirt, oil, grease, soluble salts and overspray, while in the shop. Contaminated surfaces shall be re-cleaned by the Contractor.

Surfaces that will be in contact with concrete shall be coated with the full system prior to erection. Coatings with known incompatibilities with high pH shall not be used in contact with the concrete.

Surfaces inaccessible after erection shall receive the field coats of paint in the shop, before shipment to the erection site.

If more than one coat is to be shop applied, manufacturer's recommended recoat times for the ambient temperatures shall be followed.

Generally, a minimum of 16 hours drying/curing time shall be required between the application of any paint in the shop and the moving or handling of any piece so painted. This period may be increased in cases where poor drying conditions exist, such as shop areas open to the weather in winter months. Since curing times vary with different coating products, variations from this time may occur with specific products.

Quick Dry/Cure products or products with "winter" catalysts shall not be substituted for DBSS 308 products unless specified by the Designer and accepted by the Ministry Representative.

216.12.3 Transport of Coated Items - Transport of coated items shall be done in a manner that imparts minimum damage to the coating system. The coatings shall be cured before handling and shipment.

Canvas or Fabric slings shall be used to move the items. Chains or other methods that are known to damage coatings shall not be used.

Coated items to be transported shall have sufficient dunnage to prevent coating damage. Transport tie-downs shall be padded to protect the coated surfaces and edges.

Transport damage shall be repaired by the Contractor.

216.12.4 Field Repair of Damaged Shop Coating and Field Weld Areas - After the complete erection of shop coated steel members the following procedure shall apply:

Before coating, field weld areas shall be ground off to remove all welding slag, spatter and alkaline deposits in the vicinity of the welds. Washing will be required when the shop coat or steel has been contaminated with air borne dirt, dust, salt, chemicals, etc., unless the steel shows no visible contamination, and meets the SSPC SP-12/NACE No. 5, NV2 levels for non-visible contaminants. Surfaces shall then be cleaned to SSPC-SP 11 Power Tool Cleaning to Bare Metal. The existing coating shall be feathered back 25 mm from damaged areas into good coating. Feathering shall continue until the existing coating is well adhered. This may be considerably more than the 25 mm feather back.

Care shall be taken not to damage surrounding areas.

Note: This cleaning shall include the 100 mm welding set back.

All areas of the shop applied coating system which have been damaged during handling, shipping and erection and all field connections shall be cleaned to SSPC-SP 3 Power tool clean or SSPC SP11 Power tool cleaning to bare metal at the discretion of the Quality Manager and Ministry Representative. Low pressure water cleaning shall be used as necessary to remove dirt, salts and other deleterious contamination.

All areas that have been cleaned to bare metal as required shall be coated with an organic zinc field primer, applied by brush to ensure full coverage. If the area is too large to coat practically with a brush, then spray may be used, providing overspray does not contaminate the surrounding finished coating.

Lapping of new and existing coatings shall be as DBSS 216.12.1.11 above.

If a partial system was applied in the shop then the primed areas shall be coated with successive coats to the level of the surrounding coating then the entire structure shall be topcoated. This treatment shall include a brushed-in stripe coat.

If a coating system was completely applied in the shop and on erection some damage has occurred or there are still uncoated areas, then these areas shall be cleaned per this section above and successively coated with each coat of the system up to the topcoat including a brushed-in stripe coat. Manufacturer's recoat times for the ambient temperatures shall be followed.

216.12.5 Field Topcoat - Remaining coats shall be applied as per DBSS 216.13 below.

216.12.5 Field Coating

216.13.1 Touch-up coating This section deals with the repair of small areas of coating by the Contractor. The definition of small areas, will vary depending on the situation, but in general, will apply to areas that can be economically treated using the touch-up technique.

The coating used for touch up and repair shall be one of the DBSS 308 Field Overcoat (FO) systems.

The area to be repaired and coated shall be washed to SSPC SP-12/NACE No. 5, WJ-4, with a surface cleanliness of NV-2 before attempting further cleaning. Areas of the coating that have

failed or rusted shall be cleaned to SSPC-SP 3 or SSPC-SP 11 using the appropriate tools.

The old coating shall be feathered back 25 mm from damaged areas into good coating. Feathering shall continue until the coating is well adhered. This may be considerably more than the 25 mm feather back.

Pack rusted crevices will require more thorough cleaning. The degree of cleaning required will be detailed in the Design for each specific structure. After cleaning, they shall be coated with the prime coat, and then a brush coat of penetrating sealer shall be applied to the crevice and allowed to soak in. Repeated applications of the penetrating primer may be necessary until the inside of the crevice is saturated. Where the coating system used does not include a specific primer coat, the penetrating sealer shall be applied as a first coat.

In general, coating used for touch up and repair shall be of the same type as those used initially. For example if the coating system to be touched up is an alkyd system, then alkyds are the coatings of choice. The coating to be used shall be accepted by the Ministry Representative and as specified in the Design.

The selected primer shall be applied in the damaged areas. The primer shall be cured for the time recommended by the manufacturer prior to additional coating being applied

After the primer is cured, the midcoat(s) shall be applied to bring the surface of the coating to the same level as the surrounding sound coating. The midcoat shall be applied within the manufacturer's suggested range of thickness. The midcoat(s) shall be cured for the time(s) recommended by the manufacturer.

After the midcoat material is cured, the area shall be given a topcoat. Where practical, the topcoat shall be extended to a logical edge such as the edge of the beam or plate, to present a less patchy appearance.

Lapping of new and existing coatings shall be as DBSS 216.12.1.11.

216.13.2 Overcoating - The object is to clean the surface, repair spot or area damage with coatings and to overcoat the entire area with a topcoat.

The coating used for touch up and repair shall be one of the DBSS 308 Field Overcoat (FO) systems.

The area to be repaired and coated shall be washed to SSPC SP-12/NACE No. 5, WJ-4, with a surface cleanliness of NV-2 before attempting further cleaning. Areas of the coating that have failed or rusted shall be cleaned to SSPC-SP-3 or SSPC-SP-11. Larger failed areas shall be cleaned to SSPC-SP 6/NACE No.3 Commercial blast clean. In this case, surface profile should be 50-75 µm and sharp.

Debris contaminating the rest of the structure or the immediate environment due to cleaning operations shall be removed by the Contractor.

The old coating shall be feathered back 25 mm from damaged areas into tightly adhered coating. If the coating cannot be removed with a dull putty knife, it is considered tightly adhered.

Pack rusted crevices shall be cleaned as per DBSS 216.13.1 above.

Once all the existing damaged areas are built up to the level of the existing coating, the topcoat is applied over the entire area to seal the existing coating and all the repairs.

In general, coating used for overcoating shall be of the same type as those used initially. For example if the coating system to be touched up is an alkyd system, then alkyds are the coatings of choice. Use of an over wintered test patch is recommended to test compatibility. The coating to be used shall be accepted by the Ministry Representative and as specified in the Design.

216.13.3 Recoating - The area to be recoated shall be washed to SSPC SP-12/NACE No. 5, WJ-4, with a surface cleanliness of NV-2 before attempting further cleaning. The entire area shall be blast cleaned to SSPCSP 6 Commercial blast clean. Note that some specialty coatings or coatings in some difficult applications such as immersion may require SSPC-SP 10/NACE No. 2 Near-white blast or even SSPC-SP 5/NACE No. 1 White metal blast.

Surface profile should be 50 - 75 µm and sharp.

The Contractor shall provide full containment of debris generated by the cleaning, coating and curing operations.

Debris contaminating the rest of the structure or the immediate environment due to cleaning operations shall be removed by the Contractor.

Sharp edges shall be radiused to 1 mm.

216.13.4 Zone Coating - Zone coating may use any one of or a combination of touch-up, overcoating or recoating on limited areas of a structure.

216.13.5 Field Curing of Coatings - Each coating application shall be cured before it is coated over or exposed to weather or traffic.

Coatings inside enclosed spaces shall continue to be ventilated until dry or cured to ensure that they cure correctly.

Uncured coating shall be protected against damage from dust or other detrimental foreign matter. If necessary, coating shall be delayed until the cause of the dust, etc. has abated. Uncured coating shall be protected from the weather until cured. In some cases, this may include hoarding, heating, ventilation or dehumidification. Coating contaminated or damaged by any of the above conditions shall be repaired by the Contractor.

216.14 Damage to Adjacent Property - It is the intention of the Ministry of Transportation that the coating work shall have no adverse effect on adjacent property. Repair of damage to adjacent property, vehicles, pedestrians and other portions of the structure due to the Contractor's coating operations is the sole responsibility of the Contractor.

216.15 Cleanup - All construction and painting debris must be removed from the site and the site environs. The site and surroundings shall be left in the same condition as prior to work being commenced.

216.16 Not Used

SECTION 218

CONCRETE FOR MINOR WORKS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

218.01 General - DBSS 218 shall apply only when DBSS 218 has been specifically specified for a cast in place concrete component by the Ministry in the Contract. Otherwise cast in place concrete work shall comply with DBSS 211.

The Work shall be carried out in accordance with the best modern practice of cement concrete construction.

The Designer, Quality Manager and Ministry Representative shall determine the suitability of the materials, their quantity, quality and condition; of the Contractor's plant, equipment and personnel; of the time and manner of carrying out the work and of every operation and matters incidental thereto.

218.02 Cement - Portland cement shall conform to CSA Standard A5 - Portland Cement

218.03 Aggregates - The aggregates shall be the best procurable and shall comprise inert, inorganic mineral matter only. They shall be satisfactorily clean, durable, hard, sound, strong and tough and be practically free from alkali, clay, dust, loam, mica, shale, silt or any material deemed objectionable in nature or amount by the Quality Manager and Ministry Representative. None of the particles comprising the aggregates shall be coated nor be unreasonably flat or elongated. No aggregate may be

used while frozen.

218.04 Grading of Aggregates - The grading of all aggregates shall be such as will produce an economic, plastic, practical, smooth, workable mix which when placed, set and cured, will produce a concrete of the best character possible.

To secure such grading, the Quality Manager or Ministry Representative may require the Contractor to modify the aggregate by the addition or subtraction of proportions of specific sizes of material.

218.05 Classes of Concrete - The classes of concrete are A, B, C, X and Y. Each class of concrete shall be used only when it is called for in the Contract. Unless otherwise specified, Class "A" Concrete shall be used.

Concrete deposited in water shall be Class "A" with 10% additional cement.

218.06 Classification and Proportioning of Concrete Mixtures - The materials shall be proportioned so that the amount of cement contained in 1 m³ of concrete in place shall be approximately as shown in Table 218-A.

The proportions of water, cement, coarse and fine aggregate to be used shall be determined by the Designer. Measurement shall be made by mass, and the accuracy must be satisfactory to the Quality Manager; all such allowances for contained water, bulking or otherwise must be made as found necessary to allow for the proportions ordered by the

TABLE 218-A CLASSIFICATION AND PROPORTIONING OF CONCRETE MIXTURES

CLASS OF CONCRETE	REQUIRED STRENGTH AT 28 DAYS MPa	SIZE OF COARSE AGGREGATE (mm)	CEMENT (40 kg) SACKS PER CUBIC METRE	MAXIMUM WATER CONTENT PER SACK OF CEMENT (ℓ)
A	20	25.0 to 5.0	9.1	21.0
B	15	50.0 to 5.0	7.0	24.5
C	10	63.0 to 5.0	5.6	30.0
X	17.5	50.0 to 5.0	9.2	24.0
Y	20	20.0 to 5.0	9.8	21.0

SECTION 218

CONCRETE FOR MINOR WORKS

Designer, being accurately provided in each batch.

218.07 Machine Mixing - The mixing of concrete Quality Manager shall be done in a batch mixer of type approved by the Quality Manager. The mixer shall be equipped with a suitable charging hopper, water storage and water measuring device. It shall be cleaned at frequent intervals when in use and maintained in such a condition that the mixing action will be unimpaired.

218.08 Duration of Mixing - The mixing of each batch shall continue not less than 90 seconds after all the materials are in the mixer, during which time the mixer shall rotate at a speed of from 14 to 20 revolutions per minute unless otherwise rated by the manufacturer.

218.09 Hand Mixing - When hand mixing is authorized by the Designer or Quality Manager, it shall be done on a watertight platform. The fine aggregate shall be spread on the platform and the cement spread evenly over the fine aggregate. The material shall then be shovelled into a cone shaped pile by casting centrally on the pile. This pile shall then be divided by casting into two or more cone shaped piles and the operation of dividing and reuniting continued until the batch is uniform in colour. Only sufficient water to produce the desired consistency shall then be added by sprinkling as the batch is turned. The coarse aggregate previously moistened shall then be mixed with the mortar in the manner specified for mixing fine aggregate and cement.

218.10 Retempering - The rettempering of concrete or mortar which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.

218.11 Forms - Forms shall be so constructed that the finished concrete will conform to the shapes, lines, grades and dimensions indicated on the Design.

Lumber used in forms shall be free from warp. For exposed surfaces, it shall be dressed to a uniform width and thickness and be free from loose knots, decay or other defects. For unexposed surfaces and rough work, undressed lumber may be used if means are taken to prevent leakage of mortar.

Lumber once used in forms shall have nails withdrawn and surfaces to be in contact with concrete thoroughly cleaned and smoothed before being used again.

Unless otherwise specified, suitable moulding or bevels shall be placed at the angles of forms to round or bevel the edges and re-entrant angles of the concrete.

For internal ties, bolts and rods shall preferably be used. They shall be so arranged that when the forms are removed no metal shall be within 25 mm of any exposed surface. Wire ties may be permitted only on light work; they shall not be used through surfaces where discolouration will be objectionable.

The inside of forms shall be coated with non-staining mineral oil, or other approved liquid or thoroughly wetted, (except in freezing weather). Where oil is used it shall be applied before the reinforcement is placed.

Care shall be taken to ensure that forms do not become dried and warped before concrete is deposited. Before concrete is placed, forms and reinforcement shall be checked and approved by the Quality Manager

Forms shall not be disturbed until the concrete has adequately hardened. The proper time for removal of forms shall be determined by the Designer.

Care shall be taken when removing forms to avoid roughening or injuring corners and to keep edges sharp.

Whenever forms are removed from showing faces before the concrete has become hard and dry, the surface of the concrete shall be immediately wetted and kept wet for at least three days. Defects in showing faces shall be rectified to the satisfaction of the Quality Manager and Ministry Representative.

218.12 Depositing Concrete - Concrete shall be deposited in forms in approximately uniform horizontal layers as near as practicable in its final position to avoid re-handling. Depositing shall be continuous until the unit of operation is complete and as rapid as practicable to ensure bonding of the successive layers.

Concrete shall be thoroughly worked around reinforcement and embedded fixtures and into all parts of the forms. Coarser particles shall be worked back from the face of the forms.

218.13 Not Used

SECTION 232

METAL BIN-WALL

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

232.01 Scope - This Section covers the construction of metal bin type retaining walls in accordance with the general layout and details indicated on SS Drawings 1-SP232 through 3-SP232.

232.02 Provision of Metal Bin-Wall - Bin-wall of the design (depth to height ratio) called for shall be constructed at the locations and as shown on the Design with the materials, accessories, and necessary ancillary work all in accordance with the details indicated on the Design or as directed by the Designer.

232.03 Materials - Bin-wall material will be supplied by the Contractor in accordance with the Design.

Structure backfill shall be well-graded granular material with a maximum size of 75 mm and not more than 8% passing a 0.075 mm (#200) sieve.

232.04 Construction

232.04.01 Construction - Construction shall be carried out with all labour, tools, equipment and incidentals necessary to complete all bin-walling in accordance with good work practice.

232.04.02 Foundation - Foundation excavation shall be carried down to the depths shown on the Design or to such greater depths as the Designer may direct. In the case where rock, hardpan or other unyielding material is encountered, it shall be removed to a depth 300 mm below the design grade and backfilled in accordance with DBSS 232.04.04.

232.04.03 Erection - The units shall be assembled as shown on the Design. Components shall be handled carefully and any which are damaged shall be removed and replaced.

Before the assembly bolts are tightened, columns shall be checked for line and batter or plumbness, where applicable.

232.04.04 Backfill - Structure backfill material shall be placed as wall foundation, backfill inside the bins, and for 0.6 m behind the wall. The material shall be spread in layers not exceeding 150 mm in thickness and shall be compacted to a minimum 95% of the laboratory density obtained by the current ASTM test method D 698.

Backfill inside each bin shall progress simultaneously but not in advance of that behind the wall.

Note: Bin wall may be backfilled as it is erected provided that the columns are held in correct position while the backfill is being placed.

232.05 Not Used

SECTION 303

CULVERTS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

DESCRIPTION

303.01 Scope - This Section covers the construction of pipe culverts where shown on drawings or as directed by the Designer, and in accordance with the Contract, the drawings and Special Provisions covering the various types. The trench and other preparatory work shall be approved by the Quality Manager before actual placing starts.

Culvert materials are normally durable under most conditions. Factors which affect the service life of culvert material are corrosion from acidic and alkaline conditions in the soil, abrasion from bedload carried by the stream and freeze/thaw cycles. Plastic culverts shall not be exposed to direct sunlight (ultra violet rays) or installed in areas where there is a potential fire hazard.

Filtration control devices, such as filter cloth, must not be attached to the end of culverts.

Obstructed culverts shall be cleared as outlined in DBSS 165.10.07.

All culvert pipe, unless otherwise specified, will be supplied by the Contractor to the requirements of the Contract, generally in accordance with DBSS 145.15.

MATERIALS

303.11 Concrete Pipe - Reinforced concrete pipe supplied will have joints of the tongue and groove type all in accordance with the current specification ASTM C 76 Series, and plain concrete pipe in accordance with the current specification ASTM C 14 series.

303.12 Corrugated Steel Pipe - Corrugated steel pipe supplied will conform to the requirements of DBSS 320.

303.13 Polyethylene Pipe – The materials for pipe and fitting shall be high-density polyethylene meeting ASTM D 3350 Cell Classification 335420C.

303.14 PVC Pipe – See DBSS 318.03

303.15 Structural Plate Corrugated Steel
BC - MOT

Pipe/Pipe-Arch (Field Assembled) Culverts - Special care shall be taken in the installation of all structural plate corrugated steel culverts.

CONSTRUCTION

303.31 Concrete, Corrugated Steel and Plastic Pipes – This Subsection does not cover Structural Plate Corrugated Steel Pipe/Pipe Arch installations.

303.31.01 Trenching - A trench shall be excavated to the depth and grade as given by the design. A full trench condition shall be provided wherever possible, but in no case shall the trench be of lesser depth than 50% of the diameter of the pipe. If, in the opinion of the Quality Manager, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade to such depth as ordered, backfilled with gravel or other suitable material, and thoroughly tamped or otherwise compacted to ensure a firm and uniform foundation.

Where rock, in either ledge or boulder formation, occurs in the bottom of the trench, the rock shall be excavated below grade and backfilled with sand or fine gravel so that there will be at least a 150 mm cushion between the rock and all portions of the pipe.

The bottom of the trench upon which the pipe is to be laid shall be shaped so that at least 25% of the circumference of the pipe is in contact with the prepared foundation for the whole of its length.

303.31.02 Placing - Concrete pipe shall be laid beginning at the lower end with the groove and pointing up-grade. Pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement as marked by the manufacturer in a vertical position.

When jointing concrete pipes the trench shall be in a dry condition and the joints shall be cleaned and wetted before sealing with mortar. The mortar shall consist of one part Portland Cement to two parts fine sand, mixed to the proper consistency. Sealing shall be neatly and thoroughly done, and the interior of the pipe cleaned of all surplus mortar. Joints shall be kept damp with burlap or earth for at least three days after sealing.

Corrugated steel pipe shall be laid beginning at the lower end with the outside laps pointing up-grade and

lower end with the outside laps pointing up-grade and the longitudinal joint on the side. The separate section shall be firmly jointed together and any steel in joints, which is not thoroughly protected by galvanizing, shall be coated with a suitable asphaltum paint.

303.31.03 Backfilling - Backfill and Bedding Material shall consist of mineral aggregate and shall meet the gradation specified in Table 303-A.

For metal structures with corrugation depths greater than 63 mm, the backfill maximum particle size may be as high as one-half the corrugation depth or 75 mm whichever is smaller.

Minimum bedding thickness is 150 mm or twice the corrugation depth whichever is greater.

For embankment installation, bedding and backfill will extend two-thirds of the span or 0.9 m beyond the culvert span on either side, whichever is greater. For trench installation, bedding and backfill will extend a minimum of 0.3 m on either side. Backfill will extend to the base of the pavement structure (to the surface in the case of high fines gravel surface) or to a depth of cover of two-thirds of the span (diameter) whichever is less. Bedding and backfill shall be placed in layers not exceeding 150 mm in depth. Backfill shall be placed symmetrically. The differential backfill height on either side of the culvert shall not exceed 0.3 m. Bedding and backfill shall be compacted to a minimum 95% of the laboratory density by following the current ASTM D 698, except the 0.3 m layer immediately above the pipe which shall be placed with no compaction.

TABLE 303-A GRADATION REQUIREMENTS FOR CULVERT BACKFILL AND BEDDING MATERIAL

SIEVE SIZE mm	PERCENTAGE PASSING
31.5	100
25	60-100
19	15-100
2.36	10-100
0.075	0-5

303.31.04 End Walls - End walls shall be built around the ends of pipe culverts as shown on the Design or as directed by the Designer. The construction of these end walls shall meet the requirements governing the construction of Class "A" concrete (See DBSS 218.05).

303.31.05 Inlet and Outlet Ditches - Inlet and outlet ditches to culverts shall be constructed to the lines and levels as given by the design, field-fit as necessary. The excavation shall be classified as "Roadway and Drainage Excavation," not "Foundation Excavation."

303.32 Structural Plate Corrugated Steel Pipe/Pipe-Arch Culverts

303.32.01 Foundation Excavation - If a coarse boulder material solid rock, or other unsuitable foundation is encountered when preparing the bed of the pipe, the material shall be excavated a minimum depth of 300 mm below the pipe and backfilled with granular material having a maximum size of 75 mm.

303.32.02 Backfilling - All backfill materials for a minimum width of 3 m on either side of the pipe and to a depth of 1 m above the pipe, if grade allows, shall be granular material as specified by the design and approved by the Quality Manager.

End dumped or loose pushed material shall not be piled closer than 3 m from the pipe. Spreading in layers not exceeding 150 mm and compaction shall be carried out by equipment operating parallel to the pipe. The area close to the pipe shall be compacted by small mechanical tampers. No boulders in the backfill material of a size greater than 75 mm shall be closer than 1.2 m to the pipe surface.

Extreme care must be taken to ensure the backfilling operation is carried out equally on both sides of the pipe. Hauling equipment shall not be operated over the pipe until backfill operations have completed a minimum cover of 600 mm over the pipe.

SECTION 308

COATING SYSTEMS

308.01 Scope - This Section defines the coating systems required for shop and field coating of structural steel or wood/concrete surfaces which may be exposed to exterior corrosive conditions.

The metric unit (μm) or imperial unit (mil) can be used interchangeably, at the conversion factor of:

1 mil = 25 μm (1 mil = 1 thousandth of an inch)

308.03 Standards and Specifications

a)Specifying Bodies: **SSPC** The Society for Protective Coatings, has a large number of coating and cleaning specifications. **ASTM** The American Society for Testing and Materials, produced test procedures for a wide range of products and processes. **NACE**, The National Association of Corrosion Engineers, also produces specifications and test procedures for coatings and corrosion engineering. All have a web presence available by searching the name above.

b)Colour Specifications using a five digit number refer to the US Federal Specification 595b colour numbers.

c)Measuring Units

308.04 System Selection Table - This table summarizes the coating systems currently in use. The table lists application areas where specified coating systems may be used. It is intended to assist in the choice of a coating system for specific applications. Some systems may find use in more than one specific application or in applications not mentioned.

Where a system is specified in the Contract or on the Design, only those approved coating systems listed for that system may be used.

The generic coating systems below mirror the same categories in the Recognized Products List, which lists approved coatings in each of the categories below.

COATING SYSTEM SELECTION TABLE (PART 1)

System Code	Application Area	Structure Environment	Coating System Primer - Midcoat - Topcoat
STRUCTURAL STEEL			
SS1	Steel, Shop	Standard New Steel Coating for Moderate to Severe Service	Inorganic zinc, epoxy, polyurethane
SSWP	Steel, Shop Weldable Primer	Under Development	
SF1	Steel, Field	Severe Field Application	Metallizing, epoxy, polyurethane
SF2	Steel, Field	Standard Field Recoat for Moderate to Severe Service	Organic zinc, epoxy, polyurethane
SF3	Steel, Field	Severe Where Adjacent buildings/traffic etc require a Dry Fall Material	Metallizing, vinyl, vinyl
SF4	Steel, Field	Moderate to Severe Where Adjacent buildings/traffic etc require a Dry Fall Material	Organic zinc, vinyl, vinyl
SF5	Steel, Field	Moderate	Alkyd on steel
SF6	Steel Field	Moderate to Severe Field Application	Multi-Component Urethane Systems
SFIM1	Steel Field, Immersion	Moderate to Severe Field Application	Coal Tar Epoxy or Equivalent

System Code	Application Area	Structure Environment	Coating System Primer - Midcoat - Topcoat
SFO1	Steel, Field Overcoat	Moderate conditions	Water-based Acrylics and Vinyls
SFO2	Steel, Field Overcoat	Under Development	Water Based Acrylic Epoxy
SFO3	Steel, Field Overcoat	Moderate conditions	Solvent Based Single Component
SFO4	Steel, Field Overcoat	Moderate to Severe	Solvent Based Surface Tolerant Epoxy
SFO5	Steel, Field Overcoat	Moderate	Alkyd on steel CAN/CGSB-1.59M alkyds
SFAG	Steel, Field Antigraffiti Coatings	Under Development	Varies with system

COATING SYSTEM SELECTION TABLE (PART 2)

System Code	Application Area	Structure Environment	Coating System Primer - Midcoat - Topcoat
SFTB	Steel, Field Touchup Brushable	Small Damaged Areas, or as a Holding Primer	Rust Inhibitive Primer / Topcoat
SFTA	Steel, Field Touchup Aerosol	Small Damaged Areas, or as a Holding Primer	Rust Inhibitive Primer / Topcoat
UNIQUE SITUATIONS			
U1	Steel, Unique Products	Moderate	Rust Inhibitive Sealer / Topcoat
U2	Steel, Unique Products	Low Temperature, high humidity	Organic Zinc / Midcoat / Topcoat
PENETRATING SEALERS			
SPS	Steel, Penetrating Sealers	Penetrating Sealers for Joints, Bolts, Rivets etc.	Various Unique Systems, Designed To Be Used With Coating Materials From The Same Manufacturer
CAULKING MATERIALS			
PCM	Paint Caulking Materials	For Non-immersion Service	Assorted
WEATHERING STEEL			
SW *	Steel, Weathering Field Coatings	Under Development	Two or three coat systems
CONCRETE			
CF1	Concrete, Field	Under Development	Cementitious
CF2	Concrete, Field	Under Development	Non-Cementitious
CFAG	Concrete, Field Antigraffiti	Under Development	Concrete Antigraffiti
HOT DIPPED GALVANIZING			
GO	Hot Dip Galvanizing, Overcoat	Under Development	
STEEL RAILINGS			

SRG	Steel, Hot Dip Galvanizing	Preferred Treatment for Removable Railings	Hot Dip Galvanizing
SRM	Steel, Metallizing	Primarily for non-removable posts	Zinc - Zinc Aluminum Powder or Wire
WOOD			
WFR	Wood, Railings and Rubrails	Moderate to Severe	Primer, Midcoat, Topcoat CAN/CGSB-1.59M alkyds
WF1	Wood, Fencing	Under Development	Oil based sealer 1-GP-145M
WF2	Wood, Fencing	Under Development	Latex Based Sealer 1-GP-204M
WFT	Wood, Field Touchup	Moderate to Severe	Primer, Midcoat, Topcoat CAN/CGSB-1.59M alkyds
INLAND FERRIES			
InFer	Steel Inland Ferries	Under Development	

308.05 Not Used

308.06 System Selection Criteria - The selection of a coating system is dictated by the location and environment of the structure to be coated. The coating system may be applied in a shop or in the field. The field location may necessitate a specific maintenance regimen, for example, a complete recoat or a single overcoat. The environment may be moderately or severely corrosive. In addition, there may be concerns with limiting overspray.

The following general comments apply to all coatings supplied.

- Coatings shall not be mixed and matched between suppliers, or within a supplier's product line.
- All coatings shall bear the manufacturer's name and address, batch number, paint type, date of manufacture, DOH or US Federal Specification 595b color code, and mixing and application instructions. All labels shall contain the requisite WHMIS label information and be accompanied by a valid MSDS. All

coatings are subject to inspection and testing by the Quality Manager or Ministry Representative before acceptance or at the time of application.

308.07 Coating Systems - The Ministry Recognized Products List (RPL) lists coating products that have been reviewed and accepted for use on Ministry projects. The RPL can be reviewed at the following Ministry web site:

http://www.th.gov.bc.ca/publications/eng_publications/geotech/Recognized_Products_Book.pdf

Products not on the Ministry Recognized Products List shall not be used without the prior acceptance of the Designer and the Ministry Representative. Unless noted otherwise in this Section, products on the RPL shall be used in accordance with the introduction/definitions, descriptions, notes, qualifiers and all other information given in the RPL. The use of the products from the RPL by the Contractor shall in no way relieve the Contractor from its contractual obligations.

The following pages list requirements for systems appearing in DBSS 308.04 - Coating System Selection Table.

STEEL, SHOP - SYSTEM SS1: Inorganic Zinc primer, Epoxy midcoat, Polyurethane topcoat

MoT Usage: This system is designed for use in a shop coating environment where the new steel is protected from the weather during coating and curing. The system will provide good service in a moderate to severe field environment.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Inorganic Zinc	None	Epoxy Midcoat Material	Epoxy Midcoat Material	None	Aliphatic Polyurethane
SSPC-SP 10/NACE No. 2, "Near-White Metal", Sharp Profile: 50 - 75 μm (2 - 3 mils)					

Notes for use:

- Dry film thicknesses shall be as per the manufacturer's application instructions unless otherwise approved by the Designer and the Ministry Representative.
- Depending on the system chosen, the inorganic zinc primer may require a mist coat to prevent bubbling in the mid-coat material.
- Inorganic zinc shall be dry and cured before additional coatings are applied.
- Stripe coating shall be applied on top of the primer and brushed to a minimum stripe width of 50 mm (2 inches).
- While most of the above systems require SSPC-SP 10 surface preparation, SSPC-SP 5 "White Metal" blasting will typically give a longer service life.

STEEL, FIELD - SYSTEM SF1: Metallizing primer, Epoxy midcoat, Polyurethane topcoat

MoT Usage: This system is designed for use in a field coating environment where extreme exposure such as splash zones on through trusses, fence posts (panels should be hot dip galvanized), bearings, expansion joints and any steel exposed to de-icing chemical solutions dripping from above; structures adjacent to pulp mills or smelters are present.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Zinc wire or powder 150-200 μm (6 - 8 mils)	15% thinned epoxy Midcoat Material	None	Epoxy Midcoat Material	None	Aliphatic Polyurethane
SSPC-SP5/NACE No. 1, "White Metal", Sharp Profile: 50 - 75 μm (2 - 3 mils)					

Notes for use:

- Dry film thicknesses shall be as per the manufacturer's application instructions unless otherwise approved by the Designer and the Ministry Representative. The metallizing is normally 6 to 8 mils, but may in extremely severe environments be made thicker to enhance the lifetime.
- The sealcoat is applied to partially fill the voids in the metallizing and reduce bubbling in the subsequent coat.
- Previously galvanized railings, fence posts, and panels shall be "Brush-off" cleaned and top-coated with a different colour than the structure, after a wash primer is applied.

- Metallizing can be either zinc or zinc:aluminum (85:15) alloy wire thermal spray, flame process, plasma arc process or spray and fuse powder process.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD - SYSTEM SF2: Organic Zinc primer, Epoxy midcoat, Polyurethane topcoat

MoT Usage: This system is designed for use in a field coating environment that is moderate to severe. **This is the most often used field coating system.**

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Organic Zinc Primer	May use a Penetrating Sealer	Epoxy Midcoat Material	Epoxy Midcoat Material	None	Aliphatic Polyurethane
SSPC-SP6/NACE NO. 3, "Commercial Blast", Sharp Profile: 50 - 75 μ m (2 - 3 mils)					

Notes for use:

- Dry film thicknesses shall be as per the manufacturer's application instructions unless otherwise approved by the Designer and the Ministry Representative.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level..
- Stripe coating shall be applied on top of the primer and brushed to a minimum stripe width of 50 mm (2 inches).

STEEL, FIELD - SYSTEM SF3: Metallizing primer, Vinyl midcoat, Vinyl topcoat

MoT Usage: This system is designed for use in a field coating environment where extreme exposure areas such as splash zones on through trusses, fence posts (panels should be galvanized), bearings, expansion joints and any steel exposed to de-icing chemical solutions dripping from above and no adjacent pulp mills or smelters are present. This system shall be used only when epoxies cannot be used due to adjacent buildings, traffic, etc. This system is high VOC and should only be used where other coating systems such as SF1 cannot be used.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Zinc wire or powder 15 - 200 μ m (6 - 8 mils)	May use a thin coat of Vinyl Midcoat Material	None	Vinyl Midcoat Material	None	Vinyl Topcoat Material
SSPC-SP 5 "White Metal", Sharp Profile: 50 - 75 μ m (2 - 3 mils)					

Notes for use:

- Dry film thicknesses shall be as per the manufacturer's application instructions unless otherwise approved by the Designer and the Ministry Representative. The metallizing is normally 6 to 8 mils, but may in extremely severe environments be made thicker to enhance the lifetime.
- The sealcoat is applied to partially fill the voids in the metallizing and reduce bubbling in the subsequent coat.
- Previously galvanized railings, fence posts, and panels shall be "Brush-off" cleaned and top-coated with a different colour than the structure, after a wash primer is applied.
- Metallizing can be either zinc or zinc:aluminum (85:15) alloy wire thermal spray, flame process, plasma arc process or spray and fuse powder process.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD - SYSTEM SF4: Organic Zinc primer, Vinyl midcoat, Vinyl topcoat

MoT Usage: This system is designed for use in a field coating environment that is moderate to severe. This system shall be used only when epoxies cannot be used due to adjacent buildings, traffic, etc. (e.g., pedestrian overpasses).

This system is high VOC and should only be used where other coating systems such as SF2 cannot be used.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Organic Zinc Primer	None	Vinyl Midcoat Material	Vinyl Midcoat Material	None	Vinyl Topcoat Material
SSPC-SP6/NACE NO. 3, "Commercial Blast", Sharp Profile: 50 - 75 µm (2 - 3 mils)					

Notes for use:

- Stripe coating shall be applied on top of the primer and brushed to a minimum stripe width of 50 mm (2 inches).
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD - SYSTEM SF5: Alkyd System on Steel

MoT Usage: This system is designed for use in a field coating situation where more moderate conditions are expected. It may also be used in areas where surface preparation is less than ideal.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Alkyd Primer CAN/CGSB 1.40-89	None	Alkyd Midcoat Material	Alkyd Midcoat CAN/CGSB 1.59-89M	None	Alkyd Topcoat CAN/CGSB 1.59-89M
SSPC-SP 2 "Hand Tool Cleaning" or SSPC-SP 3 "Power Tool Cleaning"					

Notes for use:

- While this system will work on the cleaning regimen listed above it will perform better on SSPC- SP 6 "Commercial blast".
- Stripe coating shall be applied on top of the primer and brushed to a minimum stripe width of 50 mm (2 inches).
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD - SYSTEM SF6: Multi-Component Urethane Systems

MoT Usage: This system is designed for use in a field coating environment in moderate to severe exposure areas.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Zinc Primer Material		Midcoat Material	Midcoat Material		Topcoat Material
High Pressure Water Wash then SSPC- SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning"					

Notes for use:

- While this system will work on the cleaning regimen listed above it will perform better on SSPC- SP 6 Commercial blast.
- Stripe coating shall be applied on top of the primer and brushed to a minimum stripe width of 50 mm (2 inches).
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD IMMERSION - SYSTEM SFIM1: Coal Tar Epoxy or Equivalent

MoT Usage: This system is designed for use in a field coating environment in immersion situations

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
None Typically		Topcoat Material Per Manufacturers Instructions	Topcoat Material Per Manufacturers Instructions		Topcoat Material Per Manufacturers Instructions
Water Wash as below then per the Manufacturer's Instructions Typically SSPC-SP 5 blast					

Total Thickness: Per Manufacturer's Instructions or Specification

Notes for use:

- Some coal tar filled products are carcinogenic. Read the MSDS for detailed information
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD OVERCOAT - SYSTEM SFO1: Water-based Acrylic or Vinyl System

MoT Usage: This system is designed for use in a field over coating situation where the original alkyd system is intact or where loose rust/paint can be removed by hand/power tools before repair and topcoating.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Primer Material	As Per Manufacturer's Instructions	As Per Manufacturer's Instructions	As Per Manufacturer's Instructions		As Per Manufacturer's Instructions
High Pressure Water Wash then SSPC- SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning"					

Notes for use:

- These products are designed primarily for overcoating and encapsulating existing coatings.
- A test patch, and subsequent adhesion measurements and observation of compatibility are recommended prior to specifying this type of coating. This reduces the risk of overcoating.
- Manufacturer's instructions are used here because there are a wide range of possibilities that require specific details of cleaning, coating and curing to address each individual circumstance.
- Areas of old coating that are feathered back should be built up to the topcoat level, before overcoating.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD OVERCOAT - SYSTEM SFO3: Solvent-based System Single Component

MoT Usage: This system is designed for use in a field over coating situation where the original alkyd system is intact or where loose rust/paint can be removed by hand/power tools before repair and topcoating. It may be used in moderate to severe exposures.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
As per Manufacturer's instructions	As per Manufacturer's instructions	As per Manufacturer's instructions	As per Manufacturer's instructions	None	As per manufacturer's instructions
Rusted areas and delaminated areas: High pressure water wash then SSPC- SP 11 "Powertool Cleaning to Bare Metal". Undamaged areas high pressure water wash					

Notes for use:

- The coatings listed under SF03 are too different to list a common application thickness.
- This system is designed as a two coat system.
- A test patch, and subsequent adhesion measurements and observation of compatibility are recommended prior to specifying this type of coating. This reduces the risk of overcoating.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD OVERCOAT - SYSTEM SFO4: Solvent-based Surface Tolerant Epoxy

MoT Usage: This system is designed for use in a field over coating situation where the original alkyd system is intact or where loose rust/paint can be removed by hand/power tools. It may also be used in damp or condensing areas on structures. It may be used in moderate to severe exposures.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
As per Manufacturer's instructions	None	As per Manufacturer's instructions	None	None	As per Manufacturer's instructions
Rusted areas and delaminated areas: Water wash as below then SSPC- SP 11 "Powertool Cleaning to Bare Metal". Undamaged areas water wash as below.					

Notes for use:

- This system is designed as a two coat system.
- This material shall not be applied to damp or condensing surfaces.
- Edges shall be feathered and where possible, bare areas shall be built up to the level of the previous topcoat before overcoating.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD OVERCOAT - SYSTEM SFO5: Alkyd System on Steel Structures

MoT Usage: This system is designed for use in a field over coating situation where the original alkyd system is intact or where loose rust/paint can be removed by hand/power tools. It may be used for moderate exposures.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Alkyd Primer CAN/CGSB 1.40-89	None	Midcoat over prime	Alkyd Midcoat CAN/CGSB 1.59-89M	None	Alkyd Topcoat CAN/CGSB 1.59-89M
SSPC-SP 2 "Hand Tool Cleaning" or SSPC-SP 3 "Power Tool Cleaning"					

Notes for use:

- While this system will work on the cleaning regimen listed above it will perform better on SSPC- SP 6/ NACE No. 3 "Commercial blast".
- Edges shall be feathered and where possible, bare areas shall be built up to the level of the previous topcoat before overcoating.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC-SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC-SP 12/NACE No. 5, NV-2 level.

STEEL, PAINT CAULKING MATERIALS - SYSTEM PCM:

MoT Usage: These materials are designed to be used immediately under the topcoat material. They are compatible with most paint systems, but a test is recommended to ensure compatibility. They are used primarily to seal joints in steel structures to prevent the ingress of water in laps, splices etc. Manufacturer's instructions are followed for use.

Notes for use:

- These materials are applied on the midcoat, then coated with the final topcoat.
- Typically the top and sides of a plate are sealed and the bottom is not caulked to enable water to exit the crack if any gets in.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, FIELD TOUCH-UP COATING SYSTEM - SYSTEM SFTA: Aerosol Products

MoT Usage: This system is designed for quick touch-up use in a field overcoating situation where the original alkyd system is intact or where loose rust/paint can be removed by hand/power tools. It is designed as a stopgap measure until proper maintenance coating can be scheduled.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Zinc Rich or Inhibitive alkyd	None	None	None	None	As needed
SSPC- SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning"					

Notes for use:

- All coatings will work better on a properly prepared surface (i.e., high pressure water washed and sandblasted).
- These products shall not be used on faying surfaces.

STEEL, FIELD TOUCH-UP COATING, BRUSHABLE PRODUCTS - SYSTEM SFTB:**Brushable Products**

MoT Usage: This system is designed for brush application in a field touchup situation where the original alkyd system is intact and where loose rust/paint can be removed by hand/power tools.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Alkyd Primer CAN/CGSB 1.40-89 Zinc Rich alkyd	None	Midcoat over prime	Alkyd Midcoat CAN/CGSB 1.59-89M	None	Alkyd Topcoat CAN/CGSB 1.59-89M
SSPC- SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning" or SP 11 Industrial					

Notes for use:

- These products require different surface preparation and application thickness, refer to manufacturer's literature.
- All coatings will work better on a properly prepared surface (i.e., high pressure water washed and sandblasted).
- These products shall not be used on faying surfaces.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC- SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC- SP 12/NACE No. 5, NV-2 level.

STEEL, PENETRATING SEALERS - SYSTEM SPS.

MoT Usage: These products are designed for use in the field to help seal joints, pack rusted areas, riveted and bolted areas, and generally any area where a product that will wick into any small cracks and crevices to help seal them. These products must be topcoated as most are epoxy based and will not provide good service in exterior sunlight.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
If Used As per Manufacturer's Instructions	As per Manufacturer's Instructions	If Used As per Manufacturer's Instructions	If Used As per Manufacturer's Instructions		As per Manufacturer's Instructions

Notes for use:

- It is important to apply these products exactly as the Manufacturer states since they do not tolerate over thickness well.
- These products shall be used only with compatible products from the same manufacturer
- When used as part of a coating system, these products shall be applied after the primer coat, before the stripe and midcoats. This is to take greatest advantage of the sacrificial primer which must be in electrical contact with the steel to be most effective.

**PRODUCTS FOR UNIQUE SITUATIONS: ENCLOSED SPACES AND PROTECTED AREAS -
SYSTEM U1: Products for Enclosed Spaces and Protected Areas**

MoT Usage: This system is designed to use in situations where corrosion protection is desired and where high gloss is not as important. It is not for use in abrasive areas or where dirt retention is a problem.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
	Penetrating Sealer	Topcoat material if needed	Topcoat material if needed	None	As Per Manufacturer's Instructions

Notes for use:

- The penetrating sealer shall be used to penetrate and seal rusted areas and lap joints that cannot be properly cleaned. This is a unique application and Manufacturer's instructions shall be followed.
- The topcoat is a relatively soft, inhibitive coating that is surface tolerant and application tolerant. It does not harden enough to place in areas that are abrasive, traveled, or accessible to the public.
- The sealer may be used before the primer or any of the successive coats. Typically the sealer is used and then coated with a mid or topcoat

**PRODUCTS FOR UNIQUE SITUATIONS: LOW TEMPERATURE / HIGH HUMIDITY -
SYSTEM U2: Products for low temperature / high humidity use**

MoT Usage: This system is designed to use in situations where low temperature and/or high humidity preclude the use of other coating systems.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
As Per Manufacturer's Instructions	As Per Manufacturer's Instructions	As Per Manufacturer's Instructions	As Per Manufacturer's Instructions	None	As Per Manufacturer's Instructions

Notes for use:

- These coatings are moisture cured, therefore the entire can shall be used at once to prevent reaction of the coating in the can resulting from contact with atmospheric moisture.
- These coatings may also be used at normal coating temperatures and humidities. Since it is cured by reaction with atmospheric moisture, it should not be used in low humidity cure situations.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC-SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC-SP 12/NACE No. 5, NV-2 level.

STEEL, RAILINGS, HOT DIP GALVANIZING - SYSTEM SRG: Hot Dip Galvanizing Coating of Removable Rails

MoT Usage: This system is designed for use where small parts such as railing can be removed and sent to the galvanizing plant.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
None	None	None	None	None	Zinc
Surface preparation is done at the galvanizing plant.					

Notes for use:

- This is the preferred treatment for rails as it provides a very long life combined with low maintenance.
- The colour is grey. A colour coat is not recommended due to the increased capital costs and maintenance.
- Sections with closed tubes shall not be done without relieving the tubes by drilling holes to let the hot gases escape. This shall be designed into the item.
- Both the inside and outside of sections are coated with zinc.
- Defects include inclusions, dross, runs and mottling.

STEEL, RAILINGS AND POSTS, METALLIZING - SYSTEM SRM: Metallizing For Steel Railings And Posts

MoT Usage: This system is used primarily to coat steel fence posts that cannot be easily removed from a structure. It can however be used to coat any structural element in place. For elements which can be removed, hot dip galvanizing is the preferred treatment.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
None	None	None	None	None	Zinc
SSPC-SP 5 /NACE No. 1 White metal, Sharp Profile: 50 - 75 µm (2 - 3 mils)					

Notes for use:

- Substrate shall be very clean.
- Zinc or zinc:aluminum (85:15) wire or powder shall be used.
- If field steel has been exposed to weather, deicing salts or dirt, an SSPC-SP 12/NACE No. 5, LP WC water wash shall be done before blasting to remove salts to an SSPC-SP 12/NACE No. 5, NV-2 level.
- This coating may be overcoated to increase lifetime, although it is not necessary

WOOD, FIELD, RAILINGS AND RUBRAILS - SYSTEM WFR: Alkyd System Wood Railings and Rubrails

MoT Usage: This system is designed for use in a field over coating situation for wooden railings and rubrails, where the original alkyd system is intact or where loose paint can be removed by hand/power tools.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
Can/CGSB 1-GP-189M	None	If Used, Midcoat Material	White/ Grey CAN/CGSB 1.59M 89	None	White latex CAN/CGSB 1.138-93 White alkyd CAN/CGSB 1.59M89 For guardrails: Yellow/White alkyd CAN/CGSB 1.28M89 For sign/posts: Green alkyd Yellow alkyd White alkyd CAN/CGSB 1.59M89
SSPC- SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning"					

Notes for use: None

WOOD, FIELD TOUCHUP - SYSTEM WFT: Alkyd System for Touchup on Wood Structures

MoT Usage: This system is designed for use in a field over coating situation where the original alkyd system is intact or where loose rust/paint can be removed by hand/power tools.

PRIMER	SEALCOAT	STRIPECOAT	MIDCOAT	2nd MIDCOAT	TOPCOAT
DOH A-3 CGSB 1-GP-18 9M	None	If Used Midcoat Material	White/ Grey CAN/CGSB 1.5 9M89	None	White latex CAN/CGSB 1.138-93 White alkyd CAN/CGSB 1.59M89 For guardrails: Yellow/White alkyd CAN/CGSB 1.28M89 For sign/posts: Green alkyd Yellow alkyd White alkyd CAN/CGSB 1.59M89
SSPC- SP 2 "Hand Tool Cleaning" or SP 3 "Power Tool Cleaning"					

Notes for use: None

SECTION 312

STEEL TRAFFIC BARRIERS AND WOOD POSTS

312.01 Scope - This Section covers the quality and manufacture of steel beam guardrails, wood posts and accessory material for use as traffic barriers.

The layout and installation of materials specified in this Section are generally indicated on the SS Drawings of the SP312 series.

DBSS 604 covers the installation of the material of this Section together with the construction of ancillary work

312.02 Standards of Reference - Standards of various authorities are referred to herein generally in sufficient detail for the purpose of this Section. For detailed testing and other requirements reference to the Standards may be necessary from actual copies obtainable as follows:

CSA	Canadian Standards Association: Standards Sales, 178 Rexdale Blvd, Rexdale, ON M9W 1R3
ASTM:	American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103
ARTBA:	American Road and Transportation Builders Association, 525 School Street SW, Washington DC 20024
AASHTO:	American Association of State Highway and Transportation Officials, 444 North Capitol Street N.W., Suite 225, Washington, DC 20001.

312.03 General - Steel traffic barriers shall consist of rail sections fabricated for installation to develop a continuous beam strength with the necessary safety end feature components.

All rail sections and other components shall match the design profiles and dimensions of the AASHTO/ARTBA requirements cited below for full interchangeability of similar components regardless of the source of manufacture.

The name and/or trademark of the manufacturer and the metal thickness shall be clearly and permanently marked on each component clear of the splicing overlap and on the opposite face to the traffic side.

312.04 Steel Beam Guardrail - Guardrail shall be manufactured from open hearth, electrical furnace or basic oxygen semi-spring steel sheet galvanized before forming (or afterwards as may be specified or ordered for authorized special installations) all in general accordance with the AASHTO Standard Designation M-180 "Corrugated Sheet Steel Beams for Highway Guardrail" and shall conform to the following detail requirements.

Note: Design and part numbers are taken from the ARTBA Technical Bulletin #268-B, current edition (unless stated to be BCH Part numbers) and are reproduced on SS Drawings 6-SP312 through 10-SP312.

312.04.01 Beam Classification (According to the AASHTO Standard) - The shape, class and type together with the ARTBA design and part numbers shall be as specified in the Contract and the Design, and in accordance with the SS Drawing SP312 series.

i) Shape - W-Beam are for ARTBA Design G4 and MB4 installations and Thrie-Beam for Design G9 and MB9 installation and both shall be accurately formed to profile, dimensions and tolerances of the AASHTO Standard with overall cross sections of 311 mm x 85 mm and 508 mm x 85 mm respectively (ARTA Designation RE-3 and RE-63).

ii) Class and Type - Unless otherwise specified or ordered, beams shall be Class A, Type 1. Authorized special installations for corrosive conditions and environment of industrial and marine areas may necessitate a Class A, Type 2 requirement.

Note: Type 4 shop primed beams will not normally be specified.

iii) Length - Normally 3.81 m (12' 6") nominal length beams (4.19 m, +0, -75 mm overall) will be required.

Note: 1.9 m (6' 3") and other lengths if specified or ordered may be considered a special order.

iv) Punchings - In addition to joining bolt holes, punchings may be designed as 7.82 m, 3.81 m or 1.9 m (25' 0", 12' 6", 6' 3" respectively), see SS Drawings 1-SP312 and 2-SP312 for requirements.

Note: Punchings at 0.95 m, 1.27 m (3' 1½" and 4' 2") and other centres if specified or ordered may be considered a special order.

v) Curved Rails - For curved rail data see SS Drawing SP312-11.

312.04.02 Metal

i) Properties - Properties of the base metal for beams and any transition section shall conform to the following requirements:

- Yield point minimum: 345 MPa
- Tensile strength minimum: 483 MPa

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- Elongation minimum in 50 mm: 12%

Note: End and buffer sections shall have minimum yield point of 227 MPa and minimum tensile strength of 310 MPa.

ii) Sheet Thickness - Class A base metal thickness shall be 2.8 mm nominal (2.67 mm minimum) and for special authorized installations Class B 3.5 mm nominal (3.43 mm minimum).

iii) Sheet Widths - Sheet Widths shall be minimum 483 mm for W-Beams and 749 mm for Thrie-Beams both with a permissible tolerance of minus 3.2 mm.

312.04.03 Zinc Coating - Zinc for coating beams and ancillary sections shall be at least equal to “Prime Western” conforming to CSA Standard HZ2 or AASHTO Standard M120 (ASTM B 6) “Slab Zinc”.

The coating shall be firmly bonded to the base metal whether fabrication is from galvanized sheet or galvanizing is specified after fabrication.

The average mass of zinc coating Type 1 (AASHTO M180) shall be 610 g/m² for three specimens but minimum 550 g/m² for any individual specimen being the total amount on both sides of the sheet or beam. When Type 2 is specified or ordered (see DBSS 312.04.01 (ii)) the coating shall have average 1220 g/m² and 1100 g/m² individual minimums.

312.04.04 Quality of Work - Beams shall be punched for splice and post bolts in strict conformity with the AASHTO Standard to the designated number of and centre to centre spacing of posts.

Upon delivery the beams shall be ready for assembly and installation.

Field cutting shall be avoided where practicable. Where necessary, field cutting shall be performed with a cut-off or hack saw; field hole cutting with a drill and/or reamer. Flame or plasma cutting or welding shall not be permitted. All field cuts or holes shall be deburred and treated with two coats of cold galvanizing or zinc-rich coating to CGSB Standard 1-GP-181M.

Warped or otherwise deformed beams will be rejected as will those with injurious defects or excessive roughness of the zinc coating.

Beams for concave and/or convex curved installations with a radius of 45 m or less shall be accurately and smoothly bent in the shop with minimum deformity. The radius of curvature shall be clearly stencilled on the back of each curved rail section.

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312.04.05 Inspection - No material shall be shipped prior to inspection and certification by quality management staff.

All materials may be inspected before shipment to the construction site, or at the construction site, or both. The supplier or manufacturer shall provide the necessary facilities to enable the Quality Manager or Ministry Representative to expeditiously examine selected pieces or take specimen samples for testing from the material lot(s) clearly identified for intended supply to the project. Identification shall be such that after inspection and testing the lot may be subsequently identified for acceptance or rejection.

Inspection of material before shipment shall not exclude its subsequent rejection at the construction site if found to fail any requirements of this specification.

312.04.06 Examination - Examination may include the following:

- i) Dimension measurements for size and thickness all of which shall be within the tolerance measurements specified by DBSS 312.04.01 (i) and Table 312-A.

TABLE 312-A

GALVANIZED BEAM THICKNESS			
FINISH			
Base Metal	Type 1	Type 2	Tolerance
Class A (2.8 mm nominal)	2.74 mm	2.82 mm	minus 0.23 mm
Class B (3.5 mm nominal)	3.51 mm	3.58 mm	minus 0.25 mm
Note: Tolerance given is for under specified thickness; there is no limit for over thickness.			

- ii) Coating generally shall be smooth, free of beading or sharp projections at edges. Coating adherence shall prevent the peeling of any portion of the zinc coating so as to expose the base metal by cutting or prying with a stout knife under considerable pressure.

312.04.07 Testing - Testing shall be carried out according to ASTM A 90 - “Weight of Coating in Zinc Coated Articles” (also AASHTO T65) to determine the mass of galvanizing in conformity with the requirements of DBSS 312.04.03. Alternatively magnetic gauge determination in accordance with ASTM E 376 may be permitted.

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The testing of the mechanical properties of the base metal shall be confirmed by or carried out by the Quality Manager for compliance with the requirements of DBSS 312.04.02.

312.04.08 Rejection and Retests - Should the beam tested fail to meet the testing requirements specified above, two additional beams as selected at random by the Quality Manager or Ministry Representative shall both meet the test requirements in every respect, otherwise the complete lot represented by the samples will be subject to rejection.

In the event of complete lot, the intended replacement lot shall be satisfactorily tested by a mutually acceptable independent testing agency at the supplier's expense. When the time delay for retesting is unacceptable to the Contractor the order or part thereof will be subject to cancellation.

Rejected material shall be replaced at the Supplier's or Contractor's expense, including shipping charges and removal of rejected material at the construction site, if applicable.

312.05 Guardrail Accessories

312.05.01 Transition Section - Transition section for W-Beam to Thrie-Beam shall be of matching metal thickness and finish and fabricated to the ARTBA design profile (RE-69) to provide a smooth and uniform transition of beam widths and corrugations.

312.05.02 End Sections - End sections shall be of the type specified or ordered as indicated on standard SS Drawing 2-SP312. Double face buffer (ARTBA Designation RE-7) sections for breakaway cable terminal (BCT) assemblies shall be of the stipulated radius and the metal thickness and finish to match the beams. Terminal connectors (RE-8), as return sections of the BCT buffer ends and as normal beam connections (RE-8 or RE-67) to bridge parapets, abutments and the like, the metal thickness shall be Class B with matching finish.

312.05.03 Back-up Plates - Back-up Plates required where steel beams between splices are to be installed to any square or channel section steel posts (standard 305 mm lengths) shall be fabricated of the stipulated lengths from the standard beam section (as or similar to RE-4 or RE-64 ARTBA Designation).

312.05.04 Bolts, Nuts and Washers - Button-head bolts for joining beam sections in the length or to end sections and for fixing beams to posts (ARTBA Designation F-3) and hexagonal-head bolts elsewhere shall be of the stipulated diameter, thread length and/or bolt length.

Bolts generally shall conform to the requirements of ASTM A 307, nuts to ASTM A 563 Grade A and plain washers to ANSI B27.2 Type A requirements, and unless otherwise specified, all galvanized according to ASTM A 153.

Plate washers where required (as ARTBA Designations F-12, F-36 and F-38) shall be of the size and thickness stipulated to ASTM A 36 and galvanized to ASTM A 153 requirements.

312.05.05 Post Sleeve - Post Sleeve for BCT breakaway cable fixing through the wood post shall be a 150 mm length of 60 mm outside diameter galvanized pipe conforming to ASTM A 120 for "standard weight" pipe (ARTBA F-34).

312.05.06 Cable Assembly - Cable Assembly for BCT installation shall consist of a swaged fitting, 25 mm diameter threaded stud, locking pin, nut and washer at each end of a cable of 19 mm nominal diameter, 6 x 19 wire strand core independent wire rope core, galvanized, right regular lay wire rope with a minimum breaking strength of 200 000 N (45,000 #) and conforming to AASHTO M-30 with the overall assembly length of 1980 mm developing a similar breaking strength (ARTBA F-37, F-35 and complete with plate washers, F-36 one end and F-38 the other).

312.05.07 Anchor Plate - Anchor Plate for the breakaway cable attachment to the steel beam for BCT assemblies shall be fabricated to the ARTBA design profile (RE-71) from steel plate conforming to ASTM A 36 and galvanized according to ASTM A 123 after forming and drilling for and including eight 16 mm diameter hexagonal-head bolts 38 mm long each with nut and 3.5 mm thick plain washer 44 mm outside diameter (ARTBA F-8 and F-13) complying with DBSS 312.05.04.

312.05.08 Anchor Inserts - Anchor Inserts for fixing terminal connector end sections to existing concrete shall be heavy duty hexagonal bolt type expansion anchor "Hilti" size HSL M16/25, or other pre-approved alternative with hardened plain washer minimum 4 mm thick and 57 mm outside diameter with all metal surfaces galvanized.

Anchors of alternative manufacture may be approved by the Ministry Representative provided equivalence of design and effect can be demonstrated.

312.05.09 Steel posts - Where required for installation on concrete, steel posts shall be fabricated from standard structural steel H-beam or bent steel plate to channel or "C" shape and with similar section short length offset "blocks" and heavy base plates and all shall conform to CSA Standard G40.21M type 300 W or ASTM A 570, Grade 45 and/or ASTM A 36.

All welding shall conform to the requirements of the American Welding Society Code AWS D1.1. All welding shall be carried out by qualified operators of a contractor approved by the Canadian Welding Bureau or the American Welding Society to the requirements of CSA Standard W47.1 Division 3 or the AWS Code.

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Galvanizing, according to CSA Standard G164 or ASTM A 123, shall be carried out after all punching, drilling, cutting and welding.

Post type, size and length similar to ARTBA Designation P-42 or P-53, complete with connecting bolts (F-8), expansion anchors similar to DBSS 312.05.08 or through bolts and backing plates or other fixing devices shall be as stipulated and/or detailed.

Alternative shape, type and size of post members and fixing devices to those detailed or ordered may be permitted by the Ministry Representative provided equivalence of design and effect can be demonstrated.

312.06 Wood Posts

312.06.01 Square Posts - Square posts and offset blocks shall be Douglas Fir/Hemlock “No. 1, Structural Posts and Timber”, graded in conformity with the requirements of NGLA “Standard Grading Rules for Canadian Lumber”.

Wanes on any face shall not exceed the following width:

- Above grade (including blocks): 25 mm
- Below grade: 60 mm

being the minimum permissible post width less the portion entirely free of wane.

Posts and blocks shall be supplied in the exact lengths ordered or specified and unless otherwise required on the Design the scantling shall be nominal 200 mm x 200 mm, and pair of 200 mm x 150 mm for each BCT installation, with dressed on four sides minimum dimension of 189 mm x 189 mm and 189 mm x 138 mm respectively and a tolerance of plus 3 mm.

312.06.02 Preservation Treatment - All posts and blocks shall be pressure treated in accordance with CSA Standard 080-M “Wood Preservation”.

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Unless otherwise specified or stipulated by the Design, the preservatives and retention of preservatives shall conform to the recommendation of CSA Standard 080.14-M Table I “Minimum Retention of Preservatives in Pressure Treated Wood for Highway Construction” under the heading of “Posts-Guardrail...” for square posts and blocks.

Prior to treatment all material shall be air seasoned in accordance with AWP Standard M1 Paragraph 1.31 to a moisture content of 15% to 22% before pressure treatment. In exceptional circumstances the Designer, Quality Manager and Ministry Representative may permit conditioning by steaming for a total of not more than 6 hours at a temperature not in excess of 115°C.

312.06.03 Inspection - All processing of the material shall be open for inspection by the Quality Manager or the Ministry Representative with free entry to the treating plant while the work is being performed.

No material shall be shipped prior to inspection by quality management staff.

Material inspected before shipment shall not bar its subsequent rejection after delivery if found to fail any requirements of this specification. Rejected material shall be replaced at the Supplier’s expense including shipping charges and removal of rejected materials if applicable.

Note: Inspection of material already in bundles ready for shipment shall be considered as “incomplete”, and the material will be subject to final inspection only when the bundles are opened immediately prior to use.

SECTION 316

STEEL AND WIRE FENCE MATERIALS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

316.01 Scope - This Section covers the quality and manufacture of wire fencing material, steel posts, gates and hardware, and various accessory material.

Treated wood fence posts are specified by DBSS 909.

For convenience, chain link fabric necessary for protection on rock slopes is included in this Section.

The uses of materials specified in this Section are generally indicated on Drawings of the SS SP741 series for construction of fences and DBSS 207 for rock protection.

The types of Standard Wire fencing and Chain Link fabric for fencing and protection on rock slopes covered by this Section are designated as follows:

- Type A - Special Wire Fabric Fence for use only on railway rights-of-way
- Type B - Standard Wire Fabric Fence
- Type C - Standard Barbed Wire Fence
- Type D - Chain Link Fence.

Chain link fence protection on rock slopes and tentative requirements for High-tensile Smooth-wire Fences are also included.

316.02 Applicable Documents - See Table 316-A.

Note: Standards referred to in this Section are obtainable from:

CGSB: Canadian Government Publishing
Centre
Supply and Services Canada
Ottawa, ON K1A 0S9

ASTM: American Society for Testing and
Materials
1916 Race Street
Philadelphia, PA 19103

316.03 Type A & B Fence Fabrics - Fence fabric for railway and highway rights-of-way shall be manufactured from good commercial quality galvanized steel wire in general accordance with ASTM A 116, but shall conform to the requirements following and those listed in Table 316-B.

316.03.01 Styles - See Table 316-B. Length of fabric rolls shall be 101 m unless otherwise ordered.

Note: Other standard and specialty fabrics when specified shall meet the following general specifications.

316.03.02 Wire Size and Strength - All wire used in the fabric shall have a minimum galvanized coated nominal diameter of 2.50 mm (12½ ga.). The variation permitted from the measured nominal diameter shall be ± 0.1 mm. The minimum breaking force shall be 4250 N.

316.03.03 Zinc Coating - The zinc used for coating shall be any grade of zinc conforming to ASTM B 6. All wire shall have a uniform coating of zinc which shall adhere firmly to the base metal. The average mass of zinc coating shall be 90 g/m² of uncoated wire surface for three specimens but minimum 80 g/m² for any individual specimen.

316.03.04 Quality of Work - Splicing of individual line wires by means of a wrap joint, electric butt weld or galvanized sleeve is permitted.

The maximum number of line wire joints shall not exceed half of the number of line wires in any roll of fencing.

All joints shall be made in accordance with good work practice.

All stay wires shall be properly spaced and substantially perpendicular to the line wires.

The locks or fastenings at the intersections of the longitudinal and vertical wires of the woven wire fencing shall be of such construction as will prevent them from slipping, either longitudinally or vertically. All locks and fastenings shall be effectively galvanized.

Horizontal wires of all woven wire fencing shall be provided with tension curves to accommodate temperature changes after erection.

316.03.05 Testing

i) Samples: Sufficient length of fabric to include at least three vertical stay wires shall be cut from each roll to be tested as required by DBSS 316.15 from which line wire and stay wire specimens shall be taken for testing.

ii) Diameter of coated wire: The average of two readings taken at right angles to each other at random on uniformly coated areas shall all be within the tolerance measurements specified in DBSS 316.03.02.

iii) Strength: The tensile strength of three line wire specimens shall be tested in accordance with ASTM A 370 on a machine calibrated to ASTM E 4 standards. The tensile strengths shall meet the requirements of DBSS 316.03.02.

iv) Coating adhesion: Three line wire specimens shall be wrapped in a close helix at least twice around a cylindrical mandrel having a diameter four times the nominal diameter of the wire: wrapping speed shall not exceed four seconds per turn. The coating shall adhere to the wire without flaking or being removed by rubbing with bare fingers.

v) Coating mass: Three line wire specimens (from each roll), each more than 400 mm in length, and three stay wire specimens of short lengths between knots, etc., but each specimen totalling more than 400 mm shall be tested in accordance with ASTM A 90 for conformity with the requirements of DBSS 316.03.03.

vi) Rejection and Retest: Refer to DBSS 316.16.

316.04 Type D Fence Chain Link Fabric - Chain link fence fabric shall be manufactured from good commercial quality galvanized steel wire (or other specified finish) in general accordance with CAN/CGSB-138.1M and shall conform to the requirements listed in DBSS 316.04.01 through DBSS 316.04.04.

316.04.01 Fabric Classification (according to CGSB Standard) - The type, class, style and grade of chain link fence fabric shall be as specified in Special Provisions in accordance with the Drawings and/or

Drawings SS SP741-05.01 and SS SP741-05.02, selected from the following:

i) Type/Class 1A - Zinc coated (galvanized) steel wire fabric normally will be specified for all heights of chain link fences as indicated on Drawing SS SP741-05.01, unless Type/Class 1B Vinyl coated steel is required for authorized special installations.

ii) Style - nominal diameter of zinc coated wire:

- Heavy, for highway protection fence from rolling rock
- Medium, for Standard and Security height fences
- Light, for Residential height fences (see Drawing SS SP741-05.01)
- See Table 316-C and 316-D (when permitted).

iii) Grade - mass of zinc coating per unit area of uncoated wire: Grade 1, average 490 g/m² for three specimens, minimum 440 g/m² for any individual specimen. The zinc used for coating shall be any grade of zinc conforming to ASTM B 6. All wire shall have a uniform coating of zinc which shall adhere firmly to the base material.

Note: When specified, Grade 2 heavy coating (average 610 g/m², individual 550 g/m² minimums) for corrosive environments and the zinc coating (average 90 g/m², individual 80 g/m² minimums) for vinyl coated wire and the vinyl coating requirements shall be in accordance with CAN/CGSB-138.1M.

316.04.02 Fabric Height, Length and Mesh - Wire shall be woven throughout to a uniform diamond mesh 50 mm ± 3.0 mm clear between parallel mesh wires: fabric height as specified ± 25 mm with both selvage edges twisted and/or knuckled:

- fabric 1.5 m high and under: knuckled both edges
- fabric 1.8 m high and over: knuckled one edge, and twisted the other
- Residential height fence light style fabric 1.0 m and 1.2 m high: knuckled both edges.

Length of rolls with slack removed by nominal tensioning shall be 100 m unless otherwise ordered.

Note: Typical (normal) ordering designation from above: Type 1, Class A, Grade 1, Medium Style with roll width (height), length, mesh size and quantity.

316.04.03 Quality of Work - Fabric shall be of uniform quality and condition, free from all defects and imperfections affecting serviceability and appearance.

316.04.04 Testing

i) Samples: Three full height pickets shall be provided from each roll as required by DBSS 316.15.

ii) Diameter of coated wire: The average of two readings taken at right angles to each other at random on uniformly coated portions of each pair of pickets between bends shall be within the

tolerance measurement specified in DBSS 316.04.01(ii).

iii) Strength: The tensile strength of three line wire specimens shall be tested in accordance to ASTM A 370 on a machine calibrated to ASTM E 4 standards. The tension applied to the undeformed portion between two adjacent bends shall meet the requirements of DBSS 316.04.01(ii).

iv) Coating adhesion: Three specimens of undeformed portions between two adjacent bends shall be wrapped in a close helix once around a cylindrical mandrel having a diameter four times

TABLE 316-A DOCUMENTS APPLICABLE FOR REFERENCE

CAN/CGSB-138.1-M and 1-GP-181M	Fence, Chain Link, Fabric Coating, Zinc-Rich, Organic, Ready Mixed
ASTM A 53	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 90	Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
ASTM A 116	Specification for Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM A 121	Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 123	Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel
ASTM A 153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 641	Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM B 6	Specification for Zinc (Slab Zinc)
ASTM B 211M	Specification for Aluminum-Alloy Bar, Rod, and Wire [Metric]

TABLE 316-B STYLES OF FENCES

Fence Types	Fabric Style No.	Number of Horizontal Wires	Fabric Height (mm)	Stay Wire Spacing (mm)	Wire Diameter (mm)
A	1047-6	10	1195	150	2.50 MIN
B	939-6	9	990	150	2.50 MIN

TABLE 316-C ZINC COATED WIRE

Type 1A	Style	Nominal Diameter of Zinc Coated Wire	Breaking Force Minimum N
	Heavy	5.0 mm ± 0.1 mm	10 000
	Medium	3.5 mm ± 0.1 mm	5 000
	Light	3.0 mm ± 0.1 mm	3 600

the nominal diameter of the wire: wrapping speed shall not exceed four seconds per turn. The coating shall adhere to the wire without flaking or being removed by rubbing with bare fingers.

v) Coating mass: Three specimens (from each roll) each more than 400 mm long excluding knuckled or twisted ends shall be tested in accordance with ASTM A 90 for conformity with the requirements of DBSS 316.04.01 (iii).

vi) Rejection and Retest: refer to DBSS 316.16.

316.05 Chain Link Fabric and Accessories on Rock Slopes - Chain link fabric for protection on rock slopes shall be manufactured and tested in general conformity with DBSS 316.04 and to the following requirements:

- Fabric shall be to CAN/CGSB-138.1M designation of wire woven to 75 mm diamond mesh in rolls 3.0 m wide, knuckled on both selvage edges, and 15 m long. See Table 316-E.

Note: For corrosive conditions and environment Grade 2 - heavy galvanizing may be specified as a special order with possible extended lead time required for delivery.

316.06 Barbed Wire - Barbed wire for Type B & C fences and for security height Type D fences shall be manufactured from good quality galvanized steel wire in general accordance with ASTM A 121 but shall conform to the following detail requirements:

a) Wire Size and Strength: The wire shall be continuously twisted double strand of 2.5 mm nominal diameter (12 1/2 ga.) and to have a minimum breaking force of 4000 N.

b) Barbs: Four point barbs shall be of not less than 2.0 mm nominal diameter (14 ga.) and regular

150 mm maximum spacings.

c) Zinc Coating Class (according to ASTM A 121): The zinc used for coating shall be any grade of zinc conforming to ASTM B 6. All wire, including barbs, shall have a uniform coating of zinc which shall adhere firmly to the base metal.

The average mass of zinc coating per unit area of uncoated wire for three specimens and the minimum for any individual specimens shall be in accordance with the class of coating as follows:

i) Class 1 for use in the construction of Type C fences and for the top strand of Type B fences (see Drawings SS SP741-01.01 and SS SP741-02.01), the coating shall be average 90 g/m² and 80 g/m² individual minimums.

ii) Class 3 for use with Security height Type D Chain Link fences (see Drawing SS SP741-05.01), coating shall be average 240 g/m² and 215 g/m² individual minimums.

d) Length: Spools shall be 400 m unless otherwise ordered.

e) Quality of Work: Splicing of individual strand wires by means of a wrap joint or an electric butt weld is permitted. Not more than three splices or joints shall exist in any 400 m spool of barbed wire. Such splices or joints shall be made in accordance with good work practice.

The twist in the double strand barbed wire shall be uniform and continuous in one direction to lock the barbs in place. The barbs shall be sharp and well formed.

TABLE 316-D VINYL COATED ZINC-COATED WIRE (when permitted)

Type 1B	Style	Vinyl Coated Zinc-Coated Wire Nominal Diameter	Breaking Force Minimum N
	Heavy	5.0 mm ± 0.1 mm	6 000
	Medium	3.5 mm ± 0.1 mm	3 000
	Light	3.0 mm ± 0.1 mm	2 600

TABLE 316-E FABRIC DESIGNATION

i.e.	Type 1	Class A Grade 1	Light Style	OR Nominal Diameter	Medium Style
	Steel	zinc coated (galvanized)	3.0 mm		3.5 mm

Wire strands showing nicks or indentures likely to cause the wire to break under flexure are not acceptable.

f) Testing

i) Samples: Sufficient length of barbed wire shall be cut from each spool to be tested as required by DBSS 316.15.

ii) Strength: The tensile strength of three line wire specimens shall be tested in accordance to ASTM A 370 on a machine calibrated to ASTM E 4 standards. The tensile strength shall meet the requirements of DBSS 316.06 (a).

iii) Coating Mass: Three single wire specimens (from each spool), each aggregating more than 400 mm in length shall be tested in accordance with ASTM A 90 for conformity with the requirements of DBSS 316.06 (c).

iv) Rejection and Retest: Refer to DBSS 316.16.

Note: Smooth (barbless) galvanized wire, not specified to be "high-tensile," shall be double strand meeting all the above requirements except those for barbs.

316.07 High-tensile Wire - Requirements for galvanized wire for high-tensile smooth-wire (no barbs) fencing are shown in Table 316-F.

316.08 Brace, Tension and Tie Wire

316.08.01 Brace Wires - Brace wire shall be manufactured of good commercial quality soft temper steel wire 3.5 mm nominal diameter gauge and zinc coated (galvanized) normally minimum 80 g/m² (Class 1 according to ASTM A 641) or as otherwise specified or approved.

Brace wire for high-tensile smooth-wire fencing may be fence wire specified in DBSS 316.07.

316.08.02 Tension Wire - Tension wire to secure bottom of chain link fencing and at top where specified shall be manufactured of good commercial quality coil spring crimped steel wire 5.0 mm nominal diameter gauge and zinc-coated (galvanized) normally 400 g/m² (Class B according to ASTM A 641) for Standard and Security height fences, or as otherwise specified or approved. Residential height fences tension wire shall be 3.5 mm nominal diameter.

316.08.03 Tie Wire and Wire Hog Ring Clips - Tie wire and wire hog ring clips shall be of steel of the nominal diameter gauge specified and zinc coated equivalent to that specified for the relevant fencing fabric: Aluminum tie wire shall be of specified gauge and according to ASTM B 211M.

316.09 Steel Fence Posts on Rock (Excluding Chain Link Fence) - Steel fence posts and braces for Type A, B and C fences where specified or required on exposed rock or rock with minimum over-burden shall be of good commercial quality steel conforming to either Category A or Category B as specified in DBSS 316.10 with the following exceptions:

- Line post mass shall be not less than 1.9 kg/m and angles 4.75 kg/m minimum, both drilled for

TABLE 316-F REQUIREMENTS FOR GALVANIZED WIRE FOR HIGH TENSILE SMOOTH-WIRE (NO BARBS) FENCING

Diameter:	2.5 mm nominal diameter (12 1/2 ga.)
Tensile Strength:	between 1170 MPa and 1590 MPa (170,000 to 230,000 psi)
Breaking Force:	in excess of 5800 N (1300 lbf)
Zinc Coating (Class 3):	minimum 240 g/m ²
Coil Length:	in excess of 1200 m (approx. 100 lb.)

TABLE 316-G REQUIREMENTS FOR PIPE COMPONENTS FOR CHAIN LINK FENCING - CATEGORY A

Pipe Sizes	Nominal Outside Diameter (mm)		
	Residential	Standard	Security
Line Posts	42	48	60
End, Corner & Straining Posts	48	60	73
Gate Posts, gates 2.5 m and less	48	60	73
Gate Posts, gates over 2.5 m	48	73	89
Top Rails	33	33	42
Brace Rails	--	33	42

attaching barbed wire or a substantial number of fence fabric line wires with wire ties or clips.

- Channel braces shall be 1.5 kg/m minimum.

316.10 Steel Pipe Posts, Rails and Braces - Chain Link Fencing

316.10.01 Category and Sizes - All posts, rails and braces shall be of Category 1 or Category 2 at the discretion of the supplier and shall be supplied in the nominal outside diameter as specified in Special Provisions or in accordance with the Drawings and/or Drawing SS SP741-05.02 and selected from Tables 316-G or 316-H or as may be otherwise specified.

Note: Specifications may permit thin wall tubing and consequent lower zinc coating for proprietary galvanized and vinyl coated residential fence posts and gates.

Bolts and nuts for fastening braces to posts shall be galvanized Class D (305 g/m² individual pipe posts, rails and braces for chain link Type D fences shall be manufactured in general accordance with ASTM A 53.

- a) Category A** - Category A posts, braces and rails

shall be steel butt weld pipe, Schedule 40, as specified by ASTM A 53, except that the hydrostatic testing requirement is waived, and the minimum weight shall be no less than 95% of the nominal weight. Pipe shall be zinc-coated in accordance with ASTM A 53. This ASTM Standard requires, among other things, an average zinc coating of 550 g/m² and a minimum zinc coating of 490 g/m².

b) Category B - Category B posts, braces and rails shall be made from steel pipes. The pipe shall be formed from steel strip conforming to ASTM A 569. The steel in the formed pipe shall have a minimum yield strength of 350 MPa (50,000 psi). The product of the yield strength and section modulus of the pipe shall be not less than that of pipe meeting the requirements for Category A posts and rails.

The outer surface of Category B posts, braces and rails shall have all of the following protective coatings, applied in the following order:

- i)** Hot dip zinc coating, conforming to ASTM B 6, High Grade or Special High Grade, applied

TABLE 316-H REQUIREMENTS FOR PIPE COMPONENTS FOR CHAIN LINK FENCING - CATEGORY A

Actual Outside Post Diameter (mm)	26.7	33.4	42.1	48.3	60.3	73.0	88.9
Wall Thickness (mm)	2.87	3.38	3.56	3.68	3.91	5.16	5.49
Mass (kg/m)	1.7	2.5	3.4	4.0	5.4	8.6	11.3
Tolerances:	Diameter \pm 1%			Mass \pm 5%			

at an average weight of 305 g/m² (1.0 oz/ft²) and at a minimum weight of 275 g/m² (0.9 oz/ft²), as determined by the test method in ASTM A 90.

ii) Chromate conversion coating, with a weight of 30 micrograms/sq. in. ± 15 micrograms/sq.in., as determined by a strip and weight method for the zinc and chromate and by determining the percentage of each by atomic absorption spectrophotometer.

iii) Clear acrylic polyurethane coating with a thickness of 0.100 mm ± 0.025 mm (0.4 ± 0.1 mils).

The combined outer coating shall have an ability to resist:

- 1000 hours of exposure to salt fog with a maximum of 5% red rust when tested in accordance with ASTM B 117.
- 500 hours of exposure to 100% relative humidity without blistering and peeling when tested in accordance with ASTM D 2247; and
- 500 hours of exposure in a weatherometer without film cracking of the clear coat when tested in accordance with ASTM G 23, Type E or EH carbon arc, or ASTM G 26, Type B or BH xenon arc.

The inner surface of Category B, posts, braces and rails shall have either a zinc coating as per ASTM F 1234, Type B, applied at an average rate of 305 g/m² and a minimum rate of 275 g/m²; or an ASTM F 1234, Type D zinc coating with a minimum zinc powder loading of 91% by weight and a minimum thickness of 0.075 mm (0.3 mils). The inner coating shall have an ability to resist 650 hours of exposure to salt fog with a maximum 5% red rust when tested in accordance with ASTM B 117.

316.10.02 Quality of Work - The finished pipes shall be reasonably free from injurious defects. All burrs at ends of pipes shall be removed.

The zinc or zinc/chromate/acrylic coating shall be free from injurious defects and excessive roughness.

316.10.03 Testing

a) **Samples:** A 100 mm specimen shall be cut from each end of one pipe in every lot of 500 or fraction thereof.

Note: Specimens may be taken from the extreme ends of pipe that has been cut to length after galvanizing; otherwise, specimens shall be taken at least 200 mm clear of each galvanized end build-up.

b) **Dimensions:** Specimens shall be measured for diameter and wall thickness/mass and all shall be within the tolerance measurements specified by DBSS 316.10.01.

c) **Mass Coating:** Specimens shall be tested for the mass of zinc or composite coating in accordance with DBSS 316.10.01 and ASTM A 90.

d) **Rejection and Retest:** Refer to DBSS 316.16.

316.11 Gates and Hardware - Gates shall be supplied with hardware ready for installation as specified by the Purchase Order, Work Order or Special Provisions in accordance with the Drawings and/or Drawings SS SP741-04.04, SS SP741-04.05, SS SP741-05.03 and SS SP741-05.04 or as may be otherwise specified or ordered.

Gates may be specified by the types as follows:

- **Type I** Pressed sheet steel frame, in-fill and brace members
- **Type II** Pipe frame and horizontal pipe in-fill members
- **Type III** Pipe frame, bracing and wire fabric in-fill
- **Type IV** Pipe frame, bracing and chain link fabric in-fill
- **Type V** Slip wire range gates barbed wire and wood droppers

with the general requirements of material, finish, hardware and quality of work specified in DBSS 316.11.01 through DBSS 316.11.06.

316.11.01 General - Gate sizes shall be the fence height or as otherwise stipulated and the nominal width designated by the clear opening width between gate posts with allowance made for hinges and latches, etc.

Gates shall be fabricated of galvanized pipe, tubing or formed sheet metal sections properly joined, braced and with in-fill all as specified by type below.

All pipe joints shall be cut to fit closely together and fully welded, vertical stiles neatly capped or mitred to horizontals with drilled holes to vent and drain closed

end pipe members. Bends where permitted at corners shall be made without deforming tube or pipe section.

All welds, conforming to the best commercial practice, shall be smooth, and with adjoining and other marred galvanized pipe surfaces, shall be painted with two heavy coats of zinc rich paint manufactured in accordance with Standard 1-GP-181M.

All hardware and required fittings and fasteners shall be of suitable aluminum alloy or of steel or malleable or ductile cast iron, galvanized in accordance with ASTM A 153. Hinges generally shall be so designed as to permit the gate to swing back against the fence and to prevent the easy removal of gate and hinges. Hinges and other fittings shall all be of adequate strength for fastening securely without distortion and shall be sound and free of defects. Chain and/or latching gate catch for padlocking together with keepers to hold the gate open and centre drop bolt and sleeve for double swing gates shall be provided as and where specified or ordered.

All galvanizing and other finished surfaces shall be smooth and free of sharp dangerous protrusions.

316.11.02 Type I Gate (sheet metal members) -

Formed heavy duty galvanized sheet metal sections with rolled edges as horizontal rails and vertical stiles, braced vertically and/or diagonally with similar members as necessary shall be rigidly riveted together to form a rugged non-sagging prefabricated gate.

Nominal sizes: 1220, 2440, 3050, 3660, 4270 and 4880 mm wide and 1220 mm high.

Gates to be supplied completely assembled with required hardware for wood (or metal) gate posts all as specified or ordered.

316.11.03 Type II Gates (all pipe) - Galvanized pipe 42 mm OD, 3.4 kg/m mass with zinc coating minimum 490 g/m² (see DBSS 316.10.01 and DBSS 316.10.03) shall be welded together as gate frame and horizontal pipe in-fill members at 305 mm on centres. Vertical centre bracing of 5 mm x 19 mm flat bar on both sides of all horizontals is not required for gates 3050 mm and 3660 mm nominal widths. Gussets shall be welded to opposite corners of the gate as shown on Drawing SS SP741-04.05.

Nominal sizes: 3050, 3660, 4270 and 4880 mm wide and 1220 mm high.

Gates shall be supplied completely assembled with required hardware for wood (or metal) gate posts all as specified or ordered.

316.11.04 Type III Gates (pipe and fabric) -

Galvanized pipe 33 mm OD, 2.5 kg/m mass with zinc coating minimum 490 g/m² (see DBSS 316.10.01 and DBSS 316.10.03) shall be formed with even radius bent corners or neatly welded corners and vertical bracing at 1/3 points in the width of 27 mm OD, 1.7 kg/m pipe. Cleats or gussets shall be welded to opposite corners of gate frame/panel(s) as indicated on Drawing SS SP741-04.05, holed for securing under tension a diagonal brace consisting of 5.0 mm nominal diameter galvanized coil spring wire (see DBSS 316.08) with or without forged turn-buckle as and when specified.

In-fill shall be wire fabric all of 3.5 mm galvanized diameter wire with seven or more horizontal line wires, and stay wires not more than 600 mm apart. Fabric shall be securely fixed taut without sag to gate frame all round and to vertical brace.

Nominal sizes: 3050, 3660, 4270, 4880 and 5490 mm wide and 1070 and 1220 mm high.

Gates shall be supplied completely assembled with required hardware for wood (or metal) gate posts all as specified.

316.11.05 Type IV Gates (pipe and chain link) -

Gate frame and required vertical bracing and/or diagonal bracing to cleats all welded as generally indicated on Drawing SS SP741-05.04 for hinged swing gates shall be fabricated to the designated size(s) complete with chain link in-fill and hardware for fixing to metal posts all as specified.

Pipe shall be in accordance with DBSS 316.10 and welding with DBSS 316.11.01. In-fill of chain link fabric as specified for fencing (see DBSS 316.04), shall be attached to gate frame stiles with tension bars and bands (see DBSS 316.12), and to horizontal members and vertical bracing with tie wire (see DBSS 316.08.03), all taut and sag free.

Sliding gates may be specified for gate openings over 4.0 m and shall be fabricated as generally indicated for swing gates but with diagonal tension rod bracing to support centre from both ends. The rolling hardware shall hold the gate vertical and parallel to the gate posts and adjoining fence at all times to allow free operation from any position while not retained by latches or keepers.

Roller assembly sheaves and wheels with bearings, grease fittings, necessary clamps, supports and fasteners, and chain and/or latching gate catch for padlocking, all approved by the designer and shall be provided as and when specified.

316.11.06 Type V Gates (range slip wire) - Barbed wire continued across standard width gate opening (for possible future farm gate) with 50 mm diameter full fence height treated wood droppers securely figure of eight wire tied and stapled to each line wire shall be provided with a galvanized steel strap loop at bottom and either similar loop at top with an intermediate chain (for padlocking) or, when specified, a Princeton or other approved cinch-up lockable latch device all for securely attaching to fence or gate posts to hold open-end dropper.

316.12 Accessory Material - All required fittings, fasteners, hardware and accessories shall be of suitable aluminum alloy or steel, malleable or ductile cast iron, and galvanized in accordance with ASTM A 153, or as may be specified.

a) Staples for securing wire and fabric to treated wood fence posts shall be nominal 3.5 mm diameter steel wire with a driving length of at least 45 mm heavy galvanized finish.

b) Hog ring clips for securing wire fabric and/or barbed wire of Type A, B and C Fences to steel posts and to tension wire of Type D Fences see DBSS 316.08.03.

c) Dowel, Spikes, Bolts and Nuts shall be of good commercial quality, galvanized where specified.

d) Metal Droppers for high-tensile fencing will be prefabricated "Waratah" or other acceptable galvanized formed sheet metal droppers, 1070 mm for 5-wire and 1170 mm long for 6-wire fences, with preformed wire clips: such metal droppers or other acceptable manufacture may be specified or permitted as an alternative to the wood droppers specified by DBSS 909.08 for barbed wire (Type C) fences.

Note: Galvanized twisted double wire fence stays are permitted only for the extension of normal fence heights to deer height and the like.

e) All terminal and tensioning posts, for Type D chain link fences, shall be provided with aluminum or galvanized weather tight caps to fit and fasten securely and with extended arms for engaging

barbed wire of security fences.

f) Caps for line posts for Type D chain link fences, shall carry top rail. Rail and brace end caps shall be provided for securing to rails and bolting with steel bands to posts.

g) Tension Bars for securing chain link fencing to terminal and tensioning posts and to vertical stiles of gates of Type D Fences shall be merchant quality mild steel strip 5 mm x 19 mm in minimum lengths of 50 mm less than full height of the chain link fabric, hot dip galvanized.

h) Tension and Brace Bands for securing brace and top rail caps and tension bars to posts shall be formed of minimum 2.5 mm x 19 mm mild steel strip, hot dip galvanized complete with bolt and nut.

i) Tensioning Devices for individual in-line high-tensile wire will be "Hayes" or other acceptable manufacture and operation.

j) Mechanical Splices and Fasteners shall be of "Nicopress FW2-3" or other acceptable manufacture applicable to the respective diameter and tensile strengths of wires.

316.13 Packaging and Marking - Each roll of fencing fabric or chain link mesh and spool of wire shall be tightly rolled and firmly tied to prevent loosening during shipment and handling.

Posts shall be securely fastened in bundles or sets, and accessories packaged in cartons or other suitable containers, to prevent loss or damage during shipment and handling.

Each product, roll, bundle or container etc., shall be clearly marked with the name, brand and/or trade mark of the manufacturer; the heat or lot number and other information sufficient to identify the style, type, class, grade, finish, height and/or length, nominal or outside diameter, gauge and the applicable Standard to which the product conforms.

316.14 Inspection - No material shall be shipped prior to inspection or until a release for shipment has been issued by the Contractor.

All material may be inspected before shipment to the construction site or at the construction site, or both. The Supplier or manufacturer shall provide the necessary facilities to enable the Contractor and the

SECTION 316

Ministry to expeditiously examine selected pieces from the material lot(s) clearly identified for intended supply to the Contractor. Identification shall be such that after inspection and testing the lot(s) may be subsequently identified for acceptance or rejection.

Inspection of material before shipment shall not exclude its subsequent rejection at the construction site if found to fail any requirements of this specification.

316.15 Sampling - One roll of fabric or spool of wire, in every lot of 50 or fraction thereof, in the shipment may be selected at random for testing but in no case will less than two samples be tested.

Specimens for testing will be required from the outside ends of the selected sample roll or spool material and both ends of one post in every 500 or fraction thereof.

Sufficient length of each roll, spool or pipe shall be taken to provide the number of specimens for each of the testing requirements specified.

Wire used for knots, knuckling, twisting and wraps and wire containing welds shall be excluded from tests.

STEEL AND WIRE FENCE MATERIALS

See respective material tests for pertinent sample lengths.

316.16 Rejection and Retests - If any tested specimen fails to meet the testing requirements specified above, the roll, spool or pipe represented by the specimens shall be replaced with two additional rolls, spools or pipes randomly selected by the Quality Manager and both shall meet the test requirements in every respect, otherwise the complete lot represented by the samples will be subject to rejection.

In the event of complete lot rejection and prior to any further testing by the Ministry or the Contractor, the intended replacement lot(s) shall be satisfactorily tested by a mutually acceptable independent testing agency at the expense of the Contractor. Where the time delay for retesting is unacceptable to the Contractor the order or part thereof will be subject to cancellation.

Rejected material shall be replaced at the Supplier's or Contractor's expense including shipping charges and removal of rejected material at the construction site, if applicable.

SECTION 317

P.E. PLASTIC DRAINAGE PIPE

317.01 Scope - This Section covers the requirements and methods of testing corrugated polyethylene (P.E.) drainage pipe. The inside wall may be corrugated or smooth. It covers nominal pipe diameters 200 mm, 250 mm, 300 mm, 400 mm, 450 mm and 600 mm.

317.02 Applicable Documents

ASTM D 883: Definition of Terms Relating to Plastics

ASTM D 2122: Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings

ASTM D 2412: Test for External Loading Properties of Plastic Pipe by Parallel Plate Loading

ASTM D 2444: Standard Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by means of a Tup (Falling Weight)

ASTM F 405: Standard Specification for Corrugated Polyethylene Tubing and Fittings

ASTM F 412: Definition of Terms Relating to Plastic Piping Systems

ASTM F 667: Standard Specification for 8", 10", 12", 15", 18" and 24" Corrugated Polyethylene Tubing

Note: ASTM Standards are obtainable from: American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

317.03 Materials - The pipe, fittings and couplers shall be manufactured from virgin polyethylene plastic of Type III or IV, Class C, Category 5 and Grade P33 as defined in ASTM D 1248.

317.04 Joining Systems - The assembly of joints shall be in accordance with the pipe manufacturer's recommendations.

Approved joint systems are as follows:

a) Integral Bell Gasketed Joint

- i) The joint shall be designed so that when assembled, the gasket will be compressed radially

on the pipe spigot or in the bell to form a watertight seal.

- ii) The joint shall be designed to avoid displacement of the gasket when assembled in accordance with the manufacturer's recommendation.

b) Corrugated Screw-On Coupler (Nominal Pipe Diameters 250 and Larger)

- i) Coupler shall be manufactured of polyethylene plastic as specified in DB SS 317.03.
- ii) Coupler length shall be a minimum of 1.1 times the nominal pipe diameter or 270 mm, whichever is greatest (a minimum of 0.4 times the length of the coupler shall be engaged on both pipes to be joined).
- iii) Average coupler wall thickness shall be a minimum 2.6 mm for nominal pipe diameters of 250 mm and 300 mm and 3.2 mm for all other diameters up to and including 600 mm.

317.05 Requirements

317.05.01 Quality of Work - The pipe shall be homogenous throughout and free from visible cracks, flaws, foreign inclusions or other injurious defects. The pipe shall be uniform in colour, opacity and other physical properties.

317.05.02 Pipe Diameter

- i) **Nominal Diameter** - The nominal diameter shall be the average inside diameter rounded to the nearest whole number (mm).
- ii) **Inside Diameter** - The permissible inside diameter tolerances shall be +3% and -1.5%. Measurement shall be taken in accordance with ASTM D 2122.

317.05.03 Length - Laying length shall be 4 m or 6 m for all diameters otherwise specified on the Design. A tolerance of ± 25 mm on the nominal laying length will be permitted.

317.05.04 Physical Properties

i) Impact Strength - The minimum drop weight impact strength shall be 36.8 Joules when tested in accordance with DB SS 317.07.01.

ii) Pipe Stiffness - The minimum pipe stiffness shall be 210 kPa when tested in accordance with DB SS 317.07.02.

iii) Pipe Flattening - There shall be no evidence of splitting, cracking or breaking when tested in accordance with DB SS 317.07.03.

317.05.05 Joint Separation Resistance - Joint systems when installed in accordance with the manufacturer's instructions shall not separate when tested in accordance with DB SS 317.07.04.

317.06 Marking - All pipe shall be clearly marked at intervals of no more than 1.5 m with 5 mm or larger letters with the following information:

- Manufacturer's name or trademark
- Nominal diameter
- Materials designation and cell class: PEGR33
- The words "Drainage" or similar
- The class: PS210
- The applicable Specification designation (ASTM F 405 or F 667)
- Date of manufacture and plant designation.

317.07 Test Methods

317.07.01 Impact Resistance - Five specimens, each at least as long as the nominal pipe diameter, shall be tested in accordance with ASTM D 2444, using a 2.5 kg Tup "B" and the flat plate holder "B". The height of the drop shall be 1.5 m (total drop energy = 36.75 Joules). The test shall be performed at 0°C ($\pm 0.5^\circ$) allowing no more than 15 seconds to complete the test after removing the sample from the conditioning medium. Any cracking or other signs of material fatigue evident after the test shall constitute a failure. All five specimens must pass. If one specimen fails, five more specimens shall be tested. Nine out of ten specimens passing will be acceptable.

317.07.02 Pipe Stiffness - The pipe stiffness shall be determined at 5% deflection of the initial inside diameter in accordance with ASTM D 2412. Three specimens, each at least as long as the nominal pipe diameter, shall be tested. The exact specimen length shall be an integer multiple of the corrugation pitch. All test specimens shall meet the required stiffness.

317.07.03 Pipe Flattening - The three specimens tested in DB SS 317.07.02 shall be flattened between parallel plates in a suitable press until the distance between the plates is 40% of the original inside diameter. The loading rate shall be uniform and such that the compression is completed within two to five minutes. Remove the load and examine the specimen. All three specimens shall meet the requirements.

317.07.04 Joint Separation - A test specimen shall be constructed using the manufacturer's joining system centred on two pieces of pipe each 0.75 m in length. The specimen shall be hung vertically and a dead weight test force applied to the bottom end of the pipe. The vertical test force shall be 0.87 N/mm of nominal pipe diameter. Any separation of the joint shall be considered a failure.

317.08 Inspection

a) The Quality Manager and Ministry shall have access to the fabrication plant for inspection and every facility shall be extended for this purpose.

b) Inspection may include checks on physical dimensions and general quality of work.

c) For the purpose of sampling for DB SS 317.05 and 317.07, one pipe from each lot of 50 pipes or fraction thereof in a shipment shall be selected for sampling. All test specimens shall be cut from the selected pipe(s).

d) If the test sample fails to meet the requirements of DBSS 317.05 when tested in accordance with DB SS 317.07, that batch will be rejected and shall be replaced by the Supplier with a new batch that conforms to this Specification.

317.09 Quality Assurance

a) The Supplier shall develop and maintain an effective quality control system to ensure that adequate inspection coverage is maintained throughout the manufacturing process. Evidence of such inspection shall be available to the Quality Manager and the Ministry prior to shipment from the place of manufacture or the Supplier's storage facility.

b) The Contractor shall, and the Ministry reserve the right to, audit the Supplier's quality control system to ensure conformance with this Specification.

SECTION 318

PVC PLASTIC DRAINAGE PIPE

318.01 Scope - This Section covers the requirements and methods for testing for:

- Type PSM* Poly Vinyl Chloride Drainage Pipe
- Ribbed Poly Vinyl Chloride Drainage Pipe

and the perforation requirements of type PSM pipe up to a nominal diameter of 375 mm.

Note: The term PSM* is not an abbreviation but rather an arbitrary designation for a product having certain outside dimensions.

318.02 Applicable Documents

CSA B182.2: Large-diameter, Type PSM PVC Sewer Pipe and Fittings

CSA B182.4: Large-diameter, Ribbed PVC Sewer Pipe and Fittings

ASTM D 883: Definition of Terms Relating to Plastics

ASTM D 1784: Standard Specification for PVC and CPVC Compounds

ASTM D 2122: Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings

ASTM D 2152: Standard Test Method for Quality of Extruded PVC and CPVC Compounds

ASTM D 2412: Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading

ASTM D 2444: Standard Test Method for Impact Resistance of Thermo-plastic Pipe and Fittings by Means of a Tup (Falling Weight)

ASTM D 3034: Standard Specification for Type PSM PVC Sewer Pipe and Fittings

ASTM D 3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

ASTM F 412: Definition of Terms Relating to Plastic Piping Systems

ASTM F 477: Standard Specification for Elastomeric Seals for Joining Plastic Pipe

ASTM F 794: Standard Specification for PVC Large-diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

318.03 Materials - The pipe shall be made of virgin PVC plastic having a cell classification of 12454-B, 12454-C, or 13364-C, as defined in ASTM D 1784.

The fittings shall be made of virgin PVC plastic and shall have a cell classification of 12454-B, 12454-C, or 13343-C, as defined in ASTM D 1784.

Elastomeric gaskets shall comply with the requirements of ASTM F 477.

318.04 Quality of Work - The pipe shall be homogenous throughout and free from visible cracks, flaws, foreign inclusion, or other injurious defects. The pipe shall be uniform in colour, opacity and other physical properties.

318.05 Joining System - All sizes of pipe shall be supplied with Elastomeric Gasket Joints providing a watertight seal in accordance with ASTM D 3034.

- a) Integral Bell Gasketed Joints shall be designed so that when assembled, the gasket shall be compressed radially on the pipe spigot or in the bell to form a watertight seal.
- b) The joint shall be designed to avoid displacement of the gasket, when assembled in accordance with the manufacturer's recommendation.
- c) Joint assembly shall be in accordance with the pipe manufacturer's recommendations.

318.06 Requirements

318.06.01 Length - Laying length shall be 4 m or 6 m for all diameters unless otherwise specified by the Design. A tolerance of ± 25 mm on the nominal laying length will be permitted.

318.06.02 Type PSM, PVC Drainage Pipe Dimensions - The average outside diameter and the minimum wall thickness of Type PSM PVC drainage pipe shall be as specified in Table 318-A when measured in accordance with ASTM D 2122.

TABLE 318-A PIPE DIMENSIONS - TYPE PSM

NOMINAL DIAMETER (mm)	OUTSIDE DIAMETER (mm)				
	AVERAGE	TOLERANCE	MINIMUM	MAXIMUM	MINIMUM WALL THICKNESS
100	107.06	± 0.22	106.84	107.28	3.06
150	159.38	± 0.28	159.10	159.66	4.58
200	213.36	± 0.30	213.06	213.66	6.10
250	266.70	± 0.38	266.32	267.08	7.62
300	317.50	± 0.46	317.04	317.96	9.07
375	388.62	± 0.58	388.04	389.20	11.10
450	475.00	± 0.70	474.30	475.70	13.57
525	560.00	± 0.85	559.15	560.85	16.00
600	630.00	± 0.95	629.05	630.95	18.00
680	710.00	± 1.05	708.95	711.05	20.29

318.06.03 Ribbed, PVC Drainage Pipe Dimensions - The average inside diameter and minimum wall thickness of Ribbed PVC drainage pipe shall be as specified in Table 318-B when measured in accordance with ASTM D 2122.

TABLE 318-B PIPE DIMENSIONS RIBBED

INSIDE DIAMETER (mm)					
NOMINAL DIAMETER	AVERAGE	TOLERANCE	MINIMUM	MAXIMUM	MINIMUM WATERWAY WALL THICKNESS
450	448.31	± 1.41	446.90	449.72	3.30
525	527.05	± 1.50	525.55	528.55	4.06
600	596.90	± 1.78	595.12	598.68	4.58
680	673.10	± 2.00	671.10	675.10	5.20
760	749.30	± 2.30	747.00	751.60	5.96
900	901.70	± 2.70	899.00	904.40	7.36
1000	1003.30	± 3.00	1000.30	1006.30	8.26
1200	1206.50	± 3.55	1202.95	1210.95	10.16

318.06.04 Perforations - Perforated pipe up to the nominal diameter of 37.5 mm shall be type PSM and perforated in accordance with Figure I and Table 318-C. The perforations shall be 8 to 10 mm in diameter, circular, and cleanly cut. The gasketed bell and spigot end of the pipe shall be unperforated for a length equal to the depth of the socket and/or shoulder.

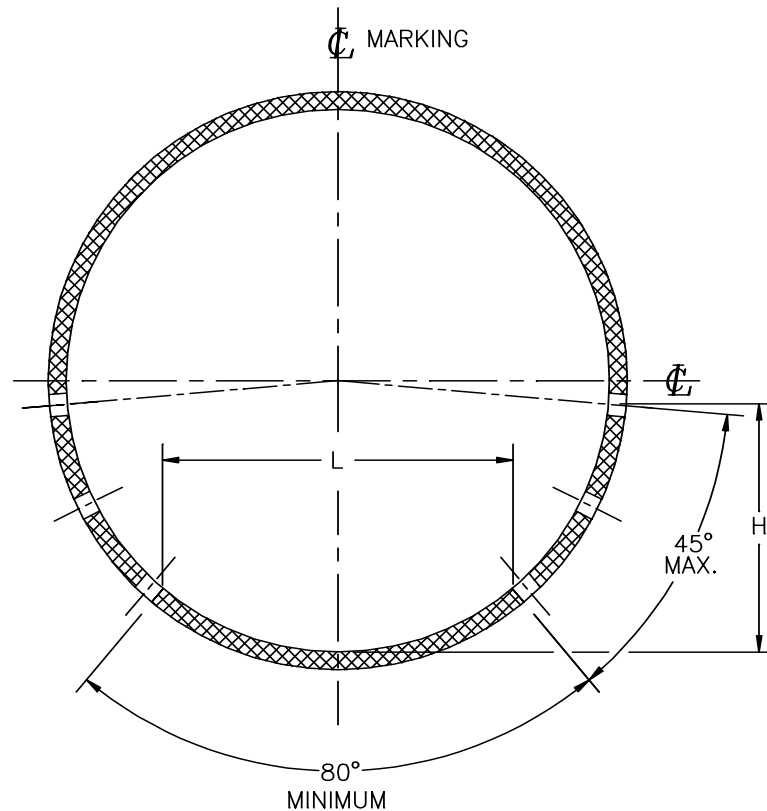


FIGURE I

TABLE 318-C PERFORATION REQUIREMENTS

NOMINAL DIAMETER (mm)	MINIMUM ROWS OF PERFORATIONS	HORIZONTAL HOLE SPACING (mm)	H (mm) *	L (mm) **
100	2	80 ± 5	30	65
150	4	80 ± 5	70	73
200	4	80 ± 5	93	130
250	4	100	115	163
300	6	150	140	195
375	6	150	175	240

*H: maximum height of the centreline of the uppermost perforations above the Invert.

**L: minimum length of the unperforated inner surface at the bottom of the pipe.

318.07 Physical Properties

318.07.01 Impact Strength - The minimum drop weight impact strength for pipe shall meet the requirements of Table 318-D when tested in accordance with DB SS 318.09.01.

318.07.02 Pipe Stiffness - The minimum pipe stiffness when tested in accordance with DB SS 318.09.02 and ASTM D 2412 shall be 320 kPa.

318.07.03 Pipe Flattening - There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with DB SS 318.09.03.

318.07.04 Extrusion Quality - The pipe shall not flake or disintegrate when tested in accordance with ASTM D 2152.

TABLE 318-D IMPACT STRENGTH AT 0°C

NOMINAL DIAMETER (mm)	joules	ft. / lb.
100	93	69
150	147	108
200	175	129
250	190	140
300	205	151
375	230	170
450 and larger	250	184

318.08 Marking - All pipe shall be clearly marked at intervals of no more than 1.5 m with 5 mm or larger letters with the following information:

- Manufacturer's name or trademark
- Nominal diameter
- Material designation and cell class: PVC-12454-B

- The word "Drainage" or similar
- The class: SDR35 or PS320
- The applicable specification designation (ASTM D 3034 or F 794)
- Date of manufacture and plant designation

The marking on perforated pipe shall be 180° from a point equidistant between the bottom row of holes as shown in Figure I and Table 318-C.

318.09 Test Methods

318.09.01 Impact Resistance - Five specimens, each nominally 150 mm long for the PSM pipe and 300 mm long for the ribbed pipe, shall be tested in accordance with ASTM D 2444, using a 15 kg Tup "A" and the flat plate holder "B". The height of the drop shall not be less than 600 mm or more than 3 m. The test shall be performed at 0°C ($\pm 0.5^\circ\text{C}$), allowing no more than 15 seconds to complete the test after removing the sample from the conditioning medium. Perforated samples shall be positioned as shown in Figure I. Any cracking or other signs of material fatigue evident after the test shall constitute a failure. All five specimens must pass. If one specimen fails, five more specimens shall be tested. Nine out of ten specimens passing will be acceptable.

318.09.02 Pipe Stiffness - The pipe stiffness shall be determined at 5% deflection of the initial inside diameter in accordance with ASTM D 2412. Three specimens, each with a length equal to one pipe diameter shall be tested; all shall meet the required stiffness. Perforated samples shall be positioned as shown in Figure I.

318.09.03 Pipe Flattening - Three specimens, each nominally 150 mm long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40% of the original nominal diameter of the pipe. The loading rate shall be uniform and such that the compression is completed within two to five minutes. Remove the load and examine the specimen. All three specimens shall meet the requirements.

318.09.04 Pipe Dimensions - Measurements shall be taken in accordance with ASTM D 2122.

318.10 Inspection

- a) The Quality Manager and Ministry shall have access to the fabrication plant for inspection and every facility shall be extended for this purpose.
- b) Inspection may include checks on physical dimensions and the quality of work.
- c) For the purpose of sampling for DB SS 318.07 and DB SS 318.09, one pipe from each lot of 50 pipes or fraction thereof in a shipment shall be selected for sampling. All test specimens shall be cut from the selected pipe(s).
- d) If a test sample fails to meet the requirements of DB SS 318.07 when tested according to DBSS 318.09, that batch will be rejected and shall be replaced by the Supplier with a new batch that conforms to this specification at no additional cost.

318.11 Quality Assurance

- a)** The Supplier shall develop and maintain an effective quality control system to ensure that adequate inspection coverage is maintained throughout the manufacturing process. Evidence of such inspection shall be available to the Quality Manager and the Ministry prior to shipment from the place of manufacture or from the Supplier's storage facility.
- b)** The Contractor shall, and the Ministry reserves the right to, audit the Supplier's quality control system to ensure conformance with this specification.

SECTION 320

CORRUGATED STEEL PIPE

320.01 Scope - The Section covers the material and fabrication requirements for corrugated steel pipe and structural plate corrugated steel pipe.

Abbreviations:

CSP - Corrugated Steel Pipe: Galvanized sheet steel formed to finished shape by the fabricator.

SPCSP - Structural Plate Corrugated Steel Pipe: Hot rolled sheets or plates, corrugated, hot-dip galvanized, curved to radius, assembled and bolted together to form large pipes, pipe-arches, and other shapes.

320.02 Materials

320.02.01 Galvanized Steel Sheet - All culverts supplied under this specification shall be fabricated from steel sheets meeting all requirements of ASTM A 444 "Standard Specification for Zinc Coated (Galvanized) Iron or Steel Sheets for Culverts and Underdrains," with the following exceptions and additions:

320.02.01.01 - Steel shall conform to the chemical composition as specified in Table 320-A

TABLE 320-A CHEMICAL COMPOSITION

ELEMENT	HEAT ANALYSIS (MAXIMUM) %
Carbon	0.15 (except SPCSP)
Manganese	0.60 (except SPCSP)
Phosphorous	0.04
Sulphur	0.05

320.02.01.02 - Each sheet, or each 600 to 1500 mm of coil or strip shall be identified by showing the following:

- i) Brand or name of sheet manufacturer (mill).
- ii) "CSP Sheet/Tole TTAO"
- iii) Nominal overall zinc coated sheet thickness in mm.

iv) Heat and Coil numbers.

v) Zinc coating designation.

vi) "ASTM A 444" or "CSPI-501-M" of "CSA G401-M."

Exceptions and additions to ASTM A 444 requirements:-

320.02.01.03 The requirement for the sheet manufacturer to run tensile tests on samples from each cast or heat (See ASTM A 444 Paragraph 5.2) will be waived if the sheet or plate is authorized to be stamped "CSPI-501-M."

320.02.01.04. - In addition to the Coating Adherence requirements of ASTM A 444 Paragraph 6, the Finish and Adherence of casting requirements of ASTM A 123, Paragraph 9 shall also apply.

320.02.01.05. - The mass of zinc coatings, total both sides shall be not less than Z610 (610 g/m²) when tested by the Triple Spot Test or not less than 550 g/m² by the Single Spot Test.

320.02.01.06. - Thickness and Tolerances shall conform to the requirements of Table 320-B.

TABLE 320-B CSP SHEET THICKNESS AND TOLERANCES

CSP SHEET - THICKNESS AND TOLERANCES (mm)		
Nominal Overall Thickness ¹ (inc. Zinc)	Tolerance on Nominal Overall Thickness	Design Base Metal Thickness ²
1.0	±0.13	0.82
1.3	±0.15	1.12
1.6	±0.18	1.40
2.0	±0.18	1.82
2.8	±0.20	2.64
3.5	±0.23	3.35
4.2	±0.23	4.08

¹ Thickness shall be measured at a point on the sheet not less than 10 mm from an edge. Field

measurement shall be made on a corrugation tangent. Nominal Overall Thickness is Order Thickness.

² Minimum Base Metal Thickness shall be not less than 95% of the Design Base Metal Thickness. Minimum Base Metal is equal to the nominal Overall Thickness minus the Tolerance on Overall Nominal Thickness minus an allowance for zinc of 0.09 mm.

320.02.01.07 - Flatness tolerances shall apply to cut lengths only.

For specified thickness of 2.0 mm and thicker, the tolerance, or maximum deviation from a horizontal flat surface, shall not exceed 13 mm for specified width up to 1500 mm.

For thickness less than 2.0 mm the tolerance shall not exceed 20 mm for 900 to 1500 mm width, and 13 mm for less than 900 mm width.

320.02.01.08 - Permissible variations in width, length, and camber of flat sheet shall be in accordance with CSA G163.2.

320.02.02 Structural Plate Corrugated Steel Sheet and Plate - SPCSP sheet and plate shall conform to the relevant requirements of DBSS 320.02.01 except:

i) The maximum carbon shall be 0.10% and maximum manganese of 0.50%.

ii) Each lift shall be identified by the mill name or brand, test number, nominal mass, mill order number and dimensions either by marking the top plate of the lift or by a durable tag attached to the lift.

iii) Thickness and Tolerances shall conform to the requirements of Table 320-C.

320.02.03 Hardware - Hardware shall conform to the following requirements:

320.02.03.01 Rivets - Rivets shall conform to ASTM A 31, Grade A copper bearing, and shall be galvanized in accordance with ASTM A 153 Class D or ASTM A 164 Type RS.

320.02.03.02 Bolts and Nuts - Bolts shall be M20 x 2.5 nominal diameter and thread pitch as shown in Figure I. Bolts shall meet the chemical and mechanical properties of ASTM A 449. Nuts shall be as shown in Figure I and shall meet the requirements of ASTM A 563 Grade C. Bolts and nuts shall be galvanized to CSA G164 Class 5.

TABLE 320-C SPCSP SHEET AND PLATE BASE METAL THICKNESS AND TOLERANCE

Nominal Base Metal Thickness ¹ (mm)	3.0	3.5	4.0	5.0	6.0	7.0
Design Base Metal Thickness ² (mm)	2.84	3.37	3.89	4.95	6.0	7.0
Width of Blank (mm)	SHEET TOLERANCES ³ (mm)			PLATE TOLERANCES ³ (mm)		
1340	± 0.20	-	± 0.20	+0.40/-0.30	+0.40/-0.30	+0.50/-0.30
1585	± 0.28	-	± 0.28	+0.50/-0.30	+0.50/-0.30	+0.50/-0.30
2315	± 0.30	-	± 0.30	+0.60/-0.30	+0.60/-0.30	+0.70/-0.30

¹ Nominal Base Metal Thickness is the specified Order Thickness. For field thickness check, add 0.09 mm to the Base Metal Thickness to account for galvanizing. Thickness shall be measured at a point on the sheet not less than 20 mm from a longitudinal edge. Field measurement shall be made on the corrugation tangent.

² Minimum Base Metal Thickness shall be not less than 95% of the Design Base Metal Thickness.

³ Mill terminology.

320.02.03.03 Coupler Band Hardware - Nuts and bolts on coupler bands shall conform to ASTM A 307, Grade A and shall be galvanized according to ASTM A 153 Class C or ASTM A 164 Type RS.

Other hardware on coupler bands such as lugs and flanges shall be of material approved at the time the design of the coupler band is approved and they shall be galvanized in accordance with CSA G-164 Class 4.

If lugs or flanges are welded in place the weld shall be thoroughly wire brushed followed immediately by the application of a dry thickness of 50 µm of zinc rich coating in accordance with CGSB 1-GP-181M Coating, Zinc Rich, Organic, Ready Mixed.

320.03 Fabrication From Culvert Sheet

320.03.01 Corrugation Profile - CSP shall have corrugations which form smooth continuous curves in either helical or annular rings about the pipe axis with nominal inside diameters and profile dimensions as specified in Table 320-D. The profile radius of curvature (R) shall not be less than 50% of the depth of the corrugation as shown in Figure II.

320.03.02 Standard Sizes and Tolerances

320.03.02.01 Riveted CSP - Minimum outside circumferences for riveted CSP shall be as shown in Table 320-E

a) Measurement of minimum outside circumference may be made with a band which covers adjacent corrugation crests.

b) Dimensional Tolerances:

- **Diameter** - The average nominal inside diameter tolerance shall be ± 13 mm or $\pm 1\%$, whichever is greater, measured between inside crests of the corrugations perpendicular to pipe axis.
- **Length** - The specified individual pipe length shall be measured from the inside crest of the last corrugation at one end to the inside crest of the last corrugation at the other end. The overall length is greater than the specified length by approximately 50% of the corrugation pitch.

320.03.02.02 Helical CSP - Minimum outside circumferences for Helical CSP shall be as shown in Table 320-F.

320.03.02.03 Pipe Arch - Helical or Riveted - Standard pipe-arch dimensions measured from the inside crests of corrugations shall be as shown in Table 320-G.

TABLE 320-D CSP DIAMETER RANGE - CORRUGATION PROFILE (mm)

NOMINAL INSIDE RANGE (mm)	CORRUGATION PROFILE DIMENSIONS Pitch ¹ x Depth ² (mm)
100, 150, 200 and 250	38 x 6.5
200 to 2400 ³	68 x 13
1200 to 3600	76 x 25
1200 to 3600	125 x 26

¹ Pitch shall be measured perpendicular to the direction of corrugations. Average pitch tolerance ± 3.0 mm.

² Depth shall be measured from outside crests to outside valley, with a straight edge laid across crests perpendicular to the direction of corrugation. Depth tolerance minus 5%.

³ Flexibility Factor of concern for diameters greater than 2000 mm.

TABLE 320-E RIVETED CSP - MINIMUM OUTSIDE CIRCUMFERENCE

NOMINAL INSIDE DIAMETER (mm)	MINIMUM OUTSIDE CIRCUMFERENCE (mm)			NOMINAL INSIDE DIAMETER (mm)
	CORRUGATION DEPTH			
	13 mm	13 mm	25 mm or 26 mm	
200	680	3830	3900	1200
250	840	4460	4520	1400
300	1000	5080	5150	1600
400	1310	5700	5770	1800
500	1630	6330	6390	2000
600	1940	6950 ¹	7020	2200
700	2260	7570 ¹	7640	2400
800	2570		8580	2700
900	2880		9510	3000
1000	3200		10450	3300
			11380	3600

¹ Flexibility Factor of concern for pipes with this corrugation depth and diameters greater than 2000 mm.

TABLE 320-F HELICAL CSP - MINIMUM OUTSIDE CIRCUMFERENCE

MINIMUM OUTSIDE CIRCUMFERENCE (mm)							
Nominal Inside Diameter (mm)	CORRUGATION DEPTH (mm)						Nominal Inside Diameter (mm)
	6.5	11	13	11	13	25 & 26	
100	350			2900	2910	2970	900
150	500			3210	3220	3290	1000
200	660			3840	3850	3920	1200
250	820				4480	4550	1400
300		1000	1010		5110	5170	1600
400		1320	1330		5730	5800	1800
500		1630	1650		6360	6430	2000
600		1950	1960		6980	7050	2200
700		2260	2280		7610	7680	2400
800		2580	2590			8620	2700
						9560	3000
						10500	3300
						11440	3600

Note: Dimensional Tolerances:

Diameter - Average nominal inside diameter tolerance shall be ± 6.0 mm or $\pm 0.5\%$ whichever is greater, measured between inside crests of the corrugations perpendicular to pipe axis.

Length - The length tolerance shall be ± 25 mm of the specified length. For CSP with recorrugated ends, the length tolerance for individual pipes shall be plus 50 mm minus 25 mm.

TABLE 320-G STANDARD PIPE-ARCH DIMENSIONS (mm)

SPAN	RISE	EQUIVALENT DIAMETER	MINIMUM CORNER RADIUS
450	340	400	75
560	420	500	75
680	500	600	75
800	580	700	85
910	660	800	100
1030	740	900	110
1150	820	1000	125
1390	970	1200	150
1630	1120	1400	175
1880	1260	1600	200
2130	1400	1800	225

Note: Span and Rise dimensional tolerance is ± 25 mm or 2% of equivalent round diameter, whichever is greater.

320.03.03 Riveted Construction

320.03.03.01 All rivets shall be according to the requirements of DBSS 320.02.03.01. All rivet diameters and lengths shall be not less than those shown in Table 320-H.

320.03.03.02 Fabrication Requirements

- a) Hole centres shall not be closer than twice the hole diameter from any sheet edge, and shall be in reasonable alignment.
- b) Rivets shall be driven cold without bending. Sheet edges shall be drawn tightly together throughout an entire lap length with rivet holes in reasonable alignment.
- c) Rivets shall have full heads and shall completely fill the holes.
- d) Longitudinal seams shall have at least one rivet for each corrugation, in the valley.
- e) Double-riveting, or two rows of rivets along a longitudinal seam, shall be as in Table 320-I. The distance between centrelines of rows of rivets shall nominally be three times the hole diameter.

f) Circumferential seams shall have a maximum rivet spacing of 150 mm measured on centres, except that six rivets will be sufficient on 300 mm diameter or smaller.

g) Longitudinal seam lap shall equal or exceed minimums shown in Table 320-I. Circumferential seam lap shall be 30 mm minimum.

320.03.04 Helical Construction

320.03.04.01 Fabrication Requirements

- a) The edges of the sheets forming the pipe shall be jointed with a continuous lock seam formed by folding over the edges of adjacent sheets so that they interlock with each other to form a tight joint. See Figure III.
- b) The sheets shall be continuous throughout the length of the pipe, the joining of sheets by butt welding shall only be permitted provided the weld meets the following requirements:
 - The butt joint shall be made by shielded electric arc process with a continuous deposit of material throughout the length of the joint. Penetration shall be

to the full depth of the material and no undercut, splatter or scale shall be permitted. If deemed necessary, sample of the joint shall pass a 90° bend test.

- The weld and adjacent area of damaged zinc shall be thoroughly wire brushed followed immediately by the application of a dry thickness of 50 µm of zinc rich coating conforming to CGSB 1-GP-181M Coating, Zinc Rich, Organic, Ready Mixed.

c) Ends of Helical CSP shall be finished with a straight cut perpendicular to the longitudinal centreline and any saw cut mismatch shall not exceed 15 mm. The ends shall be finished without significant burr. Cutting of previously manufactured stock to a shorter length with a hand held cutting torch is not permitted.

d) Standard fabricated lengths shall be in full metre lengths, as ordered. The length tolerance shall be ± 25 mm of ordered length. For CSP with recorruagated ends, length tolerance for individual pipes shall be plus 50 mm minus 25 mm.

320.03.04.02 Visual Inspection - by reference to Figure III the quality of the lock seam shall be judged by visual inspection. The pipe shall be cut so as to show the cross-section normal to the seam. The cut shall be of sufficient length to show the complete lock seam profile including offset.

- a) The minimum seam lap dimensions shall be as shown in Table 320-J.
- b) There shall be no roller indentations on either side of the 180° fold or beyond the lapped area.
- c) The retaining offset as shown in Figure III shall be that portion of the sheet profile adjacent to the lock seam, and in tight contact with the 180° fold. The total retaining offset of both sides shall be a minimum of 1 t where t is equal to the nominal overall thickness of the sheet of which the pipe is constructed. The retaining offset on any one side shall be a minimum of 0.3 t. Figure III shows retaining offset of 1 t on both sides, for a total retaining

offset of 2 t.

d) The 180° fold of metal at the lock seam shall have a smooth curvature both inside and outside with no angularity of the interior of the fold.

e) The gaps opposite the interior fold shall be equal on both sides of the seam, and each gap individually shall not exceed 1.0 t where t is equal to the nominal overall thickness of the sheet of which the pipe is constructed.

f) The helix angle (see Figure IV) shall be not more than 30° for helical CSP 600 mm diameter and greater.

320.03.04.03 Shear Strength of the Lock Seam

- If the visual inspection required by DBSS 320.03.04.02 indicates that the joint is not tight for any reason, such as the lapping surfaces apparently not in intimate or complete contact, then the shear strength of the seam shall be tested by the test method defined in Appendix I. The minimum shear strength of the lock seam shall be 80 N/mm. If this test is performed, it shall be in addition to, not in lieu of, the visual inspection requirements in DBSS 320.03.04.02 and all requirements must be met.

320.03.04.04 Recorrugated Ends - Helical pipe ends may be recorruagated to provide two or four annular corrugations on each end of pipe for coupling purposes.

The visual checks and/or pull tests required by DBSS 320.09.04 Quality Control - Helical CSP shall (where possible) be carried out prior to recorruagation. Additional quality control pull tests will be required in the reformed end and the minimum lateral seam strength of the lock seam as per Table 320-K shall be not less than 60% of that required for the remainder of the pipe. There shall be no visible cracks in the base metal in the reformed end.

For Quality Management purposes, samples of the lock seam may be taken from the undamaged portion of a recorruagated pipe by means of a 38 mm hole saw. (See Appendix IV).

320.04 Coupler Systems

320.04.01 Purpose - Coupler systems for corrugated pipe shall resist water leakage, preserve pipe alignment, resist separation of adjoining pipe sections and resist root penetration or infiltration of normal backfill materials.

Note: If recorruagated ends are specifically requested, then annular corrugated couplers (see DBSS 320.04.02) shall be provided.

Note: When culverts are to be installed on steep grades, extra wide annular corrugated couplers are recommended for diameters greater than 600 mm.

TABLE 320-H RIVET DIAMETERS AND LENGTH (mm)

NOMINAL OVERALL CSP SHEET THICKNESS (mm)	NOMINAL RIVET DIAMETER (mm)		MINIMUM RIVET LENGTH (mm)
	CORRUGATION DEPTH		
	13 mm	25 mm or 26 mm	
1.0	8		16
1.3	8		16
1.6	8	10	16
2.0	8	10	16
2.8	10	12	20
3.6	10	12	25
4.2	10	12	25

TABLE 320-I RIVETED CSP - LONGITUDINAL SEAM LAP AND ROWS OF RIVETS

DIAMETER RANGE (mm)	CORRUGATION DEPTH (mm)	ROWS OF RIVETS	MINIMUM LONGITUDINAL SEAM LAP (mm)
200 to 500	13	Single	40
600 to 1000	13	Single	50
900, 1000	25	Double	75
1200 and larger	13 or 25	Double	75

TABLE 320-J HELICAL CSP - MINIMUM SEAM LAP DIMENSIONS

CORRUGATION PROFILE (mm x mm)	38 x 6.5	51 x 11	68 x 13	76 x 25	125 x 25
LAP (mm)	4.0	6.5	6.5	8.0	8.0

TABLE 320-K HELICAL CORRUGATED LOCK SEAM PIPE MINIMUM LATERAL SEAM STRENGTH

NOMINAL OVERALL THICKNESS (mm)	MINIMUM LATERAL SEAM STRENGTH (N/mm)
1.0	36
1.3	51
2.0	65
2.8	88
3.5	136
4.2	182
Greater than 4.2	234

320.04.02 Fabrication Requirements

320.04.02.01 Coupler bands shall be compatible with the conduit shape and corrugation profile, and designed so that it can be installed to lap equal portions of the pipes being connected.

320.04.02.02 Coupler bands shall be either corrugated or have circumferential rows of projections (i.e., dimpled). Both systems shall be designed to substantially mesh with the pipe corrugations and meet the requirements of DBSS 320.04.01.

320.04.02.03 Coupler standard dimensions shall be as shown in Table 320-L.

320.04.02.04 Coupler ends shall be drawn together about the pipe by bolts, wedges or other means of fastening to meet the requirements of DBSS 320.04.01.

320.04.02.05 Coupler flanges shall consist of rolled or formed angles or lugs (meeting the requirements of DBSS 320.02.03.03) of at least 3.2 mm effective thickness riveted or welded to the coupler.

320.04.02.06 - The minimum number of 12 mm diameter bolts (meeting the requirements of DBSS 320.02.03.02) per connection shall be two

for the 180 and 300 mm coupler, three for the 600 mm coupler and four for the 900 mm coupler. Bolt length shall be not less than 150 mm.

320.04.02.07 Riveted & Weld Fasteners -

Where flanges are riveted, the rivets shall have a minimum diameter of 10 mm (and shall meet the requirements of DBSS 320.02.03.01). The minimum number of rivets per angle shall be two for the 180 mm coupler, three for the 300 mm coupler, five for the 600 mm coupler and seven for the 900 mm coupler.

Where flanges or lugs are welded in place the weld area shall be thoroughly wire brushed followed immediately by two coats of zinc-rich coating conforming to CGSB 1-GP-181M.

320.04.02.08 Wedge Fastening -

Coupler flanges shall be integrally formed in a manner to utilize fully the available areas of contact with the wedge. Lips of both coupler and wedge shall be formed to a contained angle of approximately 45° and shall be nominally 10 mm wide. Wedge shall be at least 16 mm high at the wide end suitable for hammering into position over the coupler and shall be at least 75 mm longer than the width of the couplers. Lips of wedges with engage lips of couplers shall be 13 mm minimum width. Wedges shall be no less than 2.0 mm thickness.

TABLE 320-L MINIMUM COUPLER DIMENSIONS

COUPLER TYPE	PIPE DIAMETER (mm)	NOMINAL OVERALL THICKNESS (mm)	MINIMUM WIDTH (mm)	NO. OF BOLTS	DIMPLES	
					MINIMUM NO. OF CIRCUMFERENTIAL ROWS	MINIMUM NO. PER ROW *
Flat	100-600	1.30	140	2		
Corrugated	300-600	1.30	180	2		
	700-1600	1.60	300	2		
	over 1600	1.60	300 or 600 **	3		
Universal	300-600	1.30	300	2	4	6
Dimple	700-1200	1.60	300	2	4	7
	Over 1200	1.60	600	3	4	8

* Minimum number of dimples per row is 6 for 76 mm x 25 mm corrugation profile.

** Width dependent on application.

320.04.02.09 Where gasketed joints are required for watertightness, they shall meet ASTM D 1056, ASTM C 361M, or requirements as stated in the Contract and Design.

320.05 Pipe Arch Corrugated Steel Pipe Construction

320.05.01 Pipe arch CSP is a multi radii shape having integral top, bottom and corners. The pipe arch shall conform to the dimensions shown in Table 320-G.

320.05.02 For riveted CSP pipe arch the staggered lapped longitudinal seam or seams shall be placed in the top arch section and not located in an area of change of radius or minimum radius.

320.05.03 - In the case of helical CSP pipe arch the minimum corner radii (see Table 320-G) apply also to the lock seams located at the corners; no transverse creasing of the seams will be permitted.

320.05.04 The longitudinal axis of the pipe centreline must be preserved straight, it shall not bend appreciably either vertically or horizontally. In the case of dispute the pipe arch shall be placed on a flat surface; the invert shall be in uniform contact with the flat surface throughout the length of the pipe and the inside of the pipe shall appear straight when viewed from either end.

320.06 Perforated Corrugated Steel Pipe

320.06.01 Helical and riveted perforated CSP shall meet all requirements of this specification for helical and riveted CSP before perforation.

320.06.02 The perforations shall be approximately circular and cleanly cut; they shall have a nominal diameter of 10 mm and shall be not less than 8.0 mm. The perforations shall be arranged in rows parallel to the axis of the pipe and shall be located in the outside valleys or along tangents of corrugations. Perforations are not required within 150 mm of each end of each length of pipe. The rows of perforations shall be arranged in two equal groups placed symmetrically on either side of a lower unperforated segment, corresponding to the flow line of the pipe. The spacing of the rows shall be uniform. The distance between the centrelines of rows shall be not less than 25 mm.

320.06.03 The minimum number of longitudinal rows of perforations, the maximum heights of the centrelines of the uppermost rows above the bottom of the inverts and the inside surface of chord lengths of the unperforated segments illustrated in Figure V shall be as specified in Table 320-M.

TABLE 320-M CSP INVERT PERFORATIONS

DIAMETER OF PIPE (mm)	MINIMUM ROWS OF PERFORATIONS	H ¹ (mm)	L ² (mm)
100	2	46	85
150	4	70	120
200	4	92	160
250	4	115	195
300	6	138	240
400	6	184	315
500	6	230	370
600	6	276	465

¹ **Maximum** Heights "H" of the Centreline of the Uppermost Rows above the bottom of the invert.

² **Minimum** Lengths of Inner Chord "L" of unperforated segments (See Figure V).

320.06.04 Flat band couplers shall be supplied with perforated pipe unless corrugated or dimpled couplers are specified. Couplers shall comply with all requirements of DBSS 320.04.

320.07 Structural Plate Corrugated Steel Pipe Construction

320.07.01 This Subsection covers the fabrication of SPCSP products, using sheet and/or plate as specified in DBSS 320.02. Shapes in addition to round include vertical and horizontal ellipse, pipe-arch, arch, vehicular, pedestrian, or animal underpasses, and others. Nominal inside diameters are given in Table 320-N.

320.07.02 SPCSP shall have annular corrugations. Crests and valleys shall form circumferential rings about a pipe axis. Profile (pitch x depth) shall be: 152 mm x 51 mm. Tolerances are given in Figure VI.

320.07.03 Standard Round - Nominal inside diameter for round pipe shall be as given in Table 320-M.

320.07.03.01 Structural plates shall be fabricated to standard dimensions shown in Table 320-O and Figure VII. Nominal corrugated plate lengths shall be 3050 and 3660 mm. Overall structure lengths shall be any combination of these two lengths, plus 100 mm.

320.07.03.02 Plates shall be punched along the edges with holes to form longitudinal and circumferential lap seams when assembled by bolting. Hole diameter shall not exceed bolt diameter by more than 6.0 mm.

320.07.03.03 The longitudinal hole pattern shall be a minimum of two holes per corrugation. Dependent on the seam strength requirements, three or four holes per corrugation may be specified (See Figure VII).

320.07.03.04 Plate arrangements in structures are normally designed with seams staggered such that not more than three plates come together at any one bolt hole.

TABLE 320-N SPCSP - NOMINAL INSIDE DIAMETERS (mm)

1500	2590	4610
1660	2740	4920
1810	3050	5230
1970	3360	5540
2120	3670	5850
2280	3990	
2430	4300	

TABLE 320-O SPCSP - FLAT PLATE WIDTH DIMENSIONS

WIDTH DESIGNATION NUMBER OF HOLE SPACES	NET ARC WIDTH (mm)	OVERALL OR BLANK WIDTH (mm)	NUMBER OF CIRCUMFERENTIAL BOLT HOLES
5N	1220	1340	6
6N	1465	1585	7
9N	2195	2315	10

Note: Number of circumferential bolt holes spaces (N) at 244 mm along plate net (arc) width. See Figure VII.

320.07.03.05 Plate arc width equals the number of circumferential bolt hole spaces (N) at 244 mm centres along the plate, in accordance with Table 320-O and Figure VII.

320.07.04 Plate Curvature

320.07.04.01 Plates shall be curved to a radius along the inner crest dimension (plate net arc width) to form the circular arcs as required for the shape specified.

320.07.04.02 Tolerance on calculated rise shall be ± 13 mm (See Figure VIII). Length of straight-edge shall be not less than 75% of chord length.

Note: Structural plate fabricators shall make available on request the standard rise dimensions for plates of varying curvature, using varying straight-edge inspection lengths.

320.07.05 Bolts and nuts shall be in accordance with DBSS 320.02.03.02

320.07.05.01 Bolt lengths shall be sufficient to provide full thread engagement in the nut when the assembled plates are tightened in place.

320.07.05.02 The number of bolts of each length

furnished shall be plus 2% in excess of the theoretical number to field erect the structure.

320.07.05.03 Bolts and bolt containers shall be identified by length of bolt using colour codes given in Table 320-P.

320.07.06 Drawings and Plate Identification

320.07.06.01 SPCSP plates shall be adequately identified by fabricator for field erection. Marking shall be clear and distinct for each job or order number. Identification may include thickness, radius, and drawing or code numbering.

320.07.06.02 For each structure order the fabricator shall provide a bill of material. Erection drawing(s) shall be provided where required showing plate arrangements together with assembly instructions.

320.07.06.03 Cut plates for bevelled or skewed ends shall be legibly identified to designate positions in a finished structure, and referenced on erection drawings.

320.08 Asphalt Coated Pipe - This Subsection covers asphalt coatings applied to CSP products;

it does not cover pipe manufactured of asbestos bonded sheet.

Coating Designations:

AC - Asphalt coated

ACPI - Asphalt coated Paved Invert

320.08.01 AC - Asphalt Coated - The completed CSP manufactured in accordance with this specification shall be uniformly coated by a hot dip process with asphalt inside and outside to a minimum thickness of 1.3 mm each side measured

on a corrugation crest. A minimum of two dips shall be required for each length of pipe. The first dip shall be prolonged sufficiently to ensure that the metal in the pipe is substantially at the same temperature as the asphalt, to ensure proper adhesion. The second dip shall be prolonged only sufficiently to build to the required thickness. No pin holing, bubbles or breaks in the asphalt coating shall be apparent after the second dip. During the cooling period after each dip the asphalt shall be protected from rain or snow and shall not be rolled or handled in any way to damage the coating.

TABLE 320-P SPCSP BOLT AND CONTAINER COLOUR CODE

BOLT LENGTH (mm)	COLOUR BOLT	COLOUR CONTAINER MARK	BOLT LENGTH (mm)	COLOUR BOLT	COLOUR CONTAINER MARK
30	None	White	50	Black	Black
40	Green	Green	80	None	Yellow
45	Red	Red	Nuts *	None	Blue

Note: Nuts may be shipped in Bolt containers

320.08.02 ACPI - Asphalt Coated Paved Invert - In addition to the requirements of DBSS 320.08.01 asphalt shall be applied to provide a smooth surface in the invert filling the corrugations for at least 25% of the circumference of a round pipe and 40% of the periphery of a pipe arch. Pavement shall have a minimum thickness of 3.0 mm above the crests of the inside corrugations, except where pavement edges feather into corrugations.

320.08.03 Coupler Bands - The coupler bands ordered with AC or ACPI pipe shall be coated as required by DBSS 320.08.01. Coupler band hardware shall not be coated.

320.08.04 AC Perforated Pipe - Shall be uniformly coated inside and out to a minimum of 0.8 mm per side. Not more than 15% of the specified perforations shall be covered with a film of asphalt. The diameter of the clear perforations shall be not less than 7.0 mm.

320.08.05 Coatings Generally - Surface of the asphalt coating immediately after solidification (and prior to any treatment with anti-stick material) shall have a smooth and shiny appearance free of pinholes and bubbles.

Asphalt coating shall not spall under normal handling within the range of maximum summer and minimum winter temperatures.

Asphalt coating sampled from the finished pipe shall be capable of meeting the Shock, Flow, and Imperviousness Tests as defined in Appendix II.

320.08.06 Handling - To prevent bruising, scaling, or scuffing of asphalt coated CSP, proper and careful handling shall be observed. Asphalt coated pipe shall not be dragged or pushed along the ground, or otherwise roughly handled.

The fabricator may use an anti-stick material such as soapstone, chalk, or sand to spray or dust on the finished pipe coating after cooling.

320.08.07 Storage - Prolonged storage in open sunlight of asphalt coated CSP is not recommended. Long exposure to sunlight may evaporate asphaltic volatiles, resulting in drying with alligator cracking. Asphalt coated CSP shall be installed and backfilled within a reasonable period after coating to ensure maximum protective benefits against hydraulic, abrasive, and corrosive conditions.

320.08.08 Repair - Spots where the asphalt coating has been damaged shall be repaired. The fabricator shall be responsible for the repair of any damage to

the asphalt coating preceding shipment. Repair may be made with cold asphalt mastic, provided the area is small. Redipping will be required for large areas.

320.09 Inspection, Quality of Work, and Quality Control

320.09.01 Inspection

320.09.01.01 The Contractor and the Ministry shall have access to the fabricating plant for inspection, and every facility shall be extended to the Contractor and the Ministry for this process.

320.09.01.02 Inspection may include checks on gauge thickness, weight of zinc coating, corrugation profile, outside circumference, quality of riveting or lock seam, and such other features as deemed necessary by the inspector and Quality Manager to meet this specification.

320.09.01.03 Sampling of the base metal for chemical analysis shall be made in accordance with ASTM A 444.

320.09.02 Quality of Work

320.09.02.01 In addition to compliance with the details of construction, the complete pipe shall show careful, proper quality of work in all particulars.

320.09.02.02 Among others, the following defects constitute poor quality of work, and the presence of any of them in a corrugated steel pipe may be cause for rejection: uneven laps, undue deviation from true shape, lack of rigidity, excessive variation from a reasonably straight centreline, ragged or diagonally sheared edges, loose, unevenly aligned or spaced rivets or bolts, poorly formed rivet heads of lock seams, or damaged lock seam metal, bruised, scaled or broken zinc coating, corroded or improperly cleaned and painted welds, illegible brand, significant dents or bends in the steel itself, and ragged or unfinished ends.

320.09.03 Repair of Damaged Zinc Coating

320.09.03.01 Small localized areas, scratches or burns in which the zinc coating has been damaged by welding or other fabrication procedures shall be repaired by careful wire brushing followed immediately by the application of a dry film thickness of 50 µm of zinc rich coating conforming to

CGSB Standard 1-GP-181M Coating, Zinc Rich, Organic, Ready Mixed.

320.09.03.02 Gross uncoated areas shall be repaired by re-galvanizing by hot-dip process in accordance with DBSS 320.02.01 or by metallizing process which shall meet the requirements of CSA Standard G-189.

320.09.04 Quality Control Helical CSP - The supplier shall develop and maintain an effective quality control system to ensure that adequate inspection coverage is maintained throughout the manufacturing process. Evidence of such inspection shall be available to the Quality Manager and the Ministry prior to shipment from the place of manufacture or from the supplier's storage facility.

The Contractor shall, and the Ministry reserves the right to, audit the supplier's quality control systems to ensure conformity with this specification.

The supplier shall furnish the Contractor with an outline of the supplier's quality control procedures, for inclusion in the Quality Management Plan. The outline shall include the intended method of identification of production runs, frequency of visual checks and pull tests, method of reporting and recording, and/or retention of samples.

320.09.04.01 Production run shall be considered to include all pipes of the same metal thickness and diameter produced continuously, with only minor adjustments to the machinery being required. A new production run shall be considered to start with a change in metal thickness or a change in pipe diameter.

320.09.04.02 Visual checks shall at least include observations or measurement, as applicable, of metal thickness, corrugation depth, diameter, length, square end cut and zinc coating. They shall also at least include observation or measurement, as applicable, of the lock seam as follows: lap, gap, retaining offset, loss of seam contact, interior angularity, and roller indentation.

320.09.04.03 Pull tests shall be conducted in accordance with Appendix III. The lateral seam strength shall meet the minimum requirements of Table 320-K.

If any sample fails this requirement, all pipe already

SECTION 320

produced in that production run or all pipe produced since the last pull test was conducted shall be subject to rejection. The manufacturer may however conduct additional pull tests on the previously produced pipe and thereby ascertain which, if any, can be

CORRUGATED STEEL PIPE

considered acceptable.

To be considered acceptable a lock seam must meet all visual criteria as well as the minimum lateral seam strength requirement.

SECTION 320

CORRUGATED STEEL PIPE

APPENDIX I

**Test Method for Shear Strength
of the Lock Seam of Helical Pipe**

(Referred to in DBSS 320.03.04.03)

A1.1 Apparatus

a) Testing Machine - Any standard testing machine capable of maintaining the specified rate of strain and of measuring the tensile load with an error not to exceed ± 50 N.

b) Grips - The grips for holding the test specimen in the testing machine shall be of the self-aligning type.

A1.2 Test Specimens

a) Sample - A sample shall be taken from the end of a completed pipe. The sample shall be cut out with a metal cutting saw, the cuts being made at least 12 mm on either side of the seam. The length of the sample measured along the shorter side of the seam shall be at least 255 mm. The end cut shall be made at right angles to the direction of the seam.

b) Specimen - Three separate specimens, each 75 mm long, shall be cut from the sample commencing at the end of the sample opposite the end of the pipe. See Figure 1. The remaining piece of seam at the end of the pipe shall be discarded. Each specimen shall then be prepared as shown in Figure 2. Extreme care shall be exercised in preparing the specimen to ensure that the seam is not loosened. If prepared in a vise it shall be held and cut such that no forces are applied which will tend to warp, twist or flatten the specimen.

A1.3 Procedure

a) The gauge length of each specimen shall be measured with calipers to an accuracy of ± 0.2 mm.

b) Each test specimen shall be carefully placed in the grips of the testing machine in such manner as

to ensure that the axis of the test specimen coincides with the direction of the applied pull.

c) The load shall be applied at the rate stated in Appendix A1.4 until the test specimen has slipped 6.0 mm. The maximum load in Newtons shall be recorded.

A1.4 Speed of Testing

The load shall be applied continuously throughout the test at a uniform rate of motion of the moveable cross head of 2.5 mm per minute.

A1.5 Calculation

The shear strength of the lock seam of each specimen shall be calculated by the following formula:-

$$S = P/L$$

Where: S = Shear strength of lock seam, Newtons per lineal millimetre.

P = Maximum load obtained within first 6.0 mm of slippage, Newtons

L = Gauge length, millimetres.

A1.6 Report

The shear strength of the three specimens shall be reported and the average shall be the shear strength of the sample.

A1.7 Acceptance

A test sample shall be considered to meet the test requirements provided that the above average shear strength exceeds the requirements of 80 N/mm required by DBSS 320.03.04.03 and provided that at least two of the specimens also exceed that requirement. Should any test sample

fail to meet the test requirements, the manufacturer shall be allowed a retest on two additional samples for each sample that failed.

Both retest samples are required to meet the test requirements before the pipe can be considered acceptable.

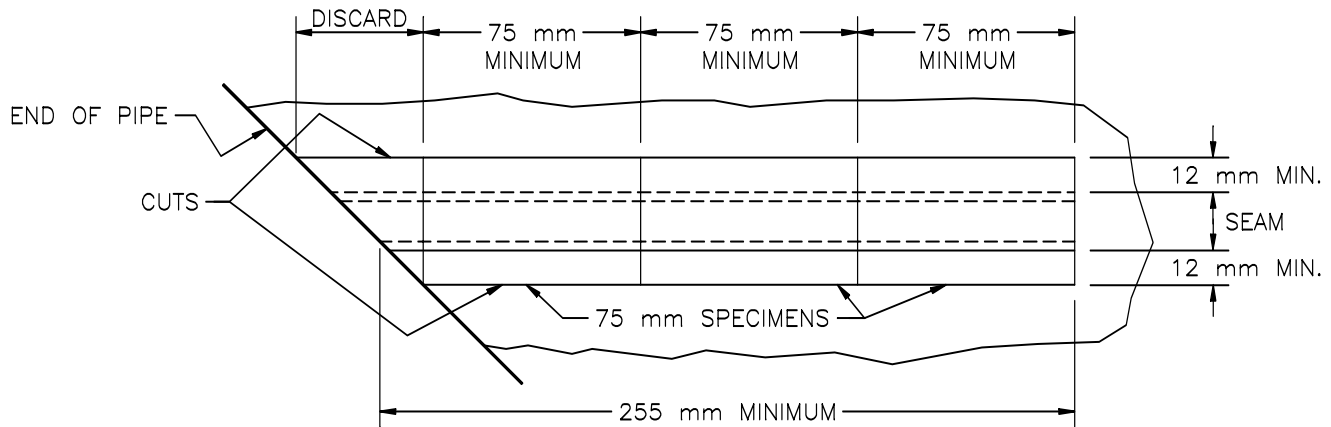


FIGURE 1 - DIAGRAM FOR CUTTING SEAM SAMPLE FROM END OF HELICAL PIPE

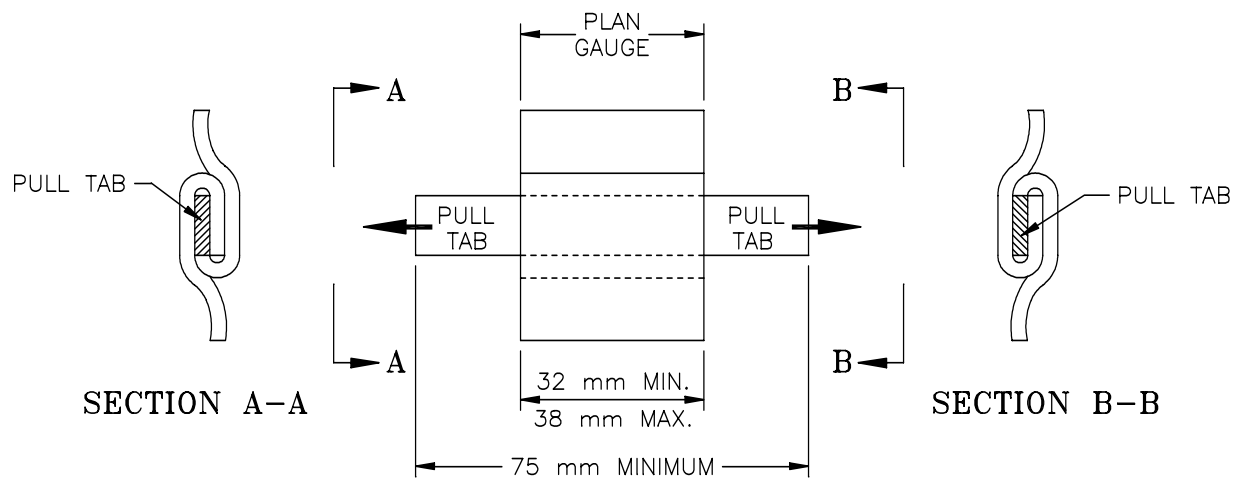


FIGURE 2 - DETAIL OF SPECIMEN FOR SHEAR STRENGTH TEST OF LOCK SEAL

SECTION 320 CORRUGATED STEEL PIPE

APPENDIX II

ASPHALT COATING (Referred to in DBSS 320.08)

A2.1 Coating

The asphalt used for the AC and ACPI pipe shall have the following properties:-

	Limit %	Test Method
Asphalt Cement with no additives		
Loss on heating to 163°C, not more than	1	ASTM D 6
Penetration of residue after heating compared with penetration of same sample before testing for loss on heating, not less than	85	ASTM D 5 & D 6

A2.2 Sampling

All tests on the asphalt coating shall be made on samples obtained from the pipe on or about to be delivered to the project.

A 150 g sample of asphalt coating shall be obtained by gathering shippings from the inside top of one or more lengths of pipe. (Care should be taken in sampling to avoid contamination from sand or soapstone that may have been applied after dipping).

A2.2 Shock Test

The ability of coated pipe to withstand handling in cold weather is indicated by successfully passing the following shock tests:

a) Apparatus: The apparatus for the shock test shall consist essentially of a rigid metal anvil or base plate not less than 12 mm thick and resting on a solid foundation, and a hammer weighing 2 kg arranged to fall freely in suitable guides against a plunger weighing

1 kg and sliding freely in a vertical sleeve. The lower end of the plunger shall be hemispherically shaped, with a radius of 12 mm. The hammer shall be held in its guide by a trip mechanism at a distance of 130 mm above the plunger. Split molds for preparing the specimens shall be made of brass with the surfaces amalgamated to prevent sticking and held together by slip rings pressed on the slightly tapered outside surfaces.

b) Procedure: Four test specimens shall be prepared in the form of discs 9.5 mm thick and 45 mm diameter. Approximately 115 g of the material sample shall be heated over a low flame until it becomes fluid, then poured into a mold or molds. The sample shall be melted at the lowest possible temperature. The sample shall be stirred thoroughly until it is homogeneous and free from air bubbles when poured into the molds. The material may be poured in a 45 mm diameter cylinder of such length that the four test specimens may be cut from it, using a wire cutter. Two of the samples used in the shock test may be used later to prepare samples for the flow test.

The four specimens shall be cooled in a brine of ice and salt at a temperature of -1°C for a period of at least one hour. The samples shall then be removed one at a time and quickly placed on the anvil of the test apparatus and centered under the plunger. The hammer shall then be tripped from a height of 130 mm. Not more than eight seconds shall elapse from the time each specimen is removed from the brine until the hammer strikes the plunger.

For material to be acceptable, not more than one of the four test specimens shall show a crack. If it is difficult to determine visually whether a specimen has cracked, it may be

removed from the test apparatus and bent slightly.

A2.4 Flow Test

The ability of the coating on the pipe to remain in place and not flow or sag at summer temperatures is indicated by successfully meeting the following flow tests:

a) Apparatus: The apparatus for the flow test shall consist of a corrugated brass plate 0.8 mm thick, 200 mm long and 100 mm wide, with corrugations running the long way of the plate and a metal support to hold the plate on a 45 angle with the horizontal. The corrugations shall have a crest-to crest dimension of 16 mm and depth of 4.8 mm. A line shall be scribed 150 mm from the lower edge. Split molds shall be similar to those specified above for the shock test.

b) Procedure: Two test specimens in the form of cylinders, each 9.5 mm in diameter and 19.0 mm in length, shall be obtained by pouring the excess molten from the shock test into the amalgamated brass molds. Each specimen shall be placed in a corrugation of

the corrugated slide (slide to be on the 45° slope) so that the lower end of each specimen will rest exactly along a line scribed 150 mm from the bottom edge of the slide. The test apparatus, with the specimens in place, shall then be placed in an oven maintained at 64°C ($\pm 1^\circ$). After 4 hours it shall be removed and allowed to cool to room temperature. The distance from the bottom of the corrugated plate to the lower edge of each test specimen subtracted from 150 mm, determines the amount of sag or flow. To be acceptable, the flow must not exceed 7.0 mm for either of the two specimens.

A2.5 Imperviousness Test

The imperviousness of the coating shall be determined by placing 25 to 50 millilitres each of a 25% solution of sulphuric acid, a 25% solution of sodium hydroxide, and a saturated salt solution, in three adjacent corrugations of the coated pipe or in three corrugations of a section approximately 100 mm wide cut from the pipe. The three solutions shall remain in corrugations for a period of 48 hours during which time no loosening or separation of the coating from the galvanizing shall have taken place.

SECTION 320 CORRUGATED STEEL PIPE

APPENDIX III

Test Method for Lateral Seam Strength of Helical CSP Lock Seam

(Referred to in DBSS 320.09.04.03)

A3.1 Apparatus

a) Testing Machine - Any standard testing machine capable of maintaining the specified rate of strain and of measuring tensile load with an error not to exceed ± 50 N.

b) Grips - The grips for holding the test coupon shall be of the self-aligning type.

A3.2 Preparation of Sample

a) Torch or saw cut a piece approximately 100 mm x 200 mm from the end of the pipe (See Figure 1).

b) Saw cut a 25 mm by 150 mm coupon with parallel sides perpendicular to the lock seam (See Figure 1).

c) Flatten ends of the coupon for gripping in the testing machine. Do this in a vise one end at a time, insert strip in vise to 12 mm from the lock seam. As vise flattens corrugation, strip will rotate. Realign lock seam with flattened ends by use of crescent wrench or vise grips tightened over the lock seam to prevent distortion of the seam itself while bending the strip back into line.

A3.3 Procedure

The gauge length of the test coupon shall be measured in the direction of the seam with calipers to an accuracy of ± 0.2 mm.

The coupon shall be carefully placed in the grips of the testing machine in such manner as to ensure that the axis of the test coupon coincides with the direction of the applied pull.

The load shall be applied at a uniform rate of motion of the movable cross head of 2.5 mm per minute. The maximum load in Newtons shall be recorded.

A3.4 Calculation

The lateral seam strength shall be calculated by the following formula:

$$S = P/L$$

where: S = Lateral Seam Strength in N/mm
 P = Maximum Load N
 L = Gauge length of test coupon in the direction of the seam in mm

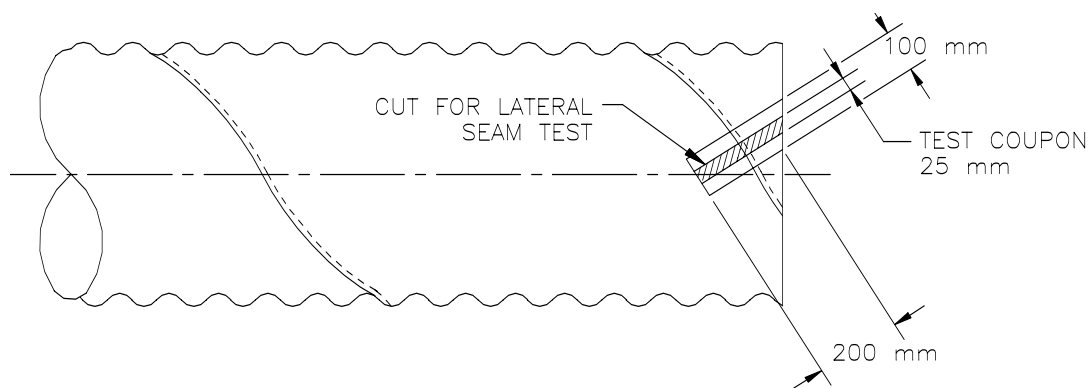


FIGURE 1 - LOCATION OF LOCKSEAM SAMPLE

SECTION 320 CORRUGATED STEEL PIPE

APPENDIX IV

Method of Obtaining Lock Seam Sample from Pipe With Recorrugated Ends

(Referred to in DBSS 320.03.04.04)

A4.1 Tools

The following tools are required:

- Heavy duty 12.5 mm variable speed drill complete with a 38 mm and a 64 mm hole saw.
- Hammer
- Centre punch
- Crescent wrench (200 mm)
- Screwdriver.

A4.2 Procedure

Drill a 38 mm diameter sample with the hole saw.
Centre the drill on the centre of the lock seam

about 600 mm from the end of the pipe clear of the recorruagated portion.

The sample of the lock seam shall be ground flat across the seam and shall be examined for all the visual inspection requirements contained in DBSS 320.03.04.02.

A4.3 Repair

Repair the pipe by bolting 64 mm zinc coated washers on either side of pipe. See Figure 1. Washers may be obtained by use of the 64 mm hole saw on the tangent of a piece of corrugated sheet.

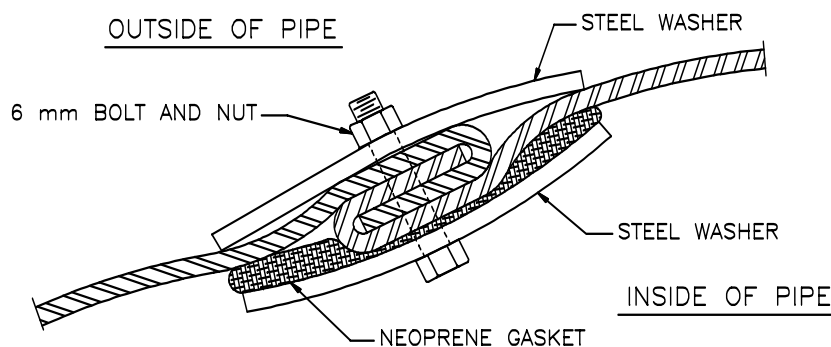


FIGURE 1

SECTION 321

TRAFFIC PAINT

321.01 Scope - This Section applies to paint suitable for spray application at a temperature of $50^{\circ}\text{C} \pm 5^{\circ}\text{C}$ to asphalt or concrete pavements for marking of traffic lines. It will be used with overlay glass reflectorized beads, and will be supplied in white or yellow without any "pre-mix" beads.

321.02 Not Used

321.03 General Requirements - The composition of the paint will be at the discretion of the manufacturer but shall be a product pre-qualified by the specified procedure. (See DBSS 321.11 for tendering prerequisites).

321.04 Detail Requirements - Paint to this specification shall comply with the following:

- a) Consistency:** 85 ± 5 Kneb units. Test method ASTM D 562-01.
- b) Drying Time:** Maximum 30 minutes at 21°C at 50-60% relative humidity. Test method ASTM D 711.
- c) Bleeding:** The paint shall have a degree of resistance to bleeding of seven or greater. Test methods ASTM D 969 and D 868.
- d) Road Service Life:** The paint shall obtain satisfactory ratings for general appearance, durability and night visibility during seven to eight months of service (June to December approximately) under heavy traffic on bituminous pavement in the vicinity of Victoria or Vancouver, British Columbia. Satisfactory ratings are defined as being equal to or better than those obtained by paints currently on the Ministry's "Recognized Products List"

Test Method: British Columbia Ministry of Transportation Standard Method of conducting and rating Road Service Tests on Traffic Paint (See DBSS 321.11).

e) Handling Qualities:

i) The degree of settling after five months storage shall be such that the paint can be readily re-mixed to a uniform consistency and there shall be no skinning. The paint shall not have marked thixotropic properties.

ii) The paint shall be capable of being sufficiently atomized to produce a uniformly applied line 100 mm in width with absence of side splatter, overspray, or cobwebbing within the limits imposed by the application equipment used on the line striping machines.

iii) The paint shall be capable of being successfully applied to at least 2 km of dash line without the necessity of making adjustments to any machine settings and without showing any evidence of distortion of the spray pattern or appreciable build up of paint in the spray gun tips.

Test Method: British Columbia Ministry of Transportation Standard Method of conducting Handling Quality Tests on Traffic Paint (See DBSS 321.11).

f) Colour:

i) White paint shall comply with US Federal Specification 595b White 17886.

ii) Yellow paint shall match British Columbia Ministry of Transportation Standard Yellow Traffic Paint colour chip.

g) Quality Control: Paint supplied under contract shall be identical with the sample submitted for qualification (See DBSS 321.03). Paint shall be considered identical if it has been manufactured within the following tolerances:

i) Mass per litre: ± 25 g of the value on the Traffic Paint Data Form.

ii) Drying time: Maximum 30 minutes and within ± 5 minutes of the value shown on the Traffic Paint Data Form.

iii) Composition of Paint: Within the tolerances indicated by the manufacturer on the Traffic Paint Data Form.

321.05 Packaging - Paint required to be supplied in sealed, vapour-proof containers.

321.06 Not Used

321.07 Release for Shipment

a) The manufacturer shall run quality control tests for each batch of material and shall report the results on the prescribed form.

b) The manufacturer shall notify the Contractor of times at which each batch is to be packaged. Samples shall be taken by the Contractor's Representative at that time.

c) The batch will be released for shipment by the Contractor after sufficient tests have been run to identify the batch with the sample originally qualified and after receipt of the manufacturer's quality control test results. Such release shall not be a bar to subsequent rejection of the material if it is found to have unsatisfactory handling qualities in the field (See DBSS 321.04 (e)) or if

its properties of consistency and drying time fail the requirements within one month of the date of manufacture.

321.08 Labelling - Each container shall be clearly marked with Batch Number, Date of Manufacture, Name of Manufacturer and Manufacturer's Code Number on both drums and lids. These markings shall be affixed so that they will not be affected by weather or handling.

321.09 Rejection - Paint rejected for non-compliance with these specifications shall be replaced with paint that does so comply.

321.11 Qualification Procedures and Ministry Test Methods - Details regarding procedures for qualification and Ministry Test Methods may be obtained from the Senior Materials and Pavement Engineer, (phone (250) 387-4360).

Note: Samples for qualification must be received not later than April 1st of each year to obtain qualification for the following year's supply.

SECTION 407

FOUNDATION EXCAVATION

407.01 Scope - This Section covers foundation excavation (i.e., excavation for abutments, piers, culverts, walls, manholes, paving, riprap, etc., not requiring cofferdams), as specified herein, and shall apply generally to all structures other than those in deep water.

407.02 Extent of Work - Foundations shall be excavated to the lines, levels and grades established by the Designer. All organic and soft materials shall be entirely removed to a firm formation and piled well back from the work. The use of explosives shall be limited strictly to the necessities of the job. As nearly as practicable, the foundation provided shall be of uniform bearing capacity.

407.03 Not Used

407.04 Not Used

407.05 Not Used

SECTION 412

REINFORCING STEEL

DESCRIPTION

412.01 Scope - This Section describes the supply, fabrication and installation of reinforcing steel for concrete structures.

The requirements of CAN/CSA-S6-00, "Canadian Highway Bridge Design Code" shall apply unless specified otherwise herein or in the Contract.

For items not covered by CAN/CSA-S6-00, "Canadian Highway Bridge Design Code" or the Contract, CAN/CSA A23.1 shall apply.

References to standards shall be to the current editions at time of Award.

MATERIALS

412.11 General - All reinforcing bars shall be deformed except for spirals and ties where plain bars may be used.

The type and grade required shall be as specified on the Design.

Wire ties for reinforcing steel, conforming to CSA G30.3, shall be minimum 1.6 mm diameter, cold drawn, annealed steel wire.

Two copies of mill certificates giving chemical and physical properties of the reinforcing steel shall be furnished to the Quality Manager and, when requested, to the Ministry Representative.

The identification of reinforcing bars shall be maintained throughout the fabrication, coating (if required) and shipping processes to the installation on the job.

TABLE 412-A REQUIREMENTS FOR UNCOATED REINFORCING STEEL

G30.3	Cold-Drawn Steel Wire for Concrete Reinforcement
G30.5	Welded Steel Wire Fabric for Concrete Reinforcement
G30.14	Deformed Steel Wire for Concrete Reinforcement
G30.15	Welded Deformed Steel Wire Fabric for Concrete Reinforcement
G30.18	Billet Steel Bars for Concrete Reinforcement

The Contractor shall as part of its quality control program have random samples (selected by the Quality Manager or Ministry Representative) of reinforcing steel, both coated and uncoated, tested for bending and tension. Two samples shall be taken of each size and grade of bar used on the project. Testing shall be in accordance with CAN/CSA-G30.18-M92 unless otherwise specified. Testing shall be performed by an approved testing agency.

412.11.01 Uncoated Reinforcing Steel - Concrete reinforcement shall conform to the requirements of the CSA Standards shown in Table 412-A, as applicable.

412.11.02 Epoxy-Coated Reinforcing Steel - Epoxy-coated reinforcing steel bars shall conform to the requirements of ASTM A-775M and D-3963M. Application plants shall be certified under the Concrete Reinforcing Steel Institute (CRSI) Voluntary Certification Program for Fusion-Bonded Epoxy-Coating Applicator Plants, and proof of certification shall be submitted to the Quality Manager and, when requested, to the Ministry Representative. Pre-treatment of the near white blast cleaned surfaces with chromate or equivalent is mandatory prior to the application of a minimum of 180 µm of cured thickness of protective epoxy-coating by an electrostatic spray method. All epoxy-coated bars shall be clearly labelled with the name of the manufacturer, the primer and the coating system used and the date of production. The method of labelling shall be determined by the applicator plants and test certificates of performance of coated bars shall be submitted to the Quality Manager and, when requested, to the Ministry Representative.

Further to paragraph 9.2 of ASTM D-3963, the identification marks on all coated reinforcing bars shall be maintained from the point of delivery until they are incorporated into the structure.

The Quality Manager or Ministry Representative may require samples of epoxy resin and epoxy patching material for acceptance testing as called for in ASTM A-775M. The Quality Manager or Ministry Representative may require tests of coated bars as called for in ASTM A-775M.

412.11.03 Galvanized Reinforcing Steel – Galvanized reinforcing bars shall be used only where shown on the Design. Substitution of galvanized reinforcing bars in place of epoxy-coated reinforcing bars will not be permitted. Substitution of epoxy-coated reinforcing bars in place of galvanized

reinforcing bars will not be permitted. Hot dipped galvanized reinforcing bars shall conform to the requirements of ASTM A-767M – *Class 1 coating*.

Only Grade W bars shall be galvanized

Galvanized reinforcing bars shall not be placed in contact with uncoated reinforcing bars.

412.11.04 Fibre Reinforced Polymer (FRP) - FRP components and FRP reinforcing bar shall conform to CSA Specification S806. FRP reinforcing bars shall be used only where shown on the Design.

412.11.05 Order Lists and Bending Diagrams - All order lists and bending diagrams shall be submitted to the Designer and if requested, the Ministry Representative for review before material is ordered.

The review of order lists and bending diagrams by the Ministry Representative shall not relieve the Contractor or Suppliers, as applicable, of responsibility for the correctness thereof.

TABLE 412-B MINIMUM INSIDE DIAMETERS OF BENDS*

BAR DESIG- NATION	UNCOATED BARS (mm)			EPOXY COATED BARS (mm)
	300R	400R or 500R	400W or 500W	
10M	60	70	60	80
15M	90	100	90	120
20M	-	120	100	160
25M	-	150	150	200
30M	-	250	200	240
35M	-	300	250	350
45M	-	450	400	450
55M	-	600	550	550

CONSTRUCTION

412.31 Bending - Reinforcement bars shall be cut and bent to the shapes shown on the Design. Bending shall be sufficiently accurate that the placing tolerances (DBSS 412.33.01) can be met. All bars shall be bent cold, unless otherwise permitted by the Designer and the Ministry Representative. Bars partially embedded in concrete shall not be field bent except as shown on the Design or as specifically permitted by the Designer and the Ministry Representative.

412.31.01 Hooks and Bend Dimensions - Where hooks are shown on the Design, they shall have the following dimensions, unless shown otherwise:

- 180° bend plus extension of at least 4 bar diameters, but not less than 60 mm.
- 90° bend plus extension of at least 12 bar diameters.
- for stirrups and ties only, either a 90° or a 135° bend plus extension of at least 6 bar diameters at the free end of the bar.
- Minimum inside diameters of bends shall be as shown in Table 412-B.

Exceptions:

- Minimum inside diameters of bends and 90° and 135° hooks for stirrups and ties shall be 4 bar diameters for uncoated bars and 8 bar diameters for epoxy-coated bars.
- Minimum inside diameters of bends in welded wire fabric, plain or deformed, for stirrups and ties shall not be less than 4 wire diameters for deformed wire larger than 7 mm and two wire diameters for all other wires, except that bends with an inside diameter of less than 8 wire diameters shall be not less than 4 wire diameters from the nearest welded intersection.
- Note: Reinforcing bars shall be pre-bent before galvanizing unless acceptable to the Quality Manager and Ministry Representative. Minimum bend diameters if pre-bent and galvanized will be as for uncoated bars.

Bars partially embedded in concrete shall not be field bent except as permitted by the Designer and the Ministry Representative.

412.32 Handling and Storage - Reinforcing bars shall be stored on platforms, skids or other suitable supports clear of the ground and shall be protected as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, loose rust or scale, mortar, paint, grease, oil, or other materials that would reduce bond.

412.32.01 Epoxy-Coated Reinforcing Steel - Epoxy-coated reinforcing bars shall be handled and stored so as to minimize damage to the coating. Equipment for handling the bars shall have protected contact areas. Nylon slings or padded wire rope slings shall be used. Suitable bundling bands shall be used to prevent damage. Bundles of coated bars shall be lifted at multiple pick-up points to prevent bar-to-bar abrasion from sags in the bundles of bars. The bars or bundles

shall not be dropped or dragged.

Coated steel reinforcing bars shall be stored off the ground on protective cribbing, and timbers placed between bundles when stacking is necessary. Supports shall be placed sufficiently close to prevent sags in the bundles.

Long term storage of epoxy-coated bars shall be minimized

If circumstances require storing coated steel reinforcement outdoors for more than two months, protective storage measures shall be implemented to protect the material from sunlight, salt spray and weather exposure. Coated steel reinforcing bars stored in corrosive environments will require protection sooner. Coated steel reinforcing bars or bundles shall be covered with opaque polyethylene sheeting or other suitable opaque protective material.

Coated bars shall not be cut or bent on the job without the permission of the Quality Manager and Ministry Representative. In any case, the flame-cutting of coated bars will not be permitted.

When placing coated steel reinforcing bars, all wire bar supports, spacers, and tying wire shall be coated with non-conductive material, for example, an epoxy-coated or plastic coated material compatible with concrete.

When immersion-type vibrators are used to consolidate concrete around epoxy-coated steel reinforcing bars, the vibrators shall be equipped with rubber or non-metallic vibrator heads

Any bar with coating damage exceeding 2 % of the surface area of the coated steel reinforcing bar in any 300 mm length shall be rejected. When the extent of the damage does not exceed 2 % of the surface area in any 300 mm length, all damaged coating shall be repaired with patching material in accordance with ASTM A 775M, Section 12. Patching material shall be applied in strict accordance with the manufacturer's written instructions. Prior to application of the patching material, rust shall be removed from the damaged areas. The patching material shall be allowed to cure before placing concrete over the coated steel reinforcing bars.

The "Guidelines for Jobsite Practices", contained as an Appendix of ASTM A 775M shall be mandatory.

Where on-site inspection or testing by the Quality Manager or Ministry Representative does not confirm compliance of the coating thickness or integrity, for any shipment of bars, such bars may be rejected, and in any case shall not be placed in the structure until the Quality Manager and Ministry Representative are

satisfied as to their acceptability.

The Contractor shall make available to the Quality Manager and Ministry Representative, for inspection and acceptance, all repairs performed to protective coatings on any reinforcing steel. Repairs of epoxy coatings shall not be performed when the coated bar or ambient air temperature is 5°C or less, or when moisture is present on the bar. Patching material shall not be applied if precipitation is expected within four hours of the procedure. If precipitation does occur within four hours, the Quality Manager shall determine as to whether the material as applied is acceptable or must be replaced. If the placed coated bars have been exposed to salt spray or road salts, the bars shall be rinsed with fresh water to remove any chloride contamination prior to placing concrete.

412.33 Placing and Fastening - Before any concrete is placed, the placing and securing of reinforcing steel including dowels, within the area of concrete placement shall be complete. Tying in place of all dowels projecting from the area of concrete placement shall be acceptable to the Quality Manager before any concrete is placed. The reinforcing steel shall be free from dirt, detrimental rust, loose scale, paint, oil or other foreign material.

Reinforcement shall be placed in the positions shown on the Design, within the tolerances specified below, adequately supported and secured against displacement. All splices of adjacent bars shall be securely tied together. Tying 100% of the bar intersections is required where the bar spacing centres are 300 mm or greater. Tying of 50% of the bar intersections is required when the bar spacing centres are less than 300 mm.

The locations of the top reinforcing steel in bridge decks shall be checked by running a full deck-width template along the longitudinal screeds. The lower edge of the template shall be set at the nominal cover dimension (reference the Design) below the level of the deck surface. No steel shall touch the template nor be more than 6 mm distant from it.

The location of reinforcing steel near deck joint anchors shall be adjusted so that there will be no interference with the deck joint anchors.

Tack welding of reinforcement for cage assembly or securing of reinforcement will be permitted only with the written acceptance of the Designer. In no cases shall stirrups be welded to tensile reinforcement.

412.33.01 Tolerances - Tolerances for placing reinforcement shall, unless otherwise specified, be as

shown in Table 412-C.

412.33.02 Bar Supports and Spacers - Bar supports and spacers shall be adequate to ensure concrete cover and bar spacings are maintained within the specified tolerances.

Bar supports and spacers shall be sufficient in number and strength to support the reinforcement and prevent displacement by workers or equipment before and during concreting and shall be adequately spaced to ensure that any sagging between supports does not intrude on the specified concrete cover.

TABLE 412-C TOLERANCES FOR PLACING REINFORCEMENT

Concrete cover to top reinforcing steel in bridge decks	+ 6 mm - 0 mm
Concrete cover to reinforcement, other than top reinforcing steel in bridge decks	± 8 mm
Bar location, except cover, when depth of a flexural member, thickness of a wall or smallest dimension of a column is 200 mm or less	± 8 mm
Bar location, except cover, when depth of a flexural member, thickness of a wall or smallest dimension of a column is larger than 200 mm but less than 600 mm	± 12 mm
Bar location, except cover, when depth of a flexural member, thickness of a wall or smallest dimension of a column is 600 mm or larger	± 20 mm
Longitudinal location, except cover, of bends and ends of bars	± 50 mm
Longitudinal location, except cover, of bends and ends of bars at discontinuous ends of members	± 20 mm

Bar supports and spacers shall be of a type and material that will not cause rust spots, blemishes or spalling of concrete surfaces.

Bar supports and spacers shall be precast concrete, plastic, steel wire, stainless steel or steel bar, except that, supports or spacers over 200 mm in height shall be precast concrete or steel bar.

Bright wire and uncoated steel supports and spacers may only be used where they are not in contact with soil surfaces, finished concrete surfaces or epoxy coated reinforcement.

Where concrete surfaces are to be exposed to sandblasting, sea water, or de-icing chemicals the bar

supports and spacers shall be either stainless steel, hot dipped galvanized steel, epoxy coated reinforcing steel, plastic or precast concrete.

Precast concrete supports shall have a compressive strength and quality not less than that of the concrete in which they are embedded. For finished surfaces, the face of the support in contact with the forms shall not exceed 50 mm in any dimension and shall have a colour and texture to match that of the finished concrete surface.

Bar supports and spacers for approach slabs and formed horizontal slabs such as bridge decks, bridge sidewalks, and top slabs of culverts shall meet the following additional requirements:

- a) Supports or spacers up to 200 mm in height shall be either precast concrete or plastic.
- b) Supports and spacers over 200 mm in height shall be either:
 - i) precast concrete,
 - ii) bent or welded steel bar that has been hot-dipped galvanized after fabrication,
 - iii) stainless steel bar, or
 - iv) epoxy coated reinforcing steel bar
- c) Plastic supports or spacers shall have an individual minimum breaking strength of 4.5 kN (1000 lbs) and shall be capable of maintaining strength and dimensional properties for the range of temperatures encountered on site.
- d) Maximum spacing between supports, for each mat of bars, shall be 1200 mm, except that the maximum spacing between plastic supports, for each mat of bars, shall be 1000 mm.
- e) Each support shall carry the load from not more than one mat of reinforcing steel, except as provided below:
 - i) Where a support is used that is specifically designed by the manufacturer to carry two mats at two separate positions, or
 - ii) If the top mat of reinforcing steel is more than 200 mm above the slab soffit, then the top mat may be supported by epoxy coated reinforcing steel spreader bars secured between the top and bottom reinforcing mats, provided that, the bottom reinforcing mat is supported on precast concrete chairs which are sufficient in number and adequately spaced to carry the additional weight of the top mat of reinforcing steel.

TABLE 412-D CONCRETE COVER FOR REINFORCING STEEL

Concrete cast against ground	75 mm
Tops of deck slabs	70 mm
Undersides of deck slabs	40 mm
Other surfaces	60 mm

412.33.03 Concrete Cover - Concrete cover for reinforcing steel shall be as listed in Table 412-D, unless shown otherwise on the Design.

412.33.04 Spirals - Spirals shall be held in place and to line by vertical spacers.

For spiral rods less than 15M spacing shall be as follows:

- two spacers per loop for spirals less than 500 mm in diameter.
- three spacers per loop for spirals 500 mm to 800 mm in diameter.
- four spacers per loop for spirals over 800 mm in diameter.

For spiral rods 15M and larger spacing shall be as follows:

- three spacers per loop for spirals up to 600 mm in diameter.
- four spacers per loop for spirals over 600 mm in diameter.

If vertical reinforcements are to serve as spacers, spirals shall be securely tied to vertical reinforcement at the spacing required for spacers.

412.34 Splicing of Bars - Special requirements for splicing, such as particular locations for splices, use of overlength bars or special lap lengths, shall be as shown on the Design.

Splices in bars larger than 35M shall be mechanical coupler splices or welded. The detail of such splices shall be subject to acceptance by the Designer and Ministry Representative.

412.34.01 Lapped Splices

- a) Horizontal bars shall not be spliced unless greater than standard mill lengths - 12 m for 10M bars and 18 m for larger bars - would otherwise be required.

b) Splices to be staggered so that no more than one third of the reinforcing steel in a member shall be spliced in any transverse section that is within the required lap length.

c) If not shown on the Design, the length of lapped splices shall be in accordance with CAN/CSA-S6-00, "Canadian Highway Bridge Design Code", Clause 8.15.9.

d) Adjacent reinforcing bars shall not be spliced at the same locations unless shown on the Design or authorized by the Designer and Ministry Representative.

Column spirals shall be lapped 48 rod diameters at splices unless otherwise shown on the Design.

412.34.02 Welded Splices - Welded splices shall be used only if detailed on the Design. Welding shall conform to the requirements of CSA Standard W186, Welding of Reinforcing Bars in Reinforced Concrete Construction and shall be performed by a company certified by the Canadian Welding Bureau to the requirements of CSA Standard W186. Welded splices shall not be used on epoxy coated bars.

412.34.03 Mechanical Coupler Splices - Mechanical couplers shall be used for splices only if pre-approved or detailed on the Design. Such couplers shall develop in tension or compression, as required, at least 120% of the specific yield strength of the bars, but not less than 110% of the mean yield strength, representative of the bars to be used, in the test of the mechanical connection.

Wedge couplers shall not be used in bars greater than 15 mm diameter.

When mechanical couplers are used the Contractor shall ensure that the minimum concrete cover as specified is maintained.

The total slip of the reinforcing bars within the splice sleeve of the connector after loading in tension to $0.5f_y$ and relaxing it to $0.05f_y$ shall not exceed the following measured displacements between gauge points straddling the splice sleeve:

Up to and including 45M bars	0.25 mm
55M bars	0.75 mm

412.81 Not Used

412.91 Not Used

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BRIDGE DECKS AND CONCRETE OVERLAYS

DESCRIPTION

413.01 General - This Section describes requirements for the construction of Bridge Decks, and for the construction of Concrete Overlays on previously constructed (old) bridge decks and on newly constructed (new) bridge decks. The requirements of DBSS 211 shall apply except as otherwise specified in this Section. Unless otherwise specified in this Section, bridge deck concrete shall include diaphragms, deck slabs, bridge parapets and medians, bridge sidewalks, approach slabs and overlay concrete.

413.31 Bridge Decks

413.31.01 General - Deck slab construction shall be full-width and continuous between the joints shown on the Design, and shall be placed in the sequence as shown on the Design. Any variation from this requirement shall be to the acceptance of the Designer and the Ministry Representative.

413.31.01.01 Camber Survey - Prior to commencing deck construction and subsequent to the completion of the erection of girders, with the girders in a thermally neutral condition and with no dead load other than the dead load of the girders and necessary fall protection, the Contractor shall profile all the girders. . Camber elevations are to be taken at 1000 mm centres maximum (or as indicated on the Design), centrelines of all bearings and ends of girders. The camber elevation locations are to be laid out to an accuracy of 25 mm horizontally and camber elevations taken to the nearest 1 mm vertically. The Contractor shall supply the camber elevations to the Designer. The Designer shall calculate and provide the Contractor with the haunch heights for setting the deck slab soffit, and the design finished grade elevations for the deck, complete with anticipated dead load deflections at 1000 mm stations along the centreline of roadway. The Designer will be responsible for providing the elevations to be used by the Contractor in establishing the required screed rail settings.

In the event that actual girder camber values vary significantly from the design values, the Contractor will be required to modify the original design finished grade as directed by the Designer.

413.31.01.02 Method, Equipment & Personnel - The Contractor shall submit to the Quality Manager and the Ministry Representative for review, four weeks prior to the scheduled start of deck slab concrete placement, a Deck Placement Plan which provides a complete description of the method, equipment and

personnel, including previous deck placement experience of the personnel to be employed. This shall include the equipment for mixing, transporting, placing, vibrating and curing the concrete and shall also include details of the finishing equipment and support rails. The submittal shall clearly demonstrate that the proposed methods, equipment and personnel have the capability to carry out the Work in accordance with DBSS 413. All review concerns raised by the Quality Manager and the Ministry Representative shall be addressed to the satisfaction of the Ministry Representative. Equipment proposed for the Work shall be subject to review by the Ministry Representative. Equipment may be rejected during operation if it is unsatisfactory.

Two weeks prior to the scheduled start of deck slab concrete placement, the Contractor shall meet with the Quality Manager, concrete supplier and the Ministry Representative to review deck concrete operations with respect to concrete mix design and performance, concrete delivery, placing, finishing and curing equipment and methods.

413.31.01.03 Haunch Setting, Screed Rails & Reinforcing Cover – The Contractor shall set the deck slab soffit formwork to within 2 mm of the haunch dimension as determined in accordance with DBSS 413.31.01.01.

After installation of the deck slab reinforcing, the Contractor shall set the screed rails for the deck finishing machine. Screed rails shall be installed to an accuracy of ± 2 mm and have a maximum deflection between supports of 1 mm. Allowance for dead load deflection of the structure shall be made in the screed rail setting as well as any anticipated deflection due to the loading of any formwork that may be supporting the screed rail system. The screed rails shall be adequately supported outside the area to be concreted and shall be completely installed before concrete is placed.

Prior to the placement of deck slab concrete and subsequent to the installation of deck slab reinforcing and screed rails, the locations of the top reinforcing steel in bridge decks shall be checked by running a full deck-width template along the longitudinal screeds. The lower edge of the template shall be set at the nominal cover dimension (as per the Design) plus any anticipated deflection of the screed rail support system below the level of the deck surface. No steel shall touch the template nor be more than 6 mm distant from it. Any discrepancies outside of these limits shall be

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corrected by the Contractor to the satisfaction of the Designer and Ministry Representative.

413.31.02 Concrete Placement

413.31.02 .01 Concrete Temperature at Placement -

Concrete designed for bridge decks including any bridge deck concrete containing silica fume shall not have a temperature in excess of 17°C at time of placement. Concrete used in elements having a minimum section thickness greater than 1000 mm shall have temperature controls as per CSA A23.1 Clause 5.2.4.4. Methods used for maintaining temperature controls shall not diminish the quality of the concrete, and shall not exceed the specified W/C_m ratio.

When the atmospheric temperature is 15°C or higher, DBSS 211.18 – Hot Weather Concreting, shall apply except as modified herein.

Concrete for bridge decks and overlays shall not have a temperature greater than 17°C when placed. Prior to the placement of bridge deck and overlay concrete, when the ambient air temperature is at or above 15°C, or when there is a probability of its rising to 20°C or above during the placement period (as forecast by the nearest official meteorological office), the Contractor shall submit to the Quality Manager and Ministry Representative for review, the proposed placing operations complying with the requirements for hot weather concreting.

When the ambient air temperature is at or above 15°C, or when there is a probability of its rising to 20°C or above during the placement period (as forecast by the nearest official meteorological office), bridge decks and overlays shall be cast when daily air temperatures are forecast to be a minimum (normally between 12:00 midnight and 9:00 AM).

413.31.02 .02 Time of Placement – All bridge deck and overlay concrete shall be fully discharged and placed in its final location within 45 minutes after the water and cement have been combined. Under conditions contributing to rapid stiffening of concrete, the Contractor shall adjust its placing operations to suit the reduced handling time. .

Time of placement extensions will be considered on a case by case basis and may require the use of Hydration Stabilizing Admixtures (HSA's) conforming to the requirements of ASTM C494 Type B, Retarding or Type D, Water-Reducing and Retarding Admixtures. If accepted by the Designer and the Ministry Representative, guidelines for the use of HSA's shall be as follows:

- HSA modified concrete for bridge decks shall be

BRIDGE DECKS AND CONCRETE OVERLAYS

fully discharged and placed within 90 minutes after water and cement have been combined.

- When HSA's are used, these time extensions are subject to preconstruction trials being conducted by the Contractor, to establish the appropriate HSA dosage to provide suitable extended slump life of concrete, without increasing the water/cementitious ratio of the concrete above that which would be required if HSA's were not used. The use of HSA's shall in no instance modify the maximum concrete temperature required at time of placement. A one time only addition of HSA will be allowed. This will be during initial batching of the concrete or immediately at completion of batching as recommended by the admixture manufacturer. Addition of HSA at any other time will be cause for rejection of the concrete.

413.31.02 .03 Concrete Placement-Diaphragms -

Unless otherwise specified by the Designer, diaphragms shall be placed either:

- a) about two hours before the deck concrete. In this case, diaphragm concrete shall have a slump less than 40 mm and shall be retarded so that it sets at the same time as the deck concrete, or
- b) a sufficient length of time ahead of the deck concrete, so that the diaphragm concrete attains a compressive strength of 15 MPa before the deck slab is cast.

Sequence for the placing of concrete for diaphragms at ends of girders on continuous and integral type spans shall be as shown on Design.

413.31.02 .04 Concrete Placement-Deck Slab - The top surfaces of concrete stringers shall be prepared in accordance with DBSS.211.12.03 and the surfaces shall be in a saturated surface dry condition immediately before the deck is cast.

Concrete shall be placed at a rate of not less than 6 m/hr. The concrete front and finishing operation shall be kept parallel to the substructure. Placing shall be started at such time as to permit finishing during daylight hours, except if ambient temperatures are as outlined in DBSS 413.31.02.01, then adequate lighting is to be provided in accordance with Workers Compensation Act, Occupational Health and Safety Regulations, BC, to allow for concrete operations under reduced light conditions.

In the event of unexpected rain, concrete placing shall cease and the surface shall be protected immediately.

Surface concrete which has been rained on shall immediately be removed to the top of reinforcing steel.

413.31.02 .05 Finishing - The deck surface shall be finished by a drum-type deck finisher on support rails. Two work bridges shall be provided. No inserts will be permitted in the finished roadway surface.

The surface behind the finisher shall be floated transversely to eliminate ridges and open texture. Areas which cannot be machine-finished shall be hand screeded and floated to conform to the machine-finished deck.

Prior to final surface texturing, the deck surfaces shall be repeatedly checked for accuracy of deck slab thickness and alignment. The Contractor shall measure and record the deck slab thickness at a frequency of at least one measurement per interior bay and overhang bay, at a maximum of 3000 mm centers longitudinally. Adjustments as acceptable to the Designer shall be made to the deck finishing machine to maintain the minimum deck slab thickness and the required concrete cover on the deck reinforcing. The deck slab thickness readings shall be supplied to the Quality Manager and upon request, the Ministry Representative at the conclusion of each placement section.

Bridge deck slab final surface texturing shall be by tining. The tining shall create transverse grooves 3 mm wide by 1.5 mm to 3 mm deep at 20 mm centre to centre spacing.

413.31.03 Repairs - Areas of the deck not meeting the required accuracy of alignment as given in DBSS 211.16 Table 211-M, shall be corrected as follows:

- a) where the required alignment can be obtained with a maximum cut of 6 mm, the bumps shall be cut with a bump cutter which will provide an acceptable longitudinal grooved texture;
- b) where the required alignment cannot be obtained with a maximum cut of 6 mm, the concrete shall be broken out with vertical edges to a minimum depth of 40 mm and shall be replaced with new concrete of the required quality.

Any physical damage to the deck surface shall be cut out and replaced. Any areas of open texture or plucked aggregates shall be repaired to the satisfaction of the Quality Manager and the Ministry Representative.

413.31.04 Interim Strength Requirements - Deck concrete shall attain a strength of 15 MPa before parapets are placed and 25 MPa before heavy loads, such as concrete trucks are allowed on the bridge.

413.31.05 Curing

413.31.05.01 General - Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, excessive moisture, moisture loss, heavy shocks, excessive vibrations and high stresses, for the period of time necessary to develop the required concrete properties.

The Contractor shall submit a detailed Deck Curing Plan for curing deck and overlay concrete. The plan shall contain details such as water source, the distribution system, the collection and run-off control system, person(s) responsible for quality control, and staff to maintain the system. The curing system shall be capable of maintaining free film of water, on the areas of concrete requiring curing, for a minimum of 8 unattended hours and this capability shall be demonstrated prior to concrete placement. It shall be the responsibility of the Contractor to ensure that the system of curing and protection is properly planned, constructed and maintained throughout the entire curing period.

Burlap shall be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. A layer of burlap shall be applied to the surface of the concrete. Strips must overlap 150 mm and must be held in place without marring the surface of the concrete.

The burlap shall be applied immediately after finishing of the concrete surface within 2 to 4 meters of the final surface texturing operation (no more than 20 minutes) and shall be maintained in a saturated condition in a manner which does not damage the finished concrete surface. The burlap shall be maintained in a continuously wet condition throughout the curing period and a continuous film of free water on the surfaces of the areas noted herein shall be maintained by means of soaker hoses, sprinklers, etc.

Concrete for diaphragms, monolithic decks, concrete overlays, approach slabs, parapets, and sidewalks shall be cured for a minimum of seven consecutive uninterrupted twenty-four hour periods at a minimum temperature of 10°C and for the time necessary to attain 80% of the specified compressive strength of the concrete. The compressive strength tests for verifying completion of the curing period shall be determined using field cured test cylinders cured in accordance with Clause 7.3.4 of CSA A23.2-3C. The curing period will begin following the completed placement of the concrete in the section cast.

The temperature of the concrete being cured must be monitored to ensure maximum and minimum temperature requirements in accordance with DBSS 211.15.02 are met.

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Regardless of ambient temperature, moist curing with burlap and water must be provided at all times. During cold weather, burlap must be prevented from freezing.

At completion of the curing period, the curing shall be discontinued in a manner so as not to subject the concrete to undue stresses due to rapid moisture loss in the concrete.

When the air temperature is at or below 5°C or when there is a probability of it falling below 5°C within the next 5 days after the curing period, then the following shall apply:

- At completion of the curing period, the addition of free water is to be discontinued and followed by an additional 5 consecutive uninterrupted twenty-four hour periods of drying with the concrete temperature maintained at a minimum temperature of 5°C.

413.31.05.02 Additional Curing Requirements for Concrete Containing Silica Fume or Fly Ash, With or Without Fibres. - A fog mist shall be applied continuously from the time of screeding until the concrete is covered with burlap, in such a way as to maintain high relative humidity above the concrete and prevent drying of the concrete surface. Water must not be allowed to drip, flow, or puddle on the concrete surface during fog misting, when placing the burlap, or at any time before the concrete has achieved final set.

Fogging equipment will consist of pressure washers (minimum output pressure of 28 MPa (4000 psi)) with suitable tips for producing a fine water mist or fog. A minimum of two pressure washers shall be used for this process and the adequacy of the range and coverage shall be demonstrated prior to placing any concrete.

When the air temperature is at or below 5°C or when there is a probability of it falling below 5°C within the next 10 days after the curing period, then the following shall apply:

- At completion of the curing period, the addition of free water is to be discontinued and followed by additional 10 consecutive uninterrupted twenty-four hour periods of drying with the concrete temperature maintained at a minimum temperature of 10°C.

Modifications to the curing process may be required if it is anticipated that the deck may be subjected to the application of de-icing chemicals within the first month after the curing period.

CONCRETE OVERLAYS

BRIDGE DECKS AND CONCRETE OVERLAYS

413.32.01 General - This Section describes requirements for repair and resurfacing of existing bridge decks (old) and newly constructed bridge decks (new) with a concrete overlay, describing the construction practices, materials and equipment required to place acceptable concrete overlay. This work is usually carried out on one half of the deck at a time, while traffic is maintained on the other half. The requirements of DBSS 413.31 shall apply except as otherwise specified in this section.

413.32.02 Gradeline - The Contractor shall survey and reference profiles of the existing bridge deck and approaches prior to scarification as follows:

- Longitudinally the profiles shall be taken at 2 to 3 metre stations for the entire length of the structure, including 21 meters on each end, with additional shots taken at the back of ballast walls and all existing or proposed new joint locations.
- Transversely the number of profiles required will be determined by:
 - A maximum spacing between elevation points of 3 meters.
 - Profiles are required 500 mm from each curb or parapet face.
 - Profiles are required 300 mm (inside area to be concreted) from longitudinal overlay construction joint lines requiring adjustable screed rails. In general longitudinal overlay construction joints shall be located at the center of a lane or between lanes. The final location of the longitudinal construction joints is subject to the acceptance of the Designer and Ministry Representative.
 - A profile is required at hinge point of crown.
- Elevation points are to be laid out in cross section ninety degrees to centerline of roadway on straight structures and radial to centerline of roadway on curved or spiraled structures.
- Profile elevation points shall be laid out to an accuracy of ± 20 mm horizontally and elevations taken to an accuracy of ± 3 mm vertically and be referenced such that they can be re-established within ± 25 mm from their original location.

The Contractor shall provide the Designer, and when requested, the Ministry Representative, with the gradeline profiles plotted at a scale of 1:10 vertical and

1:50 horizontal and a spreadsheet showing actual original elevations for all points surveyed.

In the case of old decks, subsequent to scarifying and cleaning of the deck surface, the Contractor shall re-establish the original elevation points, take new elevations for the points to the nearest millimeter and submit these elevations along with plotted profiles to the Designer and, when requested, to the Ministry Representative.

The Designer will provide the Contractor with design finished grade profiles and elevations for the survey points as originally laid out by the Contractor. These profiles and elevations shall be used by the Contractor to set the screed rails for the deck finishing machine, checking of overlay thickness during the dry run of the deck machine and for calculating the volume of overlay concrete required.

The Contractor is responsible for properly setting the screed rails to match the design gradeline provided by the Designer. Depressions creating ponded water, or localized high spots in the concrete surface, resulting from deficient finishing procedures shall be repaired.

At completion of the deck overlay the Contractor shall re-establish the original elevation points and take as built elevations for the points to the nearest millimetre and submit these elevations along with plotted profiles to the Designer and Ministry Representative.

413.32.03 Removal of Existing Concrete Deck Surface

The existing concrete surface shall be removed by use of scarification (roto-milling), hydro-demolition or alternate methods acceptable to the Designer and Ministry Representative over the full length and width of the bridge deck. If methods other than scarification are proposed by the Contractor, the Contractor shall submit all required details of the proposed work to the Designer and Ministry Representative and shall obtain the acceptance of the Designer and Ministry Representative at least two weeks prior to starting the work. Alternate methods shall meet the requirements as specified for scarification.

413.32.03.01 Scarification - If scarified, equipment shall be capable of removal to an accuracy of ± 5 mm. The scarifying equipment shall produce a surface that does not exceed 10 mm in amplitude for roughness. The maximum cut will be to within 10 mm of the reinforcing steel. Depth of scarification will be specified by the Designer.

The Contractor shall monitor the total depth of concrete cover to the top mat of reinforcing steel using a pachometer or alternate methods acceptable to the

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Quality Manager. Readings shall be taken at regular intervals ahead of the scarification. The Contractor shall adjust the rate and depth of concrete removal to ensure that the reinforcing steel is not damaged and the desired scarified profile is achieved. All reinforcing steel damaged by the Contractor's operations will be replaced. Care must be taken not to damage the existing deck drains. The Contractor will be required to repair or replace any damaged drains. Drains are to be plugged to insure containment of debris.

All areas inaccessible to the scarification equipment shall be prepared by hydro-demolition, grinders or by jackhammers that are limited to a maximum 18 kg. Preparation shall minimize damage to the sound substrate concrete. Larger jackhammers may be used if accepted by the Designer and the Ministry Representative and if performance acceptable to the Designer and the Ministry Representative can be demonstrated.

In the case of previously overlaid decks, concrete shall be removed to below the old bond line. Where the bond line is within 10 mm of the reinforcing steel, the remaining concrete and the old bonding material shall be removed by hydro-demolition or pneumatic tools.

Upon completion of scarification of the deck, prior to opening the scarified deck lane to traffic, the Contractor shall place temporary asphalt tapers (minimum 40:1) using asphalt patch material (cold mix) with tar paper underneath at all deck joints and bridge ends as required to maintain adequate traffic movement. The asphalt tapers shall be maintained until traffic is no longer using that lane or the final paving is complete. The temporary tapers shall be as per DBSS 501.

413.32.03.02 - Not Used.

413.32.04 Removal of Concrete for Partial and Full Depth Repairs

The Contractor, in the presence of the Quality Manager and Ministry Representative, shall carry out a detailed visual inspection of the deck surface for patch concrete. A chain drag method shall be used to examine the entire deck surface for evidence of additional delaminated and deteriorated concrete. These areas of unsound concrete and patch concrete shall be removed to sound concrete or removed full depth when considered necessary by the Quality Manager and Ministry Representative.

Removal and repair of a specific area will not be completed until the Contractor, the Quality Manager and the Ministry Representative have inspected the affected areas requiring repair, and have agreed on the

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extent of repair required.

The Contractor shall supply the necessary labour and supplies to mark out the repair areas.

Concrete for repair for partial and full depth repairs shall proceed as follows:

- The Contractor shall keep repair boundaries square or rectangular and avoid abrupt changes in width of a given repair area. The edge of the repair area shall be maintained vertical. No debris shall be permitted to fall from the bridge. Saw cut the perimeter of the repair areas to a minimum depth of 25 mm to prevent feather edges. Do not cut the existing reinforcing steel.
- Remove deteriorated, delaminated and patch concrete to sound concrete. Maximum jackhammer shall be 18 kg. Care shall be taken to avoid damage to the reinforcement and remaining concrete. Jackhammers are to be operated at angles less than 45° as measured from the surface of the deck to the hand tool. The Contractor shall use wedge type chisel bits. Moyles and round point chisels are not permitted. Adhering concrete shall be removed from the reinforcement using hammers no larger than 7 kg.
- Remove all concrete to allow a 25 mm space around all exposed reinforcing bar within partial depth repairs. Expose all corroded reinforcement at edges of partial and full depth repair area
- Full depth repairs will only apply when the soffit concrete is removed. For full depth repair areas, the Contractor shall install all necessary formwork prior to cleaning of reinforcing and concrete surfaces. The finished soffit repair concrete shall be flush with the surrounding soffit concrete. Areas for full depth repair exceeding 1 m² shall be patched prior to placement of the overlay. Before placement of the concrete patch, the surface of the adjoining concrete should be saturated with water for a period of no less than 30 minutes and coated with a bonding agent immediately ahead of the fresh concrete.

BRIDGE DECKS AND CONCRETE OVERLAYS

- Mildly corroded reinforcement shall be blast cleaned to commercial blast finish SSPC-SP6. Severely corroded and damaged reinforcement shall be replaced. Mechanical couplers acceptable to the Designer or laps meeting the CSA S6-00 Code requirements shall be used to attach new bars to the existing bars. Mechanical couplers shall develop at least 125% of the specified yield strength of the bar.
- Prior to the placement of the partial and full depth repair area infill concrete the surfaces of the sub deck within the repair area shall be abrasive blast (minimum 35 MPa/5000 psi) or high-pressure water blast (minimum 35 MPa/5000 psi) cleaned to remove all bruised and fractured concrete and foreign materials such as dirt, dust, laitance, sand, grease, oil, concrete slurry etc. to the satisfaction of the Quality Manager and Ministry Representative.
- The Contractor shall collect and remove all dirt, dust, and blasting sand from the repair areas of the sub deck, by vacuum or similar method, and dispose of the materials off the bridge site. Disposal shall be in accordance with all applicable environmental regulations.

413.32.05 Reinforcing Steel

Reinforcing steel shall be supplied and installed in accordance with DBSS 412. Welding of reinforcing bars will not be permitted.

Severely corroded reinforcing steel, more than 25% section loss as determined by the Quality Manager, in the existing deck shall be removed and a replacement bar spliced using mechanical couplers acceptable to the Designer or lapped with existing reinforcing steel. Mechanical couplers and lap length shall be in accordance with CAN/CSA S6-00

Reinforcing steel damaged by the Contractor's operations shall be replaced.

413.32.06 Removal and Replacement of Existing Deck Joints

413.32.06.01 Expansion joint system - The Contractor is responsible for the demolition and removal of the existing concrete and expansion Joints.

The steel portions of the deck joint shall be supplied and fabricated in accordance with DBSS 422.

The steel portions of the deck joint shall be galvanized and the joint armoring shall be installed 5 mm below the finished concrete nosing surface. Galvanized surfaces damaged by welding shall be touched up with two coats of a zinc rich coating approved by the Quality Manager..

Each joint seal shall be supplied in a single length, without splices. Before the joint seal is installed, the joint shall be thoroughly cleaned with a wire brush and all moisture removed from the joint. The seal shall be installed in accordance with the Manufacturer's recommendations.

413.32.06.02 Preparation of Filled Joints - The Contractor shall cut a transverse line, directly above the filled joint location, during casting of the deck overlay concrete using an edge cutter attached to a bull float. The line shall be neat and straight.

The Contractor shall further saw cut the filled joint along the transverse line within 48 hours of casting the deck. The saw cut will be achieved using a 4mm wide diamond blade to a depth of 30 mm below the top of the deck.

The Contractor shall fill the saw-cut with Sikaflex 1C SL, a one-component, self-leveling, polyurethane sealant or an alternate permanent filler, impervious to water and resistant to ultra violet radiation, acceptable to the Designer and Ministry Representative. Sealants shall be installed in accordance with the manufacturers' recommendations. The saw cut shall be clean and dry before placing the sealer.

413.32.07 Preparation of the Sub Deck

The Contractor shall high pressure (minimum 110 MPa/15000 psi @ 68 liters/minute using a rotating head) water blast the surface of the entire concrete subdeck including both parapet or curb faces 50 mm up from original deck elevation and abutment ballast walls, no earlier than 2 days before placing the overlay concrete.

The water blasting equipment shall effectively remove laitance, loose materials, bruised concrete, dust, slurry, oil, or other contaminants (as applicable) that are detrimental to the concrete overlay bond and shall leave behind a sound concrete surface, thoroughly cleaned and roughened to partially expose the coarse aggregate. The Contractor shall provide full containment and disposal of all debris, contaminants, etc., and shall comply with all applicable

environmental and Workers Compensation Act, Occupational Health and Safety Regulation BC, requirements. The Contractor shall provide adequate guards to contain over spray and flying debris during the scarification, water blasting, deck washing and chipping process. The Contractor shall take all means necessary to reduce and contain the amount of dust produced throughout the entire project.

For the period between water blasting and placement of overlay concrete the sub-deck shall be protected from contaminants.

Water blasting equipment shall always travel downhill, keeping all waste material ahead of the equipment and preventing the waste material from rehydrating on the previously cleaned surface.

413.32.08 Concrete Overlay Placement

All concrete works will be governed by the requirements of DBSS 211 "Portland Cement Concrete", DBSS 933 "Admixtures for Portland Cement Concrete" and DBSS 413.31 except as otherwise specified in this Section.

The Designer shall be responsible for the design of all concrete mixes. The Quality Manager shall be responsible for quality control and quality assurance of each component of the concreting operation, including aggregate and component quality, batching, mixing, transporting, placing, consolidating, finishing, curing and testing.

The Contractor shall submit a detailed plan of equipment and manpower to be used for placement and curing of the concrete overlay a minimum of 14 days prior to the scheduled placement dates for the review of the Quality Manager and Ministry Representative. The plan shall also contain details such as: water source, the distribution system, the collection and run-off control system, person(s) responsible for quality control, and staff to maintain the system. All review concerns raised by the Quality Manager and the Ministry Representative shall be addressed to the satisfaction of the Ministry Representative.

The Contractor will undertake a test placement of the proposed deck mix design as indicated by the requirements of DBSS 211.03.05.

413.32.08.01 Materials & Equipment - Acceptable types of overlay are High Density concrete and Silica fume modified concrete. For High Density concrete overlays, acceptable finishing machines are Bidwell model OF400, Bidwell model OF500 or alternate (low slump pan-type overlay finishers), acceptable to the

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Designer and Ministry Representative. Concrete shall be produced on site using volumetric concrete mobile mixers. All equipment shall be provided in good working condition.

For structures over 50 m long and structures over 20 m long with a grade greater than 3%, two finishing machines shall be used in tandem. The speed of the trailing machine shall be such that its motion is continuous. Any open texture remaining after two finishing machine passes shall be repaired by hand.

For Silica fume modified concrete overlays, acceptable finishing machines are Bidwell model 4800, Gomaco model CA450 or alternate acceptable to the Designer and the Ministry Representative. Concrete shall be produced by either a qualified concrete batch plant or at the bridge site using pre-bagging concrete mix and mixer trucks. All equipment shall be provided in good working condition.

Finishing machines shall be capable of forward and reverse motion under positive control and with provision for raising screeds to clear previously screeded surfaces while traveling in reverse.

The Contractor shall provide steel rail mounted mechanical deck concrete finishing equipment of adequate size and design to permit the complete placement and finishing of a single lane section from abutment to abutment with the prescribed surface finish, without forming any cold joints.

The Contractor is responsible for properly setting the screed rails to ensure longitudinal and transverse drainage from the deck without ponded areas or “bird baths”.

Sufficient screed guide rails will be set out for the full length of the anticipated section to be cast plus 6 m length at each end for run in and run out of the deck machine, adjusted for height and accepted by the Quality Manager and Ministry Representative prior to the pour as follows:

- i) Screed guide rails, upon which the finished machine will be placed outside the area to be concreted, will be horizontally and vertically stable. Rails shall be installed with fully adjustable supports at 350 mm maximum spacing
- ii) The finishing machine and guide rails will be adjusted so that the height of the screed above the existing subdeck at each point meets the Quality Manager’s and Ministry Representative’s requirements. To confirm the adjustment of the machine and guide rails, the

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screed will be “dry-run” and clearance measurements taken at 3 m intervals and provided to the Quality Manager and, when requested, the Ministry Representative for acceptance. The minimum overlay thickness shall be 50 mm. Resetting of the machine and/or guide rails will be done as necessary to obtain an acceptable “dry-run”. Adjustments to the machine or the rails will not be permitted after an acceptable “dry-run” is complete.

Work bridges shall be provided to facilitate bull floating, edge finishing with hand tools, correction of defects in machine finished concrete and tining and fog curing.

Rigid forms made of wood or steel shall be installed at longitudinal bulkheads in a manner that will maintain the desired shape during concrete placement, consolidation and finishing. The longitudinal bulkhead will be installed at the centerline or lane lines of the bridge deck. The top of the longitudinal bulkhead will be set at the finished deck elevation. Any honey combing or poorly consolidated concrete after stripping the longitudinal bulkhead will be cut back into the new overlay a minimum of 150 mm.

The overlay shall be placed in strips with longitudinal joints near lane markings. Each strip shall be placed continuously between joints; adjacent strips shall not be cast for 24 hours.

413.32.08.02 Bonding Agent - The Contractor shall apply a cementitious bonding slurry, pre-approved by the Designer, to the prepared sub-deck and repair concrete. The prepared concrete sub deck shall be in a saturated surface dry (SSD) state prior to slurry placement. The Contractor shall supply the necessary equipment such as water hoses and vacuum or oil free compressed air.

The cementitious bonding slurry is to consist of type GU portland cement mixed with a water/cement ratio not exceeding 0.38 by mass. The slurry must not exceed 3 mm in depth and be scrubbed into the substrate surface with coarse brooms; in particular no pooling will be permitted. The bonding slurry is to be applied immediately ahead of the overlay concrete placement and in a timely fashion so as not allow drying or setting up of the slurry prior to the placement of overlay concrete. Any areas to which the slurry has been applied, that in the opinion of the Quality Manager and Ministry Representative exhibit drying or setting shall be cleaned of the bonding slurry and re-coated prior to the placement of deck overlay concrete.

The vertical faces at the edge of the scarified sub-deck surface; at construction joints; and at concrete/deck-

joint interfaces for old bridge decks and the vertical faces at sub-deck and curb or parapet interface for new decks shall be coated with an epoxy bonding agent conforming to ASTM C881, Type V, Grade 2. The Class of bonding agent shall be appropriate for the temperature at the time of application. The bonding agent shall be applied in accordance with the manufacturer's instructions.

413.32.08.03 Interim Partial Strength - Overlay shall attain a minimum strength of at least 30 MPa before removal of the burlap and opening to traffic. All other curing requirements as specified in DBSS 413.31 shall be adhered to. The interim strength tests shall be determined using field cured test cylinders cured in accordance with Clause 7.3.4 of CSA A23.2-3C.

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MANUFACTURE AND ERECTION OF PRECAST AND PRESTRESSED CONCRETE MEMBERS

DESCRIPTION

415.01 Scope – This Section covers the manufacture and erection of precast and prestressed concrete members

415.02 General

415.02.01 The manufacture and erection of precast and prestressed concrete members shall conform to the requirements of the Contract and the Design.

415.02.02 Precast concrete elements shall be manufactured in plants certified to the current CSA-A23.4 in the appropriate category by a certification organization accredited by the Standards Council of Canada in the subject area of building products and structures. Certification shall be in effect prior to the beginning of Work, and maintained throughout the period of manufacture.

415.02.03 Materials and construction shall conform to the current CSA-A23.4 and the current PCI "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products".

415.03 Prefabrication Meeting – The Quality Manager will convene a prefabrication meeting with the Contractor, fabricator and the Ministry Representative to review procedures on quality control, quality assurance, plant certification, concrete source and mix designs, use of Hydration Stabilization Admixtures (if applicable), mill certificates, alternate details and procedures, updated schedule for prefabrication and to confirm the Contract and Design requirements.

415.04 Working Drawings - Working drawings shall consist of the following:

- Shop drawings,
- Transportation details, and
- Erection drawings

Transportation details and erection drawings shall be prepared and sealed by a professional engineer registered with APEGBC.

Shop drawings shall be prepared and sealed by a professional engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) when the Contractor is responsible for the design of items that are detailed on the shop drawings.

Working drawings shall be in the same system of units as the Design.

Working drawings shall be on D size sheets approximately 560 mm (22") by 865 mm (34"), (one drawing per sheet). Lettering for notes and dimensions shall be at least 2.5 mm and 4 mm for headings. Drawings shall be legible when half-sized or microfilmed.

415.04.01 Shop Drawings – Shop drawings shall show all information and details needed for the fabrication of the members including, but not limited to, such items as member shapes and dimensions, mark numbers and general arrangement of member locations, mass, prestressed and non-prestressed reinforcement, embedments, openings, block outs, chamfers, recesses, finishes, concrete mix design, stressing details, special tolerances, special handling instructions, lifting details and lifting locations.

415.04.02 Transportation Details – Transportation details shall include such items as:

- Description of hauling and handling equipment,
- Weight of members,
- Length and height of loads,
- Location and method of member support, and engineering calculations where members are to be supported during transportation further from their ends than outlined in DBSS 415.48,
- Details for handling, storing, and loading of members.

415.04.03 Erection Drawings

Erection drawings shall show in detail the method of erection including, but not limited to, the following:

- Erection procedures
- Procedures for off loading of members upon delivery
- Details for temporary storage and support of members on site prior to erection
- Equipment to be used
- Layout or general arrangement drawing showing the layout of the members, equipment positioning, and access roads
- Crane make, model, and capacity charts, boom length(s), crane placement, and access for transporting of members to crane(s)
- Radii and loads for crane lifts
- Rigging details
- Mass of members, rigging and special installation equipment
- Details for installation and removal of all falsework, temporary supports, temporary bearings, bracing, guys, dead-men, and lifting devices
- Attachments to the bridge members and bridge structure for temporary support and special launching

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- equipment
- Detailed description of sequence of operations
- Details for special installation equipment such as a launching truss, launching nose, head frames, spreader beams and rollers
- Details for installation of members onto the permanent bearings
- Traffic control plan for roadway and rail traffic
- Details for protection of existing utilities affected by the erection procedures
- Layout and detail of fall protection and their sequence of installation.

The Contractor shall be responsible for the lateral stability of members and shall design and provide bracing as necessary until completion of the Work.

The erection drawings shall be complete in detail for all anticipated phases and conditions during erection and during the temporary support of members. The Contractor shall submit calculations upon request, to the Designer and Ministry Representative, that demonstrate that allowable stresses are not exceeded in members, falsework, temporary bracing and temporary supports and that member capacities and final geometry will be correct. The calculations shall be sealed by the professional engineer that sealed the erection drawings.

Falsework, temporary supports and temporary bracing shall meet the requirements of CSA Standard S269.1, "Falsework for Construction Purposes" and shall also meet all the requirements for falsework given in the applicable Clauses of the Workers Compensation Act, Occupational Health and Safety Regulations BC.

A professional engineer registered with APEGBC shall be responsible for any field designs and any changes made to the erection procedures. Field designs and changes to the erection procedures must be documented and sealed by the responsible professional engineer and must be available at the Site prior to the affected erection work being carried out.

Immediately before placement of loading on falsework, the Contractor must ensure that the falsework is inspected and a sealed engineering certificate is issued by a professional engineer registered with APEGBC which:

- Indicates the specific areas inspected, and
- Certifies that the falsework has been erected in accordance with the latest approved erection drawings and supplementary instructions.

Prestressed concrete stringers shall not be set on their bearings, nor shall the bridge deck be cast, until 30 days after the casting of the stringers. If it is necessary to erect the stringers earlier, they shall be placed on temporary

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supports. Prestressed concrete twin cell box stringers up to a maximum length of 20 metres may be shipped and erected after 10 days if the specified 28 day compressive strength has been attained.

415.04.04 Submittals - The Contractor shall submit to the Designer copies of all working drawings. Copies shall also be provided to the Ministry Representative. These drawings shall be submitted at least fourteen days prior to the fabrication of the work. The Designer will review the drawings for general compliance with the Design and the Contract.

If modifications to the drawings are required, the Designer will return one set of drawings, marked up, to the Contractor. The Contractor shall re-submit copies of revised drawings to the Designer for review. Copies shall also be provided to the Ministry Representative.

If no exceptions are taken to the drawings, the Designer will return one set of reviewed drawings to the Contractor. The Contractor shall forward two sets of the reviewed drawings to the Ministry Representative.

Shop drawings will not be reviewed without the transportation and erection drawings applicable to the members in question.

Any work done or materials ordered prior to the review of working drawings shall be at the Contractor's risk. Erection will not be allowed to proceed without the Designer's review of the method proposed.

Review of working drawings shall not relieve the Contractor of any responsibility for dimensions or detail or for carrying out the work in full accordance with the Contract and the Design.

415.05 Alternative Details - All details shall, in general, conform to those shown on the Design. Subject to the Designer's consent and with notification to the Ministry Representative, alternative details may be substituted to facilitate the Contractor's work methods. Such alternative details shall comply in all respects with this specification.

415.06 Quality Control - The Contractor shall implement a quality control program to meet the Contract requirements.

415.07 Quality Assurance and Audit - The Quality Manager will implement a quality assurance program by auditing the Contractor's quality control program and by inspection at its discretion. The Ministry will implement a quality audit program by auditing the quality control and quality assurance programs implemented by the Contractor and by inspection and testing at its discretion.

The Contractor shall notify the Quality Manager and Ministry Representative at least 14 days before fabrication is to commence. The Contractor shall allow the Quality Manager and Ministry Representative access to all parts of work, and shall supply such information and assistance as is required. When the Quality Manager or Ministry Representative requests, the Contractor shall provide samples of any materials. Inspection by the Quality Manager or audit by the Ministry Representative shall not relieve the Contractor from obligation to perform the work in accordance with the Contract and the Design.

Concrete tests shall be in accordance with the current CSA A23.2. The Contractor shall make available at the plant a sheltered, heated space for the casting and storage of test cylinders, with curing tanks and a concrete cylinder testing machine.

The Quality Manager or Ministry Representative may reject any items which, in its opinion, do not comply with the requirements of this specification.

Each unit shall be certified as acceptable by the Quality Manager before it is shipped from the shop. This certification shall not relieve the Contractor of responsibility for subsequent damage or for defects which become apparent before the Work is finally accepted.

MATERIALS

415.11 Materials Supplied by the Contractor

415.11.01 Cement - Portland cement shall conform to the requirements of CAN/CSA-A3001, Cementitious material for use in concrete.

415.11.02 Aggregates - Fine and Coarse Aggregates shall conform to the current CSA A23.1. Coarse aggregates shall not exceed 20 mm nominal size.

415.11.03 Water - Water shall conform to the current CSA A23.1. The mortars and tests shall be made in accordance with the current CSA A23.2.

415.11.04 Reinforcing Steel - Reinforcing steel shall be in accordance with the current CAN/CSA G30.18, G30.3 and G30.5.

All reinforcing shall be of the lengths called for on the Design and all bends shall be made in accordance with DBSS 412.

All bending schedules shall be furnished by the Contractor for the Designer's review and, if requested a copy shall be provided to the Ministry Representative. Any material ordered before such review shall be at the Contractor's risk.

415.11.04 Epoxy-Coated Reinforcing Steel - All reinforcing steel labelled "E" on the drawings shall be epoxy-coated to the requirements of ASTM A 775 M and D 3963M.

415.11.05 Prestressing Steel - Pre-tensioning steel shall consist of seven-wire, uncoated, low relaxation strands and shall comply with the requirements of the current ASTM A 416M.

All strands shall be obtained from one mill, and preferably strands from one heat shall be used. Each reel of strand shall be identified by a secure tag showing the size of strand, CSA or ASTM Designation number, heat number, and name or mark of the manufacturer.

The Contractor shall supply to the Quality Manager and, if requested, to the Ministry Representative, for each heat number, one set of the standard mill test reports. Strands shall be protected at all times to prevent corrosion and shall be dry and clean (free from scale, rust, oil, soap, grease, and other deleterious materials) immediately before the concrete is placed. No strand which has previously been tensioned or gripped by strand chucks shall be incorporated into the members.

415.11.06 Admixtures - Chemical admixtures shall conform to the current ASTM C-494. Air-entraining admixtures shall conform to the current ASTM C-260.

Water reducing admixtures shall be of a lignosulfonic acid or salt, or hydroxylated carboxylic acid or salt.

Type B, Retarding or Type D, Water-Reducing and Retarding (Hydration Stabilizing) Admixtures conforming to the requirements of ASTM C494 shall not be incorporated into the mix design and/or added to the concrete without the acceptance of the Quality Manager and Ministry Representative. When accepted, the guidelines given in DBSS 415.37, DBSS 415.40.01 and DBSS 415.42.01 shall apply.

415.12 Storage of Materials - All materials shall be stored in accordance with the requirements of the current CSA A23.1. Cement shipments shall be used in the order in which they are received.

415.13 Premixed Aggregates - Pre-mixed aggregates in which the fine and coarse aggregates are combined in definite proportions will be permitted provided that the aggregates are delivered in batches directly to the hopper of the concrete mixer. Pre-mixed aggregates shall be transported and delivered in batches, each containing the correct quantity for one batch of concrete. At no time after the fine and coarse aggregates are combined shall any batch

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come in contact with or intermingle with any other batch.

415.14 Forms - All exterior forms shall be of steel and shall be mortar-tight and of sufficient rigidity to prevent distortion due to incidental loadings during construction. Forms for skewed ends may be of rigid steel-reinforced plywood.

Wood forms will be permitted for the side walls of ballast wall pieces and for side walls of the deck panel pieces. Wood formwork shall be designed, supplied and installed in accordance with CAN/CSA-S269.3-M. Wood formwork shall render a true smooth surface free from fins and projections. Only new plywood shall be permitted for plywood formwork.

Forms shall produce 20 mm chamfers and fillets as shown on the Design.

415.15 Ministry's Office - The Contractor shall provide at the point of manufacture a suitable lock-up office for the sole use of the Ministry Representative.

The office shall be weatherproof and reasonably soundproof and provided with ample window area and ventilation. Location of the office shall be acceptable to the Ministry Representative. The office shall measure not less than 3 m x 4 m. In the event that the office is to be used concurrently with other inspection agencies, the minimum area required for Ministry's use shall be 3 m x 4 m. The Contractor shall install satisfactory heat and lights and provide a telephone and a draughting table 1 m x 2.5 m in size with a plywood top, desk 0.75 m x 1 m, two chairs, drafting stool and one square metre of shelves.

Long distance calls made by Ministry personnel will be to the Ministry's account.

The Contractor shall, during the life of the work, regularly clean and properly maintain, heat and light to the office.

The office and contents shall be for the use of the Ministry Representative for the duration of the Work and may, if necessary, be used concurrently with other inspection agencies.

CONSTRUCTION

415.31 Reinforcing Steel - All reinforcing bars shall be accurately placed in the positions shown on the Design and firmly held during placing and setting of the concrete. Tolerances shall be as specified by the current CSA A23.4.

When placed in the work the reinforcing steel shall be free from dirt, rust, loose scale, paint, oil, or other foreign materials. Bars shall be tied at all intersections except that

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where spacing is less than 300 mm, alternate intersections shall be tied. Form clearance shall be maintained by stays, ties, hangers or other approved supports. Before placing concrete, the placing and securing of reinforcing in the forms shall be inspected by the Quality Manager.

All reinforcing shall be placed in the full lengths called for on the Design. Splicing of bars will not be permitted unless acceptable to the Designer. Splices shall be staggered. Unless otherwise shown or called for on the Design, splices shall be made by lapping in accordance with the requirements of DBSS 412. The bars shall be placed so as to maintain the minimum specified clearances between bars and the concrete surface. Welding of reinforcing steel shall be done only if called for on the Design or accepted by the Designer and Ministry Representative.

Tack welding of reinforcing steel, if permitted, shall be in accordance with the current CSA W186-M.

415.32 Stressing - The dials of gauges shall be at least 200 mm in diameter. Gauges shall be calibrated with the hoses and jacks with which they are to be used, by an approved testing agency. The calibration must have been performed within the previous 6 months of use or 12 months maximum. Before stressing commences, certified calibration curves shall be furnished to the Quality Manager and Ministry Representative if requested.

If during the work any gauges give erratic results, the tension system or tension device shall be recalibrated.

The Contractor shall schedule the work so that placement of concrete follows tensioning of strands within 24 hours. In cases of unavoidable delay, a maximum period of 80 hours will be allowed, provided that the strands do not show unacceptable corrosion (see current PCI "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products").

Before tensioning, an initial force shall be applied to each strand to equalize stresses and eliminate slack. This force shall not exceed 22 kN. After the initial tension forces have been applied, each strand shall be marked at the outer end of each chuck as a reference line from which the elongation of the strand can be measured.

The method of tensioning shall be such that the specified tension is maintained in the strands until the forces in the strands are transferred to the concrete member(s). The maximum jacking load in each strand shall be 80% of the ultimate strength of the strand.

A tensioning force shall be determined both by reading the jacking load on the calibrated gauge and by measuring the elongation of the strand. When the difference between the

two methods is greater than 5%, the cause of the discrepancy shall be ascertained and corrected.

Elongations of strands shall be calculated and shown on the working drawings. Calculations for elongations shall include appropriate allowances for possible slippage or relaxation of the anchorages, friction at hold down points, temperature difference, and strand relaxation.

415.33 Forms - The design of the forms shall take into account the effect of vibration of concrete as it is placed.

All exterior forms shall be set and maintained true to the designated lines until the concrete has hardened. When forms are unsatisfactory in any way, either before or during the placing of concrete, the Quality Manager or Ministry Representative may order the work stopped until the defects have been corrected.

The shape, strength, rigidity, mortar-tightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged formwork must be realigned before being re-used. Forms which are unsatisfactory in any respect shall not be reused.

Void forms shall be of an approved product and shall be anchored firmly by a method acceptable to the Quality Manager and Ministry Representative, to prevent displacement during the placing of the concrete. Any member with a void out of position in excess of the specified tolerance will be rejected.

Exterior forms shall be treated in moderation with form oil before placing the concrete. Any material which will adhere to or discolour the concrete shall not be used.

Side forms and any attachments which would obstruct strain of the members shall be removed before transfer of stress.

415.34 Admixtures - The Contractor shall add sufficient air-entraining agent as required by the Design as determined by an air-meter used in accordance with the current CSA A23.2.

The use of other admixtures, such as water-reducing agents or superplasticizer, shall be subject to the acceptance of the Designer and Ministry Representative.

Type B, Retarding or Type D, Water-Reducing and Retarding (Hydration Stabilizing) Admixtures shall not be incorporated into the mix design and/or added to the concrete without the acceptance of the Ministry Representative. When accepted by the Ministry Representative, the guidelines given in DBSS 415.37, DBSS 415.40.01 and DBSS 415.42.01 shall apply.

415.35 Measurement of Materials - Measurement of materials shall conform to the current CSA A23.1. The Contractor shall produce a certificate or report of inspection from a weights and measures approved, independent testing authority, and which is not more than 6 months old. The certificate or report will be accepted as proof of accuracy for the batching equipment. Cement in standard packages need not be weighed.

The surface moisture shall be determined in accordance with the current CSA A23.2 and the batch weights of aggregates and water adjusted accordingly.

415.36 Mix Requirements - Minimum compressive strength at time of transfer of stress to the concrete and at 28 days as determined by the current CSA A23.2 shall be as called for on the Design. In any case, the force in the prestressing tendons shall not be transferred to the concrete until the compressive strength of the concrete is at least 25 MPa for pretensioned components and 20 MPa for post-tensioned components.

Slump measurement shall be determined by the current CSA A23.2. The mix design shall specify the slump and the tolerances in the measured slump shall be ± 20 mm for superplasticized concrete. Slump shall not exceed 200 mm for superplasticized concrete and shall be measured within 5 minutes after discharge from the mixer.

In order to minimize shrinkage and creep the cement/aggregate ratio shall be kept as low as is consistent with strength requirements.

415.37 Batching and Mixing - The batching plant and mixing of concrete shall conform to the current CSA A23.1.

Mixing shall begin within 15 minutes after the cement has been added either to the water or aggregate.

Within 30 minutes after the introduction of the mixing water to the cement and aggregate, or the cement to the aggregate, the concrete shall be placed in its final position in the forms. In hot weather or under other conditions contributing to quick stiffening of the concrete, the Contractor shall modify work procedures as necessary to reduce the time of placement

Time of placement extensions will be considered on a case by case basis and may require the use of Hydration Stabilizing Admixtures (HSA's) conforming to the requirements of ASTM C494 Type B, Retarding or Type D, Water-Reducing and Retarding Admixtures. If accepted by the Ministry Representative, guidelines for the use of HSA's shall be as follows:

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- HSA modified concrete when used shall be fully discharged and placed in its final position within 90 minutes after the introduction of water to the cement and aggregate.
- All concrete in a given precast element shall be placed in its final position before 90 minutes.

When HSA's are used, these time extensions are subject to preconstruction trials being conducted by the Contractor, to establish the appropriate HSA dosage to provide suitable extended slump life of concrete, without increasing the water/cementitious ratio of the concrete above that which would be required if HSA's were not used. The use of HSA's shall in no instance modify the maximum concrete temperature required at time of placement. A one time only addition of HSA will be allowed. This will be during initial batching of the concrete or immediately at completion of batching as recommended by the admixture manufacturer. Addition of HSA at any other time will be cause for rejection of the concrete.

Concrete mixing and transporting equipment shall be capable of placing concrete in the forms at the rate of 20 cubic metres per hour. Batch delivery shall be uniform and at a maximum interval of 10 minutes.

The maximum size of each batch shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer of the mixer.

Concrete when placed in the form shall have a temperature not less than 10°C nor greater than 25°C.

415.38 Handling and Placing Concrete - In preparation for the placing of concrete, all construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces inside the forms shall be kept to a minimum and entirely removed when the concrete placing has reached an elevation rendering their service unnecessary.

Concrete shall be handled and placed in accordance with the requirements of the current CSA A23.1 and shall be placed in the shortest possible time after mixing is completed. When rectangular void forms are used, concrete under voids shall be placed and compacted before void forms are in position.

Concrete may be deposited a maximum of 2 m without the use of pipes, provided, when required, suitable measures are taken to prevent segregation and premature coating of upper reinforcing steel. When pipes are used they shall, as far as practicable, be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete.

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After initial set of the concrete, the forms shall not be jarred and no stress shall be placed on reinforcing bars which project.

415.39 Vibration - Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be accomplished by mechanical vibration subject to the following provisions:

- a) Vibration shall be internal for all accessible parts and shall be external for inaccessible parts.
- b) Vibrators shall be of a type and design acceptable to the Designer and Ministry Representative. They shall be capable of transmitting vibration to the concrete at frequencies recommended in the current CSA A23.1.
- c) The intensity of vibration shall be such as to visibly affect a mass of concrete of 50 mm slump over a radius of at least 500 mm.
- d) The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms.
- e) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcing and embedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted into and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

f) Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

g) Vibration shall be supplemented by such spading as is necessary to ensure a smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

h) Vibrator heads shall be smaller than the minimum clear distance between prestressing strands.

415.40 Test Cylinders - The Contractor shall make available, as may be required by the Quality Manager or Ministry Representative, samples of the concrete to be used in casting the members.

Further, the Contractor shall take samples and make test cylinders in the presence of the Quality Manager and Ministry Representative and in accordance with the current CSA A23.2-1C, -3C and -9C. At least 8 cylinders per casting bed shall be made for testing.

415.40.01 Release Strength - Two cylinders from each end of the casting bed shall be cured in the same manner as the members and tested by the Contractor under the discretionary observation of the Quality Manager or Ministry Representative (QM or MR) at the Contractor's plant to assess the strength of the concrete at the time of transfer of force to the concrete. Only one cylinder from each end need be tested if the average strength of the two cylinders is equal to or greater than the required release strength at transfer and no test cylinder is more than 1.4 MPa below the release strength. No transfer of force shall occur without the acceptance of the Quality Manager.

If all release cylinders are tested and the release strength has not been attained, further testing with an impact hammer shall be allowed, provided a written procedure acceptable to the Designer and Ministry Representative is provided by the Contractor. The procedure shall correlate readings from areas of a prestressed girder where the release strength has been determined by concrete test cylinders with similar areas on the girder in question. If this situation occurs, extra pairs of release cylinders shall be made on future casts until confidence in determining the release strength is re-established.

When HSA's are incorporated into the mix design, pre-construction tests shall be conducted to determine the rate of early strength development for the selected concrete mix design. Tests shall be repeated when there is a change in the HSA dosage rate.

415.40.02 28 Day Strength - Two cylinders from each end of the casting bed shall be identified as "acceptance cylinders" and shall be cured in the Contractor's curing tanks. These cylinders shall be tested by the Contractor under the discretionary observation of the Quality Manager or Ministry Representative to determine the twenty-eight day strengths. The strength of the concrete in the member shall be taken as the average of the compressive strength of the "acceptance cylinders", however, no individual cylinder shall be more than 3.5 MPa below the specified strength and the average strength shall equal or exceed the 28 day strength.

415.40.03 Additional Cylinders - For special cases, extra

cylinders shall be made and tested if required by the Quality Manager or Ministry Representative. In the case of ready mix, and plant mixed concrete with no established records, extra cylinders, in addition to the release strength or 28 day strength cylinders, shall be made from each load.

415.41 Surface Finish - Throughout the work, special precautions shall be employed in formwork and concrete placing to produce a smooth and dense concrete. Exposed surfaces shall be as free as possible from form marks, fins, honey-combing and pock marking. Only a minimum amount of pointing will be allowed. Poor surface finish upon the removal of the forms shall be sufficient cause for the rejection of any member. All exposed edges shall be chamfered unless otherwise noted on the Design.

Roadway and surfaces to be bonded to shall be rough screeded by wood floating following initial strike off. Surfaces to be bonded to shall be sandblasted or exposed with chemical retarder and water blasted to remove all laitance and foreign matter and to roughen the surface. The amplitude of the surface roughness shall be equal to one third of the nominal size of the concrete coarse aggregate or 6 mm, whichever is less. Loose sand and debris shall be washed or blown off. Water, cement or proprietary topping material shall not be added to the surface during finishing.

Walkway surfaces shall be given a coarse transverse broomed finish following initial screeding and floating. Roadway surfaces not requiring any wearing surface shall be given a tined surface in accordance with DBSS 413.31.02.05. Roadways receiving a membrane shall be finished in accordance with DBSS 419.33.

The outer surfaces of the outside stringers and any other surfaces indicated on the Design shall be given a Class 2 finish in accordance with DBSS 211.17.

415.42 Curing - Members may be cured by steam or heat as outlined herein.

415.42.01 Steam Curing: The concrete shall be allowed to attain its initial set before application of steam (generally 2 to 4 hours after the final placement of concrete or as justified by previous experience and acceptable to the Quality Manager and Ministry Representative).

If HSA's are used in the mix design, time to attain initial set after concrete has been placed may exceed that required for conventional concrete. The concrete shall have attained initial set before the application of steam.

After the placement of concrete, sufficient steam shall be applied during initial curing to hold the air surrounding the member at a temperature not less than 13°C.

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Steam curing shall be done within a suitable enclosure to contain the steam and minimize moisture and heat losses. The enclosure shall allow free circulation of steam around the sides and tops of members and shall not be in contact with the member.

Steam at the outlets shall be at 100% relative humidity and low pressure. Application of the steam shall not be directly on the concrete or test cylinders and shall be from outlets distributed uniformly along the whole length of the member.

During application of the steam the ambient air temperature shall increase at a rate not to exceed 22°C per hour until an optimum temperature of 55°C is reached. In no case shall the ambient curing temperature exceed 80°C. The maximum temperature shall be held until the concrete has reached the transfer strength. In discontinuing the steam, the ambient air temperature shall not decrease at a rate greater than 33°C per hour until a temperature has been reached about 11°C above the temperature of the air to which the concrete will be exposed. The forms shall not be stripped until the completion of this cooling off period.

Provision shall be made for checking the ambient air temperature either by placing minimum-maximum thermometers under the enclosure or periodically checking with hand thermometers.

415.42.02 Curing With Radiant Heat and Moisture - Curing with radiant heat and moisture shall be done by heating the casting area in combination with the continuous application of moisture.

Heat shall be applied by means of pipes circulating steam, hot oil or hot water or by electric heating elements. Pipes shall not be in contact with concrete, form surfaces or test cylinders.

Moisture shall be applied by a continuous sprinkling to a cover of burlap or cotton matting or any other approved method for keeping the members continuously moist.

An auxiliary cover in addition to the moisture retaining cover shall be used above the entire bed to retain the heat. This cover shall be supported at a sufficient distance above the member to allow circulation of the heat.

The cycle of application of heat, temperature limitations, reduction of temperatures and use of recording thermometers shall be similar to the cycle specified for steam curing.

415.43 Draped Strands - Where called for on the Design, strands shall be draped in accordance with the current CSA A23.4.

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415.44 Transfer of Force to Concrete Members - The transfer of the forces in the strands to the concrete member(s) shall be in accordance with the current CSA A23.4 (section on Detensioning).

415.45 Protective Coating for Ends of Strands - After completion of concrete curing the ends of tensile strands shall be ground flush with the concrete surface. Where the ends of the members are to be embedded in concrete, the ends of the strands shall be painted with two coats of an organic zinc rich paint acceptable to the Designer and Ministry Representative. Where the ends of the members are not to be embedded in concrete, the ends of the members shall be covered with thixotropic epoxy to provide at least 3 mm cover for a band width of 50 mm on each side of all strands. This material is to be applied in accordance with the manufacturer's recommendations.

415.46 Tolerances - For bridge stringers, the tolerances specified in the PCI "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products 1999" shall be modified so that the length of each member, measured parallel to the longitudinal axis, to extreme corners, at 20°C, does not exceed the specified length by more than 10 mm / 10 m (25 mm maximum).

The Contractor shall employ an adequate method of checking tolerances both before and after placement of concrete. Review of the method of checking tolerances by the Quality Manager and Ministry Representative will not limit the Contractor's responsibility for the accuracy of the members.

415.47 Repairs to Members - Defective areas should be repaired immediately following removal of forms and before detensioning of strands. Holes, honeycomb spots, etc., shall be treated as for Class 2 finish in accordance with DBSS 211.17. The method of repair for cracks, broken corners and edges, bulges and other defects shall be submitted to the Designer and Ministry Representative for review.

415.48 Handling, Storing and Loading of Members - Stringers shall at all times be kept in their normal upright position during handling, storage and transportation. They shall be picked up by means of vertical forces or forces inclined towards the opposite ends of the members by no more than 30° from the vertical, applied to lifting devices near the ends of the stringers. I-beams shall be adequately stiffened during lifting and transportation.

Stored stringers shall rest on unyielding level supports near the ends of the stringers.

When loaded for transportation, members shall be supported so that they will not be overstressed. In general, beams with straight strands may be supported up to one-tenth of their

lengths from each end, whereas beams with draped strands should be supported at their bearings. If the Contractor believes that it is possible to safely support members further from their ends, the Contractor shall submit to the Designer and Ministry Representative, sketch(es), sealed by a registered professional engineer, showing the proposed support arrangement. Adequacy of support shall be based on the following assumptions:

- 100% impact on cantilevering ends, when checking stresses at supports,
- 50% negative impact on the whole member, when checking stress near midspan,
- 50% of prestress losses at time of shipping (unless circumstances dictate otherwise),
- allowable tensile stress = $0.5\sqrt{f_c}$
- allowable compressive stress = $0.6f_c$
- where f_c = estimated strength of concrete at time of shipping.

Such sketch(es) shall be submitted at the time of submittal of the working drawings (see DBSS 415.04). Members transported on supports further from their ends than outlined above, without the submittal of sketch(es) acceptable to the Designer and Ministry Representative, will be rejected.

Piles shall be lifted in the horizontal position at the pick-up positions shown on the drawings and at no other points. When stacking for storage or for delivery, piles shall be supported at the pick up points. They shall be handled carefully, avoiding dropping and jarring and avoiding surface abrasions or other damage.

Any member damaged so as to be, in the opinion of the Designer or Ministry Representative, unfit for the use for which it is intended shall be replaced.

415.49 Placement of Concrete in Keyways - Keyways between box stringers shall be clean and shall be saturated surface dry surfaces, before being filled with concrete.

Concrete in keyways shall attain a strength of at least 15 MPa before light traffic such as one-tonne trucks are allowed on the bridge, and at least 25 MPa before heavy loads such as concrete trucks are allowed on the bridge.

415.50 Post-Tensioning - All post-tensioning shall be done in accordance with the DBSS 416 - "Manufacture and Installation of Post-Tensioned Concrete Members".

QUALITY CONTROL PROGRAM

415.61 Quality Control Program – These Subsections describe the general Quality Control Program required for any Fabricator undertaking the fabrication of permanent precast concrete structural components. The Quality Control

Program shall be part of the overall Quality Management Plan for the project.

The term "Quality Control" defines those activities that the Fabricator performs to conform to the Contract.

The term "Quality Assurance" defines those activities that the Quality Manager performs to ensure conformance to the Contract.

The term "Quality Audit" defines those activities that the Ministry performs to provide confidence that the QC and QA processes and resulting products satisfy the Contract.

These Subsections contain statements of the Quality Objectives and Policies that the Ministry considers essential for successful and economical quality management. They also outline the Procedures and Documentation to implement and confirm that the Objectives are met.

The provisions of the Quality Control Program set forth in these Subsections shall apply to all precast concrete structural components.

These Subsections require the establishment of a Quality Management Team with the responsibility for the successful and timely implementation of all necessary Quality Control and Quality Assurance activities. Some positions shown in the Suggested Organization Chart (see Figure 1) may be held by the same individual. For example, the General Manager may also be the Contract Administrative Manager and the Purchasing Manager. The Plant Superintendent may also be the Receiver and the Structural Supervisor.

415.62 Quality Objectives and Policies

415.62.01 Quality Objectives - The Quality Objectives of the Ministry of Transportation cover all precast concrete structural components produced under the Contract, as follows:

- a) Completed products shall conform fully to the governing Codes and Specifications stipulated in the Design and the Contract.
- b) The Quality Control Program shall be fully integrated into the ongoing manufacturing activities of the Fabricator.

415.62.02 Quality Policy - It is Ministry policy that the interests of the Contractor and the Ministry coincide when a product meets the Quality requirements of the Contract and is delivered on time.

The Quality Control Program is an essential part of this policy. It is based on the fact that the best way to do any job is to do it right the first time. This applies to all stages of the

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design, drafting, procurement, manufacturing and testing of the product.

The Quality Control Program involves the Quality Manager, Ministry Representative and Fabricator personnel. Their activities must be consistent with the Quality Objectives of the Ministry.

A Fabricator's Quality Control Manager shall be appointed with defined responsibilities in resolving quality matters and shall report to a senior management level. At each hold point, the Fabricator's Quality Control Manager shall:

- Document the successful completion of each stage as it progresses through fabrication and erection.
- Identify and report nonconforming components.
- Initiate or recommend disposition of nonconforming components.
- Verify corrections.

Any persons assigned to perform quality control inspections shall be other than those performing or directly supervising the work and they shall not report directly to immediate supervisors responsible for producing the work.

The Fabricator's Quality Control Program is not subordinate to any design, drafting, procurement, manufacturing and testing activities, it is an essential part of them.

415.63 Scope of the Quality Control Programs - This Quality Control Program governs the fabrication of precast concrete structural components for the Work. The Suggested Organization Chart is shown in Figure 1

The Fabricator's General Manager shall be responsible for:

- adhering to this Quality Control Program in all respects.
- ensuring that completed structural components shall conform fully to the Design and fabrication requirements stipulated in the Contract.
- ensuring that all required documentation is produced according to this Quality Control Program.

415.64 Range of Capability - Within the Company, there shall be the necessary knowledge, skill (in-house or on a contract basis) and equipment to do the following work on precast concrete structural components:

- Design of lifting and erection devices not shown on drawings
- Preparation of shop fabrication drawings
- Preparation of bills of material
- Preparation of material requisitions and purchase orders
- Receiving, checking and storing materials for bridges
- Layout, form set-up, reinforcing steel, prestressing and post-tensioning

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- Mix designs, batching, mixing, placing and curing of concrete
- Sampling, testing, making and breaking of concrete test cylinders
- Dimensional checking and verification
- Resolution of non-conformances
- Documentation of all stages of work with capability of tracing all major components
- Finishing, patching, storing and shipping
- Erection of structural components

415.65 Drawings and Specifications – The Fabricator's Chief Design Engineer shall be responsible for:

- the design and location of lifthooks and the preparation of stressing sheets for prestressing or post-tensioning; and for the design of the erection procedures and any special erection equipment needed.

The Fabricator's Chief Draftsperson shall be responsible for:

- obtaining the latest revision of the Design and specifications for the work.
- submitting shop drawings and erection drawings to the Designer for acceptance before commencement of the work.
- preparing material requisitions containing a full description of the material sizes, material specifications, and certifications required for conformance to the contract.
- delivering the material requisitions to the Fabricator's Purchasing Manager in ample time to permit ordering, delivery and documentation and not delay the progress of the work.
- issuing requisitions for all sub-contracted drafting work and shall ensure that all conditions of the Contract are part of such sub-contracts.

415.66 Material Control - All materials for structural components shall be ordered by the Fabricator's Purchasing Manager in full conformance with the material requisitions provided by the Fabricator's Chief Draftsperson.

The Purchase Orders shall contain all information necessary to ensure that materials purchased will comply fully with the terms of the Contract. Where mill certificates and test reports are required, it shall be so stated on the Purchase Order. Instructions shall state when the certificates and reports are to be delivered to the Fabricator.

If a supplier proposes a substitute for any material, the Fabricator's Purchasing Manager shall refer the proposed substitution to the Fabricator's Chief Design Engineer for review. If the substitute is acceptable to the Designer and the Ministry Representative, the Fabricator's Chief Draftsperson shall amend all drawings and requisitions,

withdraw old issues and issue the new versions.

The Fabricator's Receiver shall:

- inspect all materials on arrival for conformance with the Purchase Orders.
- confirm that mill certificates and test reports are provided and that they correctly identify the materials delivered.
- arrange with the Fabricator's Plant Superintendent to store all materials for the Contract in segregated areas.
- ensure all materials are clearly identified with the Contract.
- issue a non-conformance report covering overage, shortage or damage to the materials. Copies of the report shall be provided to the Fabricator's Purchasing Manager and the Fabricator's Quality Control Manager.

The Fabricator's Purchasing Manager shall deliver all documentation to the Fabricator's Quality Control Manager for inclusion in the Fabricator's Quality Control file for the Contract.

415.67 Pre-Pour Inspection and Reporting - The Fabricator's Quality Control Manager shall ensure only documented materials are used for the contract.

Forms used in the casting of members shall be inspected prior to use and shall meet all the requirements of the current CSA-A23.4 and the Design.

Reinforcement shall be fabricated and placed to satisfy the current CSA-A23.4 and the detailed shop drawings for quantity and spacing. Any reinforcement used to anchor cast in hardware by being welded to it will require the Fabricator to be certified to CSA W186-M.

All cast in hardware shall be fabricated and placed according to the current CSA-A23.4. Any hardware requiring welding, including stud welding, will require the fabricator to be certified under CSA W47.1 Division 3 and have approved procedures for each weld.

All pre-tensioning operations shall be done according to the current CSA-A23.4. Care shall be taken to properly execute, supervise and record the operations in a clear and legible manner.

The Fabricator's Quality Control Manager shall file a written report of verification with the Fabricator's General Manager and report any non-conformance that may exist on any of the above items in DBSS 415.67.

415.68 Concrete Control - All materials used in concrete mixes such as cement, fine and coarse aggregates, and

admixtures, shall have representative certificates that can verify the quality of them.

Production of concrete shall be done according to the Contract and the Design specifications. Records shall be kept of the mix type and quantity used in each pour.

Handling, placing and vibration of freshly mixed concrete shall be done as per the Contract and the Design specifications. Any variations and interruptions in the process shall be recorded.

The sampling and testing of freshly mixed concrete shall be in accordance with the Contract and the Design specifications and procedures laid out in the current CSA-A23.2. Concrete test cylinders shall be made, cured and tested in accordance with the Contract and the Design specifications.

Reports for all concrete testing shall be kept on file and all non-conformities reported.

415.69 Post Pour Inspection and Reporting - Dimensions of all members shall be verified to ensure tolerances are being maintained as per the Contract and Design specifications.

Verification shall be made of finishes, blockouts, keyways, projecting rebar, sole plates and protection of the cut off strands.

Camber shall be monitored at release and 28 days.

Members shall be stored according to the fabricator's documented procedures.

Members shall only be allowed to be shipped out for erection after they have been approved by both Quality Control and Quality Assurance.

Records shall be kept on file for all items in this section.

415.70 Correction of Non-Conformities - When a non-conformance is encountered, the Fabricator's Quality Control Manager shall determine a recommended disposition and submit such disposition to the Quality Manager and Ministry Representative for acceptance as quickly as possible.

If there is non-conformance to the material specification stipulated in the Purchase Order, the Fabricator's Purchasing Manager shall immediately find out the reasons for the delivery of non-conforming materials. If the material is of a grade superior to that ordered, the Fabricator's Quality Control Manager and the Fabricator's Chief Engineer shall be notified. They shall verify that the material is an

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acceptable alternative in all respects. This verification shall include consultation with the Quality Manager and Ministry Representative. If the material is of a grade inferior to that ordered, it shall be rejected and the correct material or a superior material shall be obtained.

If there is non-conformance of material delivery that will delay production, the Fabricator's Contract Administrative Manager and the Fabricator's Plant Superintendent shall be notified immediately. They shall be given revised delivery dates for the adjustment of production scheduling. The Fabricator's General Manager shall determine the alternatives available and shall notify the Quality Manager and the Ministry Representative.

If there are pre-pour non-conformities in form set-up, prestressing, rebar placement, hardware and blockout size and location, the Fabricator's Quality Control Manager and the Fabricator's Structural Supervisor shall immediately review the non-conformance and notify the Fabricator's Chief Design Engineer who may require further investigation prior to submitting corrective action to the Quality Manager and the Ministry Representative for acceptance. If the necessary corrective action will result in delay to production, the Fabricator's General Manager shall be notified for adjustment to the production schedule. The Fabricator's Plant Superintendent shall inform the Fabricator's Quality Control Manager when the corrective actions are being done so that conformance can be verified and the non-conformance report cancelled.

If there are post-pour non-conformities such as honeycombs or large voids after form removal, before de-tensioning the Fabricator's Quality Control Manager shall notify the Fabricator's Chief Design Engineer who will investigate and submit corrective action to the Quality Manager and Ministry Representative for acceptance. Other non-conformities such as low concrete strength, dimensional errors due to faulty forms, variations in camber from design and missing hardware shall all be reported by the Fabricator's Quality Control Manager.

415.71 Welding - All welding on structural components shall conform to the Welding Standards of the Fabricator as Approved by the Canadian Welding Bureau.

All welding consumables shall conform to the Approved Welding Standards and shall be received, stored and conditioned according to the applicable Welding Standards.

All welders and welding operators on the Contract shall be qualified under the requirements of the current CSA W47.1 division 3 or better.

All welding of reinforcing steel, when acceptable to the Designer and Ministry Representative, shall be done by

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fabricators certified under CSA W186.

415.72 Calibration of Measurement and Test

Equipment - All measurement and testing equipment owned by the Fabricator and used in the Quality Control Program shall be calibrated and re-calibrated at the intervals and in the manner stipulated in the current CSA-A23.4.

When the concrete testing services are contracted to a testing firm, then the testing firm shall meet the requirements of the latest edition of CSA A283. The testing firm shall confirm in writing to the Quality Manager and, if requested, to the Ministry Representative that all their measurement and test equipment used in the testing is properly calibrated. If requested, they shall furnish copies of the calibration test data for inclusion in the contract documentation.

415.73 Records Retention - The Fabricator's Record File shall contain the pertinent drawings, purchase orders, bills of material, material mill certificates, test reports, Quality Control documents, and certificates of compliance.

The Fabricator's Record File shall be made available to the Quality Manager and Ministry Representative upon request.

Items in the Fabricator's Record File shall be retained as per company policy.

The Quality Control Manager shall ensure that each file is complete in all respects before it is placed in the Company archives.

415.74 Hold Points - In planning the work flow, it is essential to coordinate with the Quality Manager and Ministry Representative to decide "hold" points for inspection. A list of hold points shall be drawn up by the Fabricator, Quality Manager and the Ministry Representative at a prefabrication meeting. The Quality Manager and Ministry Representative should be continuously informed of progress so that delays are minimized.

The "hold" points will typically include, but not be limited to, the following:

- verification of form size, quality and layout
- after stressing, rebar and hardware placement
- prior to form close up
- sampling and testing of concrete
- release cylinders
- after patching and finishing
- 28 day cylinder results
- shipping arrangements.

It must be understood that work will not proceed past a

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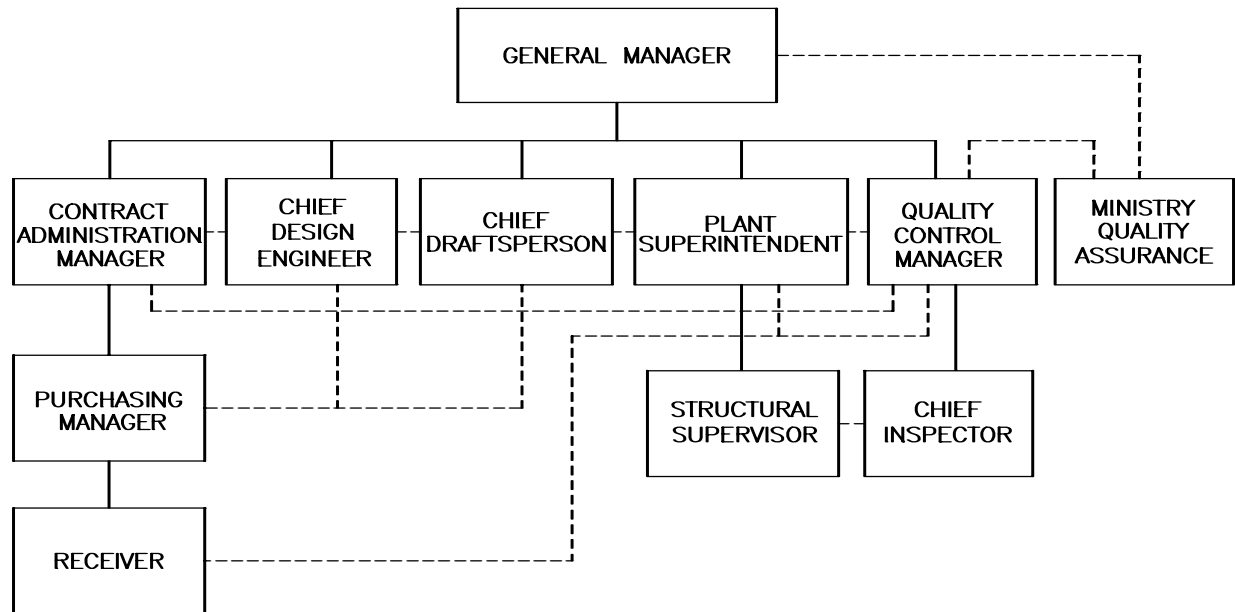
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"hold" point until it has been signed off by Quality Control and Quality Assurance. Reports must be completed promptly.

(Refer to the current edition of the PCI Manual - Publication MNL-116 for "Sample Record Forms")

Figure 1

SUGGESTED ORGANIZATION CHART



Direct Functional Reporting _____

Quality Control Reporting -----

Signed _____
General Manager

Date _____

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MANUFACTURE AND INSTALLATION OF POST-TENSIONED CONCRETE MEMBERS

DESCRIPTION

416.01 Scope – This Section covers the manufacture and installation of post-tensioned concrete members.

416.02 General Requirements

416.02.01 The requirements of CAN/CSA-S6-00 and DBSS 415 shall apply unless specified otherwise herein or in the Contract.

For items not covered in CAN/CSA-S6-00, DBSS 415 or the Contract, then CSA A23.1, Subsection 6.8, shall apply.

416.02.02 Three weeks before post-tensioning, the Contractor shall submit to the Designer and Ministry Representative for review, complete details of the proposed procedure, including jacking sequence and loads, procedure for testing grout cubes, and a list of equipment. This procedure shall be prepared and sealed by a professional engineer registered with the APEGBC.

MATERIALS

416.11 Anchorages - Anchorages tested in an unbonded state shall develop at least 95% of the minimum specified ultimate strength of the prestressing tendons, without exceeding anticipated set and without slippage. Test results or certificates meeting these requirements shall be supplied by the Contractor.

Anchorages shall be able to sustain the loads applied to them without slippage, distortion or other changes that will permit loss of prestress.

The anchorages shall be of such a nature that they will not kink, neck down or otherwise damage the prestressing steel.

416.12 Ducts - The ducts shall be provided with vents at all high points and at the anchorages, so as to facilitate grouting. Drains may be provided at low points. In any case, in cold weather, care shall be taken to prevent water from collecting and freezing in the ducts. The locations of the vents and drains shall be as shown on the Design.

Cored and external ducts shall be watertight when tested under an internal water pressure of 0.35 MPa.

The vents and drains shall be 13 mm minimum diameter flexible tubes. The connections to the ducts shall be made with metallic structural fasteners.

416.12.01 Internal Tendons - The sheaths for post-tensioning ducts shall be made of galvanized steel or plastic. Galvanizing shall meet the requirements of CAN/CSA G164-M. Plastic sheaths shall meet the requirements of DBSS 416.12.02. The sheaths shall be corrugated, and chemically non-reactive with concrete,

tendons, or grout. The inside cross-sectional area of the sheaths shall be at least two times the area of the prestressing steel.

Rigid steel sheaths shall have a wall thickness of at least 0.60 mm and shall be capable of bending to an inside radius of 9 m without distress. Semi-rigid steel sheaths shall have a wall thickness of at least 0.25 mm and shall be capable of bending to an inside radius of 3.50 m without distress.

The ducts shall be spliced with telescopic sleeves. The joint lines between the ducts and the sleeves shall be wrapped with tape or heat-shrink material to make the connections mortar-tight.

416.12.02 External Tendons - Unless otherwise specified, sheaths for external post-tensioning shall be made of plastic. Plastic sheaths, including their splices shall be made of high density polyethylene conforming to ASTM Standard D 3350, cell classification 334420C. The polyethylene sheath shall be manufactured in accordance with ASTM Standard D 2239.

Plastic sheaths shall not be used when the radius of curvature of the tendon is less than 10 m. Sheaths and their splices for external posttensioning shall be smooth, seamless and capable of withstanding a grouting pressure of at least 1 MPa.

416.13 Condition - Tendons, ducts, anchor assemblies and other accessories shall be free of grease, oil and other foreign matter. A light coat of rust will be permissible provided any loose rust is removed and the surface of the steel is not pitted.

416.14 Epoxy - Epoxy applied to match-cast segment ends shall be as specified by AASHTO Standard Specifications for Highway Bridges (2002), 17th Edition, Division II, Section 8.13.7.

416.15 Grout - Cement, water and admixtures for grout shall conform to the requirements of CSA Standard A23.1, Clause 4.2. Unless otherwise specified, grout for post-tensioning shall have a compressive strength of at least 20 MPa at 7 days and 35 MPa at 28 days. The Contractor shall propose a design mix for the grout and submit it for review by the Designer and Ministry Representative before grouting may begin.

The Contractor shall supply all materials for the grout.

The grout shall have a maximum water/cement ratio of 0.45. The grout shall consist of a mixture of Type GU (general use) cement, water and an approved admixture to control expansion and pumpability. The admixture shall be an aluminum powder base premixed material. Type HE (high early strength) cement may be substituted for Type GU

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during low temperature periods. The Contractor shall determine the dosage of the admixture by using volume change and bleeding tests conducted before grouting commences. The Contractor shall make test grout cubes and deliver them to a testing agency acceptable to the Quality Manager and Ministry Representative.

EQUIPMENT

416.21 Stressing Equipment

416.21.01 Supervision - The Contractor shall provide a supervisor skilled in the use of the system of post-tensioning to be used.

416.21.02 Gauges and Calibration - The tensioning system shall be equipped with gauges that have been calibrated for the specific jacks and controls by an approved testing agency within the last 6 months. The dials of the gauges shall be at least 150 mm in diameter. Before stressing commences, certified calibration curves shall be furnished by the Contractor.

The tensioning system or tensioning devices shall be recalibrated if during the work any gauges give erratic results.

416.22 Grout - The grout shall be mixed in a shear type mixer with sufficient capacity to guarantee a continuous supply of grout to the pump. The accessory equipment to batch all materials shall accurately measure all materials.

The pump shall be a positive-displacement type and shall produce an outlet pressure of at least 1 MPa. The pump shall have seals to prevent introduction of oil, air or other foreign substance into the grout and to prevent loss of grout.

The grouting equipment shall utilize gravity feed to the pump inlet from a hopper attached to and directly over it. The hopper must be kept partially full of grout to prevent air from being drawn into the ducts.

The grouting equipment shall contain a screen having clear openings of 2.5 mm maximum to screen the grout prior to its introduction into the grout pump. A screen opening of 5 mm is satisfactory if a grout with a thixotropic additive is used. This screen shall be readily accessible for inspection and cleaning.

The Contractor shall have on site a pressure gauge with a full-scale of no greater than 2 MPa. The Designer and/or Ministry Representative may request the Contractor to install the gauge in the grout line between the pump outlet and the duct inlets to confirm pumping pressures.

The grouting equipment shall be capable of continuously grouting the largest tendon on the project in 20 minutes.

CONSTRUCTION

416.31 Anchorages - The spacing between anchorages

shall be sufficient to allow the operation of the stressing jacks to be unimpeded by the adjacent tendons.

The axis of the tendons shall be in line with the anchorages for a minimum of 400 mm.

The load from the anchoring devices shall be effectively distributed to the concrete.

Anchorages shall be rigidly held in position when the concrete in the section is placed. Anchorages shall hold the tensioned tendons without slip of more than 6 mm; otherwise detensioning will be required.

416.32 Ducts - Vents and drains in the ducts shall be mortar-tight, taped as necessary and shall provide means for injection of grout and for sealing. The ends of vents and drains shall be removed 25 mm below the concrete surfaces after grouting has been completed. If drains are used, they shall be vented downward and shall remain open until grouting commences to permit the removal of any water that may be present in the duct.

416.33 Placement and Protection of the Tendons and Other Accessories - The plan and profile location of the ducts shall be as shown on Design. Ducts shall be securely held at intervals of 1000 mm or less to prevent displacement or flotation during the placement of concrete. They shall be placed with a tolerance of ± 6 mm in both the vertical and the horizontal directions. The location of the ducts shall permit the post-tensioning steel to follow the prescribed profiles.

The anchorage assemblies shall be placed so that the bearing surfaces are concentric with and perpendicular to the tendons within $\pm 1^\circ$.

Immediately before concrete is placed, the post-tensioning steel profile and alignment shall be checked and corrected where necessary. The ducts, grout fittings, vents and drains shall be inspected and damage shall be repaired to prevent concrete from leaking into the ducts.

The grout fittings and the ducts shall be adequately protected from collapse and other damage. Grout openings, vents and drains must be securely anchored to prevent displacement during concrete placing operations.

The ends of the ducts shall be covered to prevent the entry of water or debris after the installation in the forms.

The ducts shall be blown out with compressed, oil-free air immediately after the completion of the concrete pour. The compressed air shall be used to the extent necessary to break up and remove any mortar in the ducts before it hardens. The ducts shall be blown out clear of any water or debris again prior to the placing of the tendons.

Duct ends at match-cast segment ends shall be fitted with gaskets or other sealing devices to prevent infiltration of epoxy during assembly. A uniform pressure of approximately 0.3 MPa shall be applied to the joint during

the epoxy curing period. The pressure may be supplied by stressing a cable to a predetermined level, or by other means.

Segmental section joints of 10 mm to 70 mm wide shall be filled with a sand-cement mortar. Joints over 70 mm wide shall be filled with concrete. The strength of the mortar or concrete used in joints shall be at least equal to the parent concrete. The Contractor shall colour the mortar or concrete to match the parent concrete. The Contractor shall submit a trial mix with a proportion of white Portland cement, if requested, to the Quality Manager and Ministry Representative for review.

All post-tensioning steel shall be installed in the ducts prior to the concreting of the cast-in-place elements.

The concrete shall be vibrated with particular care at each cast-in-place end block (push-through diaphragm) and post-tensioning anchorage location. This will ensure adequate consolidation in the anchorage zones.

The prestressing steel in each tendon shall be pulled immediately after concreting, to ensure that it is free to move and is not bonded by concrete or grout leakage.

416.34 Stressing - The structure shall be stressed only after the concrete has reached its transfer strength as shown on the Design. No tendons shall be stressed until authorized by the Designer and Ministry Representative.

Tendons shall be stressed from the end as shown on the Design.

The supports under the segmental sections shall be able to accommodate horizontal movements caused by the stressing.

The multiple strands composing a tendon in a common duct shall be tensioned simultaneously. Tendons shall be tensioned in sequence as specified in the reviewed procedure. The tendon force at lock-off shall be as shown in the procedure.

Before commencing the stressing operation an initial tensioning force shall be applied to each tendon to equalize stresses and to eliminate slack. This force shall not exceed 10% of maximum jacking force.

After the initial tension forces have been applied, reference points shall be established for each tendon from which elongation by final tensioning forces will be measured.

The specified tensioning force shall be maintained steady in the strands until they are anchored. The sequence of tensioning shall be such that no undue tension stresses occur in the concrete near the ends of the members.

The tensioning force shall be determined by the calibrated gauge and by the elongation of the strands. When there is a difference of over 5% between the two means of calculation, the cause of the discrepancy shall be ascertained and corrected.

Tendons shall not be subjected to jacking forces in excess of 85% of their specified ultimate tensile strength. Any tendon subjected to such forces will be rejected.

The required tendon elongation and jacking force shall be computed, based on the required prestressing force and the estimated prestress losses.

The safety of the stressing procedure shall be in accordance with Workers Compensation Act, Occupational Health and Safety Regulations, BC.

Stressing records shall be kept by the Contractor. Stressing records shall clearly identify the tendons that were stressed, the sequence, the final jacking loads, the tendon elongations, the times, the temperatures and the dates. Stressing records shall be signed by the person supervising the stressing and submitted to the Quality Manager and if requested, the Ministry Representative.

416.35 Grouting - The temperature of grout shall be controlled by water temperature. Grout shall not be warmer than 30°C or colder than 5°C at the pump. The grout shall be mixed for a minimum of 2 minutes. The materials shall be charged in this order: water, cement and admixture. The admixture shall be added in accordance with the manufacturer's instructions.

The grout shall be mixed to a uniform consistency of thick cream without lumps or undispersed cement. The grout shall be agitated continuously and shall be recirculated when not injecting from the line.

Water shall not be added to the grout to increase the flowability that was decreased by delayed use of the grout. The grout shall be discarded when flowability has so decreased it cannot be pumped satisfactorily.

The time between the tensioning and grouting of a tendon shall not exceed 4 days.

Cored ducts with concrete walls shall be flushed with clean water to ensure that concrete is thoroughly wetted prior to grout injection. The ducts for external tendons shall be checked for leakage and blockage by flushing with clean water under pressure followed by oil-free compressed air immediately prior to grouting. Metal sheaths for internal ducts shall be flushed to clean out foreign materials, or oil free compressed air shall be used to check for blockages.

All grout and high point vent openings shall be open when grouting starts. Grout shall be allowed to flow from the first vent until any residual flushing water or entrapped air has been removed. The vent shall be capped or otherwise closed at that time. The remaining vents shall be closed in sequence in the same manner.

The pumping pressure at the tendon inlets shall be at least 0.7 MPa and shall not exceed 1.5 MPa.

If the pumping pressure exceeds the maximum allowable,

grout may be injected at any grouted vent, as long as a one-way flow of grout is maintained. If this procedure is used the vents that are to be used for injection shall be fitted with positive shutoffs.

The grout shall be pumped through the ducts and continuously wasted at the outlet pipes until no visible slugs of water or air are ejected. The efflux rate of the ejected grout shall not be less than the influx rate of the injected grout.

To ensure that the tendons remain filled with grout, the outlets shall be closed and the pressure held for 10 seconds. The grouting ends shall then be plugged. Plugs, caps or valves shall not be removed or opened until the grout has set. Alternatively, the outlets and inlets shall be kept under a 1000 mm head of hydrostatic pressure. The 1000 mm grout head shall be maintained until the grout has hardened.

The grout shall be immediately flushed out of the ducts with water when one-way flow of grout cannot be maintained. Standby water flushing equipment, with its own source of power, shall be available in addition to the grouting equipment. It shall be capable of developing a pressure of 2 MPa, and sufficient capacity to flush out any partially grouted enclosures. After flushing, the ducts shall be blown out with oil-free compressed air and then checked for blockages. The grouting procedure shall be repeated if there are no blockages.

The ducts shall be completely filled with grout. The presence of ungrouted lengths of duct shall be cause for nonacceptance of the members. Members with partially ungrouted duct(s) shall be replaced or repaired to the satisfaction of the Designer and the Ministry Representative.

Great care shall be taken to prevent blockages of the ducts due to grouting of nearby ducts or other causes.

The grouting shall not be done when air temperatures are above 32°C or below 5°C, nor when freezing temperatures

are predicted within the next 24 hours.

The temperature of the concrete shall be 2°C or higher from the time of grouting until site-cured cubes of grout reach a compressive strength of 6 MPa.

The grouted ducts may be subject to gamma ray radiography inspection by the Ministry to ensure that all ducts are fully grouted. The cost of the inspection will be borne by the Ministry if the inspection indicates that ducts are completely filled with grout. Otherwise, the costs of inspection and the cost of reinspection shall borne by the Contractor.

416.36 Cropping - The cropping of post-tensioning strand shall be by a cold-cutting procedure. It shall not take place until authorized by the Designer and Ministry Representative. Under no circumstances shall heat be applied to post-tensioning strand from cropping or other operations. The cropped strand shall be provided with a minimum concrete cover of 25 mm.

416.37 Anchorage Recesses - The anchorage recesses shall be cleaned and sandblasted after completion of post-tensioning and grouting. The surfaces shall be coated with an epoxy bonding agent conforming to ASTM C 881, Type V, Grade 2. The Class of bonding agent shall be appropriate for the temperature at time of application. The bonding agent shall be applied in accordance with the manufacturer's applications. Wire mesh shall be placed before concreting in recesses larger than 300 mm square.

The Contractor shall fill the recesses flush with adjoining surfaces. All parts of anchorages shall have a minimum cover of 50 mm unless otherwise approved by the Ministry Representative. All recesses exposed to view shall be filled with concrete coloured to match the parent concrete. If requested, the Contractor shall submit a trial mix with a proportion of white Portland cement to the Quality Manager and Ministry Representative for review.

SECTION 418

CONCRETE BRIDGE DECK SEALANTS

SILANE SURFACE TREATMENT OF NEW PORTLAND CEMENT CONCRETE

418.01 Scope - This Section describes the treatment of new concrete bridge surfaces with a silane protective solution. The Specification describes surface preparation and application.

Surfaces to be treated shall be as specified on the Design and in the Contract.

418.02 Silane Solution - The silane solution shall be a minimum 40% solution of alkyl trialkoxy silane (isobutyl trimethoxy silane or n-octyl triethoxy silane) dissolved in a maximum of 60% anhydrous alcohol.

418.02.01 Delivery and Storage of Silane Solution - The silane solution shall be delivered to the Site in unopened, sealed containers with original seals intact, also with a manufacturer's label identifying the product (including a batch number). The containers holding silane solution shall be stored in dry, enclosed structures to protect the contents from misuse, weather and excessive heat.

418.02.02 Quality Assurance - Only silane solutions listed in the Recognized Products List shall be permitted for use on the job.

The Recognized Products List may be found on-line at:
http://www.th.gov.bc.ca/publications/eng_publications/geotech/Recognized_Products_Book.pdf

Certification shall be required for each batch shipment of silane solution, prior to its use.

418.03 Contractor's Qualification - The applicator shall have a minimum of three years of successful and documented experience in application of liquid water repellents to concrete or masonry substrates, or else the applicator must provide documentation certifying that training approved by the manufacturer for applying silane solution was received.

418.04 Site Conditions

418.04.01 Substrate Condition - Prior to silane treatment:

- New concrete shall be cured for a minimum of 28 days.
- All concrete surfaces shall be fully dry.

418.04.02 Weather Limitations - Application of silane solution shall be undertaken only during periods when rain or snow has not occurred during the previous two days and no rain or snow is forecast by the weather office for the next

two days.

Application of silane solution shall proceed only when the concrete surface temperature is above 4°C and below 32°C, and windspeed is less than 24 km/hr.

418.05 Surface Preparation - All concrete surfaces prepared for treatment shall be thoroughly cleaned prior to application of the silane solution. The method of cleaning shall be capable of removing loose concrete, curing compounds, laitance, dirt, dust, salt, oil, asphalt or other foreign materials. The cleaning process shall expose concrete pores and capillaries to readily accommodate silane penetration.

The cleaning process shall not damage the concrete surface, remove or alter the existing surface finish, or expose the coarse aggregate of the concrete. The method of cleaning shall be performed in such a manner as to provide a uniform appearing surface colour.

418.05.01 Pre-Surface Cleaning - If necessary, pre-surface cleaning preparations may include the use of solvent and hand tools to remove materials detrimental to the silane treatment of the concrete surface.

418.05.02 Surface Cleaning - Suitable methods to clean the concrete surface are:

- Sand blasting
- Steel shotblasting
- Hydro blasting
- Steam cleaning
- Water pressure washing using a minimum of 3.5 MPa (500 psi) nozzle pressure.

The cleaning method used shall be capable of cleaning concrete surfaces, as specified.

418.06 Silane Application - Silane application shall proceed only if the condition of the cleaned concrete surface is approved by the Quality Manager and Ministry Representative.

418.06.01 Surface Condition - All concrete surfaces shall be fully dry prior to silane solution application. Concrete surfaces previously steam cleaned or water washed must be allowed to dry prior to application of silane solution for:

- Minimum one day during windy or sunny days when air temperatures are over 20°C.
- Minimum two days during calm or cold days when air temperatures are between 4°C to 20°C.

SECTION 418

CONCRETE BRIDGE DECK SEALANTS

418.06.02 Silane Solution - The silane solution shall be used as supplied by the manufacturer. It shall not be diluted or altered in any way. Water shall not be allowed to contaminate the silane solution.

418.06.03 Application Equipment - The silane solution shall be sprayed on the concrete surface by using low pressure 0.1 MPa - 0.2 MPa (15 - 30 psi) positive displacement airless spray equipment. Suitable equipment is a pressurized garden sprayer or drum mounted pump. Large deck areas over 400 m² shall be sprayed using a spraybar type unit.

All spray equipment shall be fitted with fan spray nozzles and the spray adjusted to a "wet spray" condition (i.e., minimum atomization of silane solution).

i) Cleaning of Application Equipment - All application equipment must be clean and dry prior to use. If equipment is wet, it shall be rinsed with a small amount of methyl hydrate (methanol) prior to commencement of the actual application.

418.06.04 Rate of Application

i) Surfaces Subject to Traffic Wear - Bridge decks and other surfaces subject to traffic wear shall be treated with silane solution at a rate of 0.40 ℓ/m².

ii) Surfaces not Subject to Traffic Wear - Surfaces not subject to traffic wear (parapets, pier caps, sidewalks, etc.) shall be treated with silane solution at a rate of 0.23 ℓ/m².

418.06.05 Method of Application - Silane solution shall be applied at a coverage rate according to this Specification. Horizontal surfaces shall be uniformly sprayed to saturate/flood the surface. Vertical surfaces should be treated from the bottom up and uniformly sprayed to saturate

the surface.

If it is not possible to complete the silane treatment in one application, the boundary between the treated and untreated areas shall be clearly marked.

418.06.06 Curing - Following the application, the surface of silane treated concrete shall be cured by mist spraying with water after:

- 4-6 hrs, during days with temperatures between 25°C - 32°C
- 6-12 hrs, during days with temperatures between 15°C - 25°C
- 12-24 hrs, during days with temperatures between 4°C - 15°C

The traffic may be allowed on silane treated concrete one hour after the water wetting operation.

418.07 Safety and Health Hazards - Personnel exposed to silane solution and methyl hydrate shall wear personal protective equipment such as coveralls, goggles, rubber gloves and proper respirators.

No smoking, open flames, sources of heat or ignition shall be permitted during the construction operation.

Special precautions must be taken during the construction operation to prevent any over spray or spillage of materials on plants and vegetation or into fish-habitat water bodies, (Reference DBSS 165, Protection of the Environment).

Manufacturer's material safety data and handling instructions shall be followed.

SECTION 419

CONCRETE BRIDGE DECK WATERPROOFING SYSTEM

PREFABRICATED MEMBRANE

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

DESCRIPTION

419.01 Scope - This Section describes the protection of concrete bridge decks with rubberized asphalt prefabricated membrane overlaid with hot mix asphalt pavement. The Section describes materials, surface preparation and application.

NOTE: This Section is not applicable to existing concrete with high levels of chloride contamination. Membrane and pavement overlay shall not be installed on concrete bridge decks contaminated with acid-soluble chloride ion (Cl⁻) in excess of 0.10% by mass of cement.

MATERIALS

419.11 General - The membrane and accessory materials shall be supplied as a package containing:

- a) full-width membrane, self-adhering internally reinforced sheet of rubberized asphalt. Membrane shall have a minimum thickness of 1.6 mm (65 mils) and shall be supplied in rolls in width between 900 mm and 1500 mm (3' to 5').
- b) detailing strip of membrane, self adhering internally reinforced sheet of rubberized asphalt. Membrane shall have thickness between 1.50 and 1.75 mm (60 to 70 mils) and shall be supplied in rolls in width between 200 and 305 mm (8" to 12").
- c) primer, rubberized asphalt dispersed in organic solvent with minimum solids of 45% (by mass), and maximum drying time of one hour.
- d) mastic, single component material, consisting of rubberized asphalt, organic solvent and fillers, supplied in caulking tubes.

419.12 Delivery and Storage - Membrane and accessory materials shall be delivered to the Site in unopened packages and containers with manufacturer's label identifying the product and a batch number.

The packages and containers shall be stored in a dry secured place protected from weather and excessive heat. Specific manufacturer's instructions for storage shall be followed.

419.13 Quality Assurance - Only membranes and materials accessories (supplied as a package) from the Recognized Products List prepared by the Ministry will be permitted for use.

Certification shall be provided for each batch (package) shipment, prior to its use.

CONSTRUCTION

419.31 Applicator's Qualification - The applicator must have a minimum of three years of successful and documented experience in application of solid membranes to concrete substrates, or else the applicator must provide documentation certifying that training approved by the manufacturer for applying solid membranes has been received.

419.32 Site Conditions

419.32.01 Substrate Conditions - Prior to application of membrane, new concrete shall be cured for a minimum of 28 days.

419.32.02 Weather Limitations - Application of primer and installation of membrane and pavement overlay shall be undertaken only during stable weather when precipitation has not occurred during the previous 24 hours and is not imminent, and when the minimum ambient and concrete surface temperature is 5°C and rising.

419.33 Surface Preparation - All concrete surfaces shall be sound, smooth, clean and free from any contamination.

- a) All defects in concrete surfaces, cracks, delamination and spalled areas shall be repaired with a suitable patching material. All patching shall be completely cured.
- b) All protrusions and sharp edges shall be removed by using hand tools or power tools.
- c) New concrete overlays on bridge decks and concrete-filled shear keys between prestressed concrete box stringers shall have smooth finish. Broom finishes are not acceptable.
- d) All loose aggregates, laitance dust, soil, oil and other debris and contaminations shall be removed from the concrete surface by one or a combination of the following methods:

- i) high pressure clean dry air sweeping
- ii) sand blasting
- iii) steel shotblasting
- iv) hydro blasting using a minimum of 3.5 MPa (500 psi) nozzle pressure
- v) steam cleaning.

The method used shall be capable of cleaning concrete surfaces as specified.

419.34 Priming - All concrete deck surfaces that are to receive membrane must be primed.

419.34.01 Concrete Surfaces - All concrete surfaces shall be fully dry prior to application of primer. Concrete surfaces previously steam cleaned or water washed must be allowed to dry prior to application of primer for:

- minimum 24 hours during windy or sunny days when air temperatures are over 20°C.
- minimum 48 hours during calm or cold days when air temperatures are between 5° to 20°C.

419.34.02 Primer Material - Primer shall be used as supplied by the manufacturer. It shall not be diluted or altered in any way.

419.34.03 Primer Application - Primer application shall proceed only if the condition of cleaned and repaired concrete surfaces is approved by the Quality Manager and the Ministry Representative.

All concrete surfaces to be covered with membrane shall be uniformly treated with primer at the rate of 0.15 to 0.25 ℓ/m² depending on the porosity of the substrate surface.

The primer shall be uniformly applied on substrate surface by roller or brush.

419.34.04 Primer Curing - Only as much surface as will be covered by membrane in the workday shall be primed. Primed concrete surfaces not covered by membrane within the workday must be reprimed immediately prior to membrane installation.

All primed areas must be tack free prior to application of the membrane.

419.35 Membrane Application

419.35.01 Detail Work - Extra attention must be given to all detail work. Detail work shall be performed first, prior to installation of the full-width membrane. The membrane

shall be installed as called for on the Design and on SS Drawings SP419-01 through SP419-08 and as follows:

i) curb or parapet - inside corners at curbs or parapets shall be covered using a detailing strip of membrane. The uppermost edge of the detailing strip of membrane shall be placed and extended up the face of curb or parapet to 6 mm (1/4") below the finished height of the asphalt pavement overlay. The detailing strip of membrane shall be installed in such a manner to ensure it is smooth and that it adheres strongly to the face of curb or parapet, and bridge deck without any visible defects ("tenting", "fish mouth" or "bubbles"). The first sheet of the full width of membrane shall then be applied as close as possible to the curb or parapet.

ii) bridge deck edge - on bridge decks without curbs or parapets, the full width membrane or detailing strip of membrane shall terminate 6 mm (1/4") from the outer edges of the deck. The membrane shall be heated at the edge of the deck with light flame from a torch or with a hot air gun, followed by pressing the membrane down with a roller.

iii) drains - areas around drains, basins and any other protrusions shall be double covered with membrane. First, flashing pieces of detailing strip of membrane are applied, followed by the application of the full width membrane. The membrane shall be installed in such a way as not to obstruct openings of drains and basins.

iv) weep holes - do not require detailing strip. The membrane around weep holes shall be heated with light flame from a torch or hot air gun, and pressed down to expose the opening of the hole.

v) joints and cracks - all filled cracks wider than 3 mm (1/8"), and all joints with a gap less than 6 mm (1/4"), shall be covered with a detailing strip of membrane prior to application of a full width membrane. Joints wider than 6 mm (1/4"), shall be treated as a standard expansion joint and membrane shall be terminated at expansion joint assembly.

vi) bridge ends - detailing strip of membrane shall be installed over the joint between the existing pavement and the bridge deck. At each end of the bridge deck, a full-width membrane shall extend at least 900 mm (3') over the paved bridge approaches. In the case of new construction, when the existing structure has gravel approaches, the detailing strip of membrane shall be folded over the deck edge and covered with a full width membrane.

419.35.02 Membrane Installation - The full width membrane shall be applied in a longitudinal direction from the low point to the high point so that laps shed water. The

area along the lower edge of the deck shall be covered first.

The full width membrane shall be laid flat, avoiding wrinkles and entrapped air. Each succeeding sheet of membrane shall be applied overlapping the side laps a minimum 65 mm (2 1/2") and the end laps a minimum 150 mm (6"). The entire surface of the membrane, especially laps, and all terminations shall then be rolled with sufficient pressure to affect a bond between the membrane and the concrete surface.

419.35.03 Mastic Application - All membrane terminations shall be sealed with a trowelled application of mastic 12 to 25 mm (1/2" to 1") wide and 1.5 to 3.0 mm (1/16" to 1/8") thick. Mastic shall be applied along the edge of the membrane at the face of the curb or parapet, along both sides of the deck joints, around drains and at termination of the membrane on both ends of bridge approaches.

At the end of each working day, or when application is interrupted by a change in construction scheduling, all membrane terminations shall be sealed with the mastic.

419.35.04 Inspection and Repairs - Prior to paving over the membrane, any defective areas of the membrane shall be repaired to the satisfaction of the Quality Manager and Ministry Representative, including:

- tears, damaged areas and inadequately lapped seams shall be patched;
- fish mouth shall be slit and repaired;
- large blisters shall be punctured and repaired; and
- if water migrates underneath the installed membrane, then the membrane covering the affected area shall be removed and replaced.

419.35.05 Traffic On Membrane - Traffic shall not be permitted on the membrane prior to installation of asphalt overlay with the exception of vehicles and equipment engaged in installing the asphalt overlay. Only vehicles or equipment provided with pneumatic tires or with flat tracks with rubber bonded pads, shall be permitted on the membrane. Any turning or sudden braking on the membrane shall be avoided. Any damage to the membrane resulting from the movement of vehicles or equipment shall be repaired.

419.36 Paving - Asphalt overlay construction shall proceed only when the final condition of the installed waterproofing membrane is accepted by the Quality Manager and Ministry Representative.

Prior to commencing asphalt pavement construction, the weight of equipment, including loaded trucks, paver and rollers, and their maximum combined weight must be accepted by the Designer. Only this accepted equipment and equipment combination shall be permitted on the bridge

structure at the time of construction. Asphalt materials, mix design, mix production and hot mix asphalt pavement construction shall meet the requirements of DBSS 501 and DBSS 951.

419.36.01 Asphalt Mix and Pavement Design - Asphalt mix shall meet the requirements of DBSS 501 for Pavement Class I, Medium Mix and appropriate asphalt binder. The asphalt pavement thickness constructed over the membrane shall be not less than 100 mm and shall be constructed as indicated in DBSS 501.

419.36.02 Placing The Asphalt Mix - In addition to standard paving practice:

- i) no paving shall proceed over wet membrane;
- ii) no primer shall contaminate membrane surface;
- iii) paving operation shall commence as soon as possible after the waterproofing membrane is installed;
- iv) paving shall proceed in the direction of the end laps in the membrane (i.e., from overlap to underlap);
- v) the Contractor shall take due precautions to avoid damage to the waterproofing membrane during the paving operations by the paver and hauling trucks;
- vi) the paver shall move at a constant speed avoiding any unnecessary stopping;
- vii) hauling trucks shall maintain a steady supply of asphalt mix to the paver;
- viii) excessive accumulation of asphalt mix in the paver hopper and auger shall be avoided;
- ix) unloading of the asphalt mix from the hauling trucks onto the membrane surface will not be permitted;
- x) paver screed burners shall be set in such a way as to avoid any damage to the membrane from excessive heat;
- xi) the path in front of the screed side end plate must be kept continuously free from spilled asphalt mix. The bottom of the side end plate shall slide freely, otherwise the entrapped asphalt mix could damage the underlying membrane;
- xii) screed adjustments during paving shall be made in such a way as to achieve a uniform thickness of mat, surface texture, smoothness and designed pavement geometrics;
- xiii) the bridge deck joints, drains and other openings (except weep holes) shall be protected to avoid intrusion

of asphalt during the paving operation; and

xiv) during a "one lane at a time" construction method, as on bridges partially open to traffic, the constructed pavement mat shall terminate not less than 100 mm (4") from the edge of installed membrane in order to provide a sufficient area for lapping of the next sheet of membrane.

419.36.03 Compaction - In addition to standard compacting practice:

- i) drum vibration mode must not be used during compaction.
- ii) steel drum shall run as close as possible to the curb or parapet.
- iii) compaction along the expansion joints or concrete dams shall be performed transversely.
- iv) sudden stops or sharp turns by rollers shall be

avoided.

419.36.04 Hand Work - Placing of asphalt mix in areas inaccessible to paving equipment shall be done in accordance with DBSS 501.35.10 and DBSS 501.36.08.

419.37 Protection Of The Environment - The Contractor shall comply with DBSS 165, environmental requirements of Fisheries and Oceans Canada, the Ministry of Environment, Lands and Parks and any related municipal regulations.

Special precautions shall be taken during the construction operation to prevent spillage of materials into water bodies.

419.38 Safety and Health Hazards - Materials used in the construction of membrane and asphalt pavement overlay are flammable, toxic and hot. Personnel exposed to these materials and operations shall wear all appropriate personal protective equipment such as boots, coveralls, goggles, rubber gloves and proper respirators as specified by Workers' Compensation Board. Manufacturer's material, data and handling instructions shall be followed.

SECTION 421

STRUCTURAL STEELWORK

DESCRIPTION

421.01 Scope - This Section covers the supply, fabrication, erection and quality management program of all major structural steel elements.

In general, all shop connections shall be welded, and all field connections high-strength bolted.

Except as otherwise specified herein, steelwork shall be fabricated and erected in accordance with the AASHTO Standard Specifications for Highway Bridges (17th Edition - 2002 including all subsequent interim revisions and updates), Division II, Section 11. Welding and associated work shall be in accordance with the current edition of CSA W59-M - Welded Steel Construction. Fracture control requirements, welding requirements for fracture critical members and welding requirements for primary tension members shall be in accordance with CAN/CSA-S6-00.

421.02 Prefabrication Meeting - The Quality Manager will convene a prefabrication meeting with the Contractor, fabricator and the Ministry Representative to review procedures on quality control, quality assurance, welding procedures, procedures for non-destructive testing, mill certificates and heat numbers, splices, coatings, updated schedule for fabrication, and to confirm the Contract and Design requirements.

421.03 Alternative Details - All details shall, in general, conform to those shown on the Design. Any proposed variation shall be submitted to the Designer in writing with copy to the Ministry Representative, with the reason for the variation. The submission of Drawings of alternative details shall be prepared and sealed by a professional engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC).

If, in the opinion of the Designer, the variation represents a clear improvement, it may be accepted.

If the variation results in a product of equivalent quality, it may be accepted at the discretion of the Designer.

Alternative details must meet the requirements of the Contract.

421.04 Working Drawings - Working drawings shall consist of the following:

- Shop drawings
- Transportation details and
- Erection drawings

Transportation details and erection drawings shall be prepared and sealed by a professional engineer registered

with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC).

When the Contractor is responsible for the design of items that are detailed on the shop drawings, the shop drawings shall be prepared and sealed by a professional engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC).

Working drawings shall be in the same system of units as the Design.

Working drawings shall be on D size sheets approximately 560 mm (22") by 865 mm (34"), (one drawing per sheet). Lettering for notes and dimensions shall be at least 2.5 mm and 4 mm for headings. Drawings shall be legible when half-sized or microfilmed.

421.04.01 Shop Drawings – Shop drawings shall show all information and details needed for the fabrication of the members including, but not limited to, such items as member shapes and dimensions, connection details, material and product standards, mark numbers and general arrangement of member locations, details of attachments, fastener details, weld details, mass of members, special tolerances, special handling instructions, coating details, lifting details and lifting locations.

421.04.02 Transportation Details – Transportation details shall include such items as:

- Description of hauling and handling equipment
- Weight of members
- Length and height of loads
- Location and method of member support
- Details for handling, storing, and loading of members.

421.04.03 Erection Drawings - Erection drawings shall show in detail the method of erection including, but not limited to, the following:

- Erection procedures
- Procedures for off loading of members upon delivery
- Details for temporary storage and support of members on site prior to erection
- Equipment to be used
- Layout or general arrangement drawing showing the layout of the members, equipment positioning, and access roads
- Crane make, model, and capacity charts, boom length(s) , crane placement, and access for transporting of members to crane(s)

- Radii and loads for crane lifts
- Rigging details
- Mass of members , rigging and special installation equipment
- Details for installation and removal of all falsework, temporary supports, temporary bearings, bracing, guys, dead-men, and lifting devices
- Attachments to the bridge members and bridge structure for temporary support and special launching equipment
- Detailed description of sequence of operations
- Details for special installation equipment such as a launching truss, launching nose, head frames, spreader beams and rollers
- Details for installation of members onto the permanent bearings
- Traffic control plan for roadway and rail traffic
- Details for protection of existing utilities affected by the erection procedures
- Layout and details of fall protection and their sequence of installation.

The Contractor shall be responsible for the lateral stability of members and shall design and provide bracing as necessary until completion of the Work.

The erection drawings shall be complete in detail for all anticipated phases and conditions during erection and during the temporary support of members. The Contractor shall submit calculations, upon request, to the Designer and Ministry Representative that demonstrate that specified factored demand/capacity ratios or allowable stresses are not exceeded in members, falsework, temporary bracing and temporary supports and that member capacities and final geometry will be correct. The calculations shall be sealed by the professional engineer that sealed the erection drawings.

Falsework, temporary supports and temporary bracing shall meet the requirements of CSA Standard S269.1 – 1975, “Falsework for Construction Purposes” and shall also meet all the requirements for falsework given in Clauses 20.17 to 20.26 inclusive of the WCB Occupational Health and Safety Regulations.

A professional engineer registered with APEGBC shall be responsible for any field designs and any changes made to the erection procedures. Field designs and changes to the erection procedures must be documented and sealed by the responsible professional engineer and must be available at the Site prior to the affected erection work being carried out.

Immediately before placement of loading on falsework,

the Contractor must ensure that the falsework is inspected and a sealed engineering certificate is issued by a professional engineer registered with APEGBC which:

- Indicates the specific areas inspected and
- Certifies that the falsework has been erected in accordance with the latest approved erection drawings and supplementary instructions.

421.04.04 Submittals - The Contractor shall submit to the Designer copies of all working drawings. Copies shall also be provided to the Ministry Representative. These drawings shall be submitted at least fourteen days prior to the fabrication of the work. Any work done or materials ordered prior to the review of the working drawings shall be at the Contractor's risk. The Designer will review the drawings for general compliance with the Design and the Contract.

If modifications to the drawings are required, the Designer will return one set of drawings, marked up, to the Contractor. The Contractor shall re-submit copies of the revised drawings to the Designer for review. Copies shall also be provided to the Ministry Representative.

If no exceptions are taken to the drawings, the Designer will return one set of reviewed drawings to the Contractor. The Contractor shall forward two sets of the reviewed drawings to the Ministry Representative.

Shop drawings will not be reviewed without the transportation details and erection drawings applicable to the members in question.

Erection will not be allowed to proceed without the Designer's review of the method proposed.

Review of working drawings shall not relieve the Contractor of responsibility for carrying out the Work in accordance with the Contract and the Design.

421.05 Quality Control - The Contractor shall implement a quality control program to meet the Contract requirements.

421.06 Quality Assurance and Audit - The Quality Manager will implement a quality assurance program by auditing the Contractor's quality control program and by inspection at its discretion. The Ministry will implement a quality audit program by auditing the quality control and quality assurance programs implemented by the Contractor and by inspection and testing at its discretion.

The Contractor shall notify the Quality Manager and Ministry Representative at least 14 days before fabrication is to commence. The Contractor shall allow the Quality Manager's and Ministry's representatives access to all parts of the work, and shall supply such information and assistance as is required. The Contractor shall provide samples of any materials requested by the Quality Manager and Ministry Representative. Inspection by the Quality Manager and audit by the Ministry Representative

shall not relieve the Contractor from obligation to perform the Work in accordance with the Contract and the Design.

The Quality Manager will be required to test welds by non-destructive testing methods, in accordance with CSA W59-M. Fillet welds will be tested by the dry powder magnetic particle method and butt welds by radiography.

The Quality Manager will attempt to schedule non-destructive testing operations so as not to interfere with the progress of the Work.

The extent of non-destructive testing is required to be as follows:

- | | |
|----------------------------------|------|
| • Butt Welds | 100% |
| • Flange/web fillet welds | 100% |
| • Flange/stiffener fillet welds | 100% |
| • Web/stiffener fillet welds | 25% |
| • Bracing/stiffener fillet welds | 25% |

The inspection of welds shall be carried out as soon as possible after the completion of welding. The Ministry Representative may carry out additional non-destructive testing as may be deemed to be necessary.

The Contractor shall be prepared to move and support the pieces being inspected. In general, inspection shall be done on the flat and a minimum of 1.25 m of headroom shall be available.

The Quality Manager shall reinspect welds after defects are repaired.

The Quality Manager will inspect bolted connections in accordance with the AASHTO Specifications for Highway Bridges (17th Edition - 2002 including all subsequent interim revisions and updates), Division II, Section 11.

The Quality Manager and Ministry Representative shall be notified of any defects found in the work. No repair shall be made until agreed to by the Designer and Ministry Representative. In the case of minor or routine corrections, approval to proceed may be given verbally by the Designer with notification to the Ministry's Representative. In such cases as repair of major cracks or a revised design to compensate for deficiencies, the means of correction shall be prepared and sealed by a professional engineer registered with the Association of Professional Engineers and Geoscientists of BC (APEGBC). It shall be submitted in writing, with adequate sketches, to the Designer and Ministry Representative for review.

Each main member shall be certified as acceptable by the Quality Manager before it is shipped from the shop. This certification shall not relieve the Contractor of responsibility for subsequent damage or for defects which become apparent before the Work is finally accepted.

421.07 Quality and Details of Welds - The quality and

details of welds shall be in accordance with CSA W59-M.

421.08 Design Specifications - CAN/CSA-S6-00 shall be used in the design of alternative details and calculating the effect of stresses incurred in fabrication and erection.

No increase in allowable stresses due to vertical loads shall be used for erection conditions.

MATERIALS

421.11 Materials

421.11.01 Structural Steel - Steel shall conform to the requirements of CAN/CSA-G40.20/G40.21-M, and shall be of the grades called for on the Design. Plates provided from coils shall not be used. Prior to fabrication, the Contractor shall supply to the Quality Manager and the Ministry Representative the manufacturer's mill certificates giving details of all chemical and physical properties of steel to be used in the Work.

Chemical composition of steel to be galvanized shall be in accordance with DBSS 421.42.

Steel shall be supplied free of surface defects and internal discontinuities, with due regard for the end use of the steel in the Work.

Edges of all plates will be subject to inspection by the Quality Manager. Any discontinuities will be examined and may be accepted.

The Quality Manager and Ministry Representative shall be supplied with a record of all observed discontinuities and repair methods.

Repairs to defective plates shall not proceed until review of the proposed repair method by the Designer and Ministry Representative.

421.11.02 Welding Consumables - All electrodes shall match the base metal specified in accordance with CSA W59-M, Table 12.1. The deposited weld metal shall provide strength, ductility, impact toughness and corrosion resistance equivalent to the base metal.

Welding consumables for all processes shall be certified by the Canadian Welding Bureau (CWB) as complying with the requirements of CSA W48.01.

421.11.03 High-Strength Bolts - Unless otherwise specified on the drawings, high-strength bolts, nuts and washers shall conform to the requirements of ASTM A325, and as follows:

- a) for painted steelwork, Type 1, hot-dip galvanized to the requirements of CAN/CSA-G164-M.
- b) for unpainted weathering steel, Type 3.
- c) for painted weathering steel, Type 3 bolts will be acceptable provided that they are painted after installation in accordance with the field painting specifications.

421.11.04 Shear Connector Studs - Shear connector studs shall conform to the requirements of ASTM A108, Grades 1015, 1018 or 1020.

421.12 Material Storage and Care

421.12.01 Steel - Structural material, either plain or fabricated, shall be stored above the ground in an upright and shored position upon platforms, skids, or other supports. It shall be kept free from dirt and other foreign matter, and shall be protected as far as practical from corrosion. Long members shall be supported on skids placed near enough together to prevent overstress from deflection.

Prior to fabrication, all steel shall be marked for identification by heat number and specification by a marking system approved by the Quality Manager.

421.12.02 Welding Consumables - Electrodes and fluxes shall be stored and kept in condition as required by CSA W59, Section 5.2.

Gas for welding shall be stored in marked steel bottles and shall not be subjected to temperatures in excess of 50°C or temperatures of less than 0°C.

421.13 Fabrication - Prior to fabrication, the welders and welding operator's qualifications, shop drawings, welding procedures, mill certificates and welding consumable certificates shall be submitted for the Quality Manager's review.

No fabrication, welding or coating of steelwork shall commence until permission to do so has been received from the Quality Manager.

421.14 Ministry's Plant Office - The Contractor shall provide in the fabrication plant or nearby a suitable lock-up office for the sole use of the Ministry Representative throughout the period of fabrication.

The office shall be at least 2.5 m x 3 m and shall be weathertight and reasonably soundproof, provided with ample window area and ventilation, furnished with a 0.75 m x 1.2 m desk, a 1 m x 2 m drafting table, a two-drawer filing cabinet, two chairs, a drafting stool and 3 m of shelves, and equipped with a telephone, which shall be operational throughout the period of fabrication. All long distance telephone calls will be paid for by the Ministry.

The Contractor shall clean, heat and light the office throughout the period of fabrication.

EQUIPMENT

421.21 Qualifications and Equipment

421.21.01 Contractor - The Contractor shall produce evidence that the plant is currently fully approved by the CWB to the requirements of CSA W47.1, Division 1 or Division 2 prior to beginning work.

The Contractor shall also produce evidence of at least five years of satisfactory experience in the fabrication of heavy structural steelwork.

The Contractor shall employ or retain a registered professional engineer experienced in steel bridge fabrication, to provide guidance throughout the work.

A qualified welding supervisor shall be employed on each shift where welding is done on the work.

Prior to fabrication, the Contractor shall submit to the Quality Manager the names of the welding engineer, the engineer experienced in steel bridge fabrication, and the welding supervisors who are to be employed on the work.

421.21.02 Welders and Welding Operators - The Contractor shall produce evidence that all welders and welding operators to be employed on the work are currently qualified by the CWB at the time of fabrication in the processes in which they are to be employed on the work.

The Contractor shall also produce evidence relative to each welder and welding operator, that they have been executing satisfactory welding in the required processes within the six-month period previous to the award of this Contract.

421.21.03 Welding Equipment - All equipment to be used in the work shall be in good working order and shall be subject to the inspection of the Quality Manager.

For any arrangement of automatic welding, the Quality Manager or the Ministry Representative may require that a preliminary test run of the equipment be made, without welding, over the length of the joint, to prove that the disposition of the equipment and the method and accuracy of travel are satisfactory.

421.22 Welding Procedures - The Fabricator shall submit copies of the proposed welding procedures for review by the Quality Manager. Gas metal arc welding shall not be used. Where the submerged arc or flux cored arc process is to be used, the Quality Manager or the Ministry Representative may order that each welder and welding operator make a weld specimen not less than 1 m in length for fillet welds and 150 mm in length for butt welds. Steel of the same specifications and thickness as that to be used in the Work shall be used in the specimen welds.

No welding shall be done on the Work until the welders' and welding operators' qualifications are established to the satisfaction of the Quality Manager and Ministry Representative.

Welding procedures shall be accompanied by documentary proof that they have been qualified previously by the CWB at the plant where the work is to be carried out.

The procedures shall include the following information: joint type, welding process, welding position, base metal

specification, welding consumable specification and size, preheat requirements, amperage and voltage requirements, speed, polarity, and welding equipment, including a description of travel for automatic welding.

421.23 Butt Joints - Except as called for on the Design, butt joints will not be permitted.

The Fabricator may submit an alternative butt joint design for approval by the Designer provided that such design has been approved by the CWB.

421.24 Assembly and Welding Sequences - If requested by the Designer or the Ministry Representative, the Contractor shall supply full details of the proposed assembly and welding sequence of any particular weldment.

CONSTRUCTION

421.31 Preparation of Material

421.31.01 Straightening Material - Prior to being used in fabrication, all structural steel shall be straight and free from kinks or bends. The flatness tolerance of plate in excess of 900 mm wide shall be in accordance with the tolerances of the finished product as specified in CSA W59-M. If straightening is necessary, it shall be done by methods that will not injure the metal. The steel shall not be heated unless permission is given by the Designer and the Ministry Representative.

In no case shall the temperature of the steel exceed 620°C. After straightening, the surfaces of the metal shall be carefully inspected for evidence of fracture and if necessary, the material shall be replaced or repaired to the satisfaction of the Designer and Ministry Representative. Sharp kinks and bends will be cause for rejection of the steel.

421.31.02 Camber - Girders shall be cambered as shown on the Design.

421.31.03 Edge Preparation - Steel may be cut to size by sawing, shearing or flame cutting. All steel before cutting shall be marked by a method agreed to by the Quality Manager and Ministry Representative so that its specification may be immediately identified.

All cut edges shall be smooth and regular, free from fins, cracks, tears and notches. Freehand cutting shall be done only where approved by the Quality Manager and Ministry Representative. Roughness of cut surfaces shall not exceed the U. S. Standards Institute B46.1 value of 1000. Roughness exceeding this value shall be removed by machining or grinding. Occasional gouges will be tolerated only at the discretion of the Quality Manager and Ministry Representative and shall be repaired as instructed.

Sheared edges of plates more than 16 mm in thickness shall be planed to a depth of 6 mm.

Re-entrant flame cuts shall be filleted to a radius of not less than 20 mm.

All exposed sharp corners of members, which are to be painted, shall be ground to a minimum radius of 1.6 mm.

All corners of oxygen-cut edges of main stress-carrying members, except unpainted bearing stiffeners and girder webs, shall be ground to a minimum radius of 1.6 mm.

Special attention shall be given to the cutting of flange plates. All flange plates prepared by flame cutting shall be preheated in accordance with DBSS 421.34.

The Quality Manager is required to carry out Brinell hardness testing of the edges of flange plates on fracture critical members. The Brinell hardness of the edges of flange plates on fracture critical members shall not exceed 220. If greater hardness is measured, the edges shall be ground by the Fabricator to remove the hard layer, or annealed by the Fabricator by means of a preheating torch.

Surfaces to be welded shall be free from loose scale, slag, rust, grease, moisture or other material that will prevent proper welding. Mill scale that withstands vigorous wire brushing, a light film of drying oil or a thin rust inhibitive coating may remain except that all mill scale shall be removed from the surfaces on which flange-to-web welds are to be made. Surfaces within 55 mm of any weld location shall be free from any paint or other material that would prevent proper welding or produce objectionable fumes while welding.

Edges of material thicker than specified in the following list shall be trimmed if and as required to produce a satisfactory welding edge wherever a weld along the edge is to carry calculated stress:

- a) Sheared edges of material thicker than 12 mm;
- b) Rolled edges of plates (other than Universal Mill Plates) thicker than 10 mm;
- c) Toes of angles or rolled shapes (other than wide flange sections) thicker than 16 mm;
- d) Universal Mill Plates or edges of flanges of wide flange section thicker than 25 mm.

421.31.04 Direction of Rolling - Steel plates for main members and splice plates for flanges and main tension members shall be cut and fabricated so that the direction of rolling is parallel to the direction of the primary stresses.

421.31.05 Bolt Holes - Standard holes for high tensile bolts shall be either punched, sub-punched and reamed, or drilled, and shall be of a nominal diameter not more than 2 mm in excess of the nominal bolt diameter, except that the following bolt/hole combinations will be permitted:

- a) either 3/4 inch or M20 bolts in 22 mm holes;
- b) either 7/8 inch or M22 bolts in 24 mm holes;
- c) either 1 inch or M24 bolts in 27 mm holes.

Oversize or slotted bolt holes will be allowed only in special circumstances with the approval of the Designer.

Punched holes shall be clean cut, without torn or ragged edges. The diameter of the die shall not exceed the diameter of the punch by more than 2 mm. If a punched hole must be enlarged to admit a high tensile bolt, it shall be reamed.

Reamed holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Reaming shall be done with twist drills or reamers.

Drilling shall be done with twist drills or core drills. Burrs on the outside surfaces shall be removed.

Poor matching of holes will be cause for rejection.

421.31.06 Faying Surfaces - All faying surfaces of steelwork shall be cleaned by sand blasting in the shop. Faying surfaces of steelwork to be painted shall be painted only with one coat of inorganic zinc primer. Primer coatings shall meet the Class B coating requirements as specified in CAN/CSA-S6-00. The class of coating shall be determined based on testing in accordance with the "Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts" issued by the Research Council on Structural Connections. Primers shall be supplied with a Class B certificate and be applied and cured at the conditions on the certificate. Over thickness will not be accepted. If over thickness occurs then the surface will be cleaned and recoated.

421.32 Marking - Prior to fabrication, all steel shall be marked for identification by heat number and specification by a marking system approved by the Quality Manager and Ministry Representative. Steel, which is unidentified, shall not be used in the Work.

421.33 Assembly of Weldments - The shop assembly of the various components of the weldments shall be executed in accordance with CSA W59-M.

Tack welding shall be done by qualified welders, using the smallest size weld required to hold the components of the assembly together. Tack welds shall be incorporated in the final weld.

421.34 Preheat and Interpass Temperatures - No welding shall be done when the temperature of the base metal is lower than -18°C. At temperatures below 0°C, the steel shall be preheated to a temperature of at least 10°C in excess of that stated in CSA W59-M, Table 5.3.

Preheat shall be applied to all steel to be welded so that the steel within 75 mm of the weld is heated to the temperature shown in CSA W59-M, Table 5.3.

Preheat shall be applied in such a manner that moisture from the heating equipment does not penetrate the joint.

Preheat temperatures above the minimum shown in CSA

W59-M, Table 5.3 may be required for highly restrained joints if designated by the Designer.

Preheat temperature shall in no case exceed 200°C.

Preheat requirements for tack welds shall be as in the above table except that where single pass tack welds are used and are to be incorporated and consumed in a weld made by the submerged arc process, preheat is unnecessary.

421.35 Welding - Welding shall be done by the manual, shielded metal arc, flux-cored arc or submerged arc processes in accordance with the reviewed procedures and CSA W59-M, Section 5.

Any weld between the web and flange of a bending member shall be made by an automatic process, which provides a continuous weld throughout the length of the member.

All welding shall be done under cover and, in the case of flux-cored arc welding, shall be done in an area free from wind or draft.

Where the submerged arc process is to be used, the Contractor shall:

- a) Carry out a preliminary test run of the procedure over the length of the joint to prove that the disposition of the equipment, the handling of hoses, and the method and accuracy of travel are satisfactory.
- b) Have each operator make a weld specimen not less than 1200 mm in length for fillet welds and 150 mm in length for butt welds. Steel of the same specification and thickness as that to be used in the work shall be used in the specimen welds. No welding shall be done on the Work until such a specimen is satisfactory to the Quality Manager.

Butt welds shall be extended beyond the edges of the parts to be joined by means of start and run-off tabs providing sufficient thickness to avoid the weld burning through and with a joint preparation similar to that on the main material. For manual shielded metal arc welding the width of the tabs shall be not less than the thickness of the thicker part being joined or 75 mm, whichever is greater. For submerged arc, welding the width of the tabs shall be not less than 75 mm. Each weld pass shall be carried far enough beyond the edge of the parts being joined to ensure sound welds in the joint. Tabs shall be removed upon completion, and the weld cooled without damage to the parent plate. The end of the weld shall be made smooth and flush with the edges of the abutting parts.

In flux-cored arc welding the equipment shall be capable of sustaining a gas flow rate of from 0.85 to 1.25 m³/h.

421.36 Shear Connector Studs - Shear connector studs shall be welded in the locations shown on the Design, to the requirements of CSA W59-M, Section 5.5.6. Shear connectors will be inspected by the Quality Manager and

shall be repaired if necessary in accordance with the same standard.

421.37 High-Strength Bolts - Installation of high-strength bolts shall be in accordance with the AASHTO Specifications for Highway Bridges (17th Edition - 2002 including all subsequent interim revisions and updates), Division II, Section 11.5.6.

Galvanized bolts shall be lubricated with beeswax or other approved lubricant before installation.

Heads of bolts shall be placed on the outsides of girders and box members, and generally on the more conspicuous side, if any, of any connection.

421.38 Bent Plates - When bending plates, the plates shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling. The radius of the bend measured inside shall be not less than the thickness of the plate. Before bending, the corners of the plate shall be rounded to a radius of 2 mm throughout that portion of the plate at which bending is to occur.

421.39 Shop Assembly of Bolted Connections - Holes in girder and truss field splices shall be drilled while assembled in the shop or yard, or sub-punched or sub-drilled and reamed while assembled. Unless otherwise specified, the structure shall be progressively assembled in accordance with AASHTO Standard Specifications for Highway Bridges (17th Edition - 2002 including all subsequent interim revisions and updates), Division II, Section 11.5.3.1. The assembly, including camber, alignment and accuracy of holes shall be inspected by the Quality Manager before drilling or reaming is commenced.

Connecting parts assembled in the shop or yard for the purpose of reaming or drilling holes shall be match-marked by a method agreed to by the Quality Manager to indicate the location and orientation of all pieces.

Alternatively, the Contractor may drill holes full-size using automatic drilling equipment, as described in AASHTO Standard Specifications for Highway Bridges (17th Edition - 2002 including all subsequent interim revisions and updates), Division II, Section 11.4.8.3. In this case a check assembly will be required for the first of each major structural type, as described in AASHTO Standard Specifications for Highway Bridges (17th Edition - 2002 including all subsequent interim revisions and updates), Division II, Section 11.5.3.3. Reaming of holes shall be as specified in DBSS 421.47, if the bolt holes do not line up during field assembly.

421.40 Dimensional Tolerances - The dimensions of completed members shall comply with the appropriate dimensional tolerances as specified in CSA W59-M.

The maximum deviation from specified length shall be $\pm L/1000$ but not over 20 mm.

Warpage of box members shall be determined by taking measurements at any two cross-sections in a member, at opposite edges of one face of the member. Warpage is defined as the distance by which any point deviates from a plane defined by the other three points. This warpage shall not exceed $1/200$ of the width of the member, or 3 mm, whichever is greater.

421.41 Machined Surfaces - Machine-finished surfaces, as designated on the Design, shall be coated with an approved protective compound.

421.42 Galvanizing or Metallizing (if required) - All steelwork to be galvanized shall be galvanized after complete fabrication to the requirements of CAN/CSA-G164-M. The galvanizer shall safeguard against embrittlement as required in CAN/CSA-G164-M, Appendix A. Galvanized members shall be subject, at the discretion of the Quality Manager or the Ministry Representative, to the tests for embrittlement outlined in CAN/CSA-G164-M, Section 5.5.

The chemical composition of steel being galvanized shall be as follows:

- Carbon less than 0.25%
- Phosphorus less than 0.05%
- Manganese less than 1.35%
- Silicon less than 0.03% or between 0.15% and 0.25%

For steel not meeting these chemical composition requirements, special galvanizing techniques shall be developed by the galvanizer to ensure that the specified coating thickness and adherence is achieved. A detailed description of the special techniques shall be submitted to the Quality Manager and Ministry Representative for review 2 weeks prior to galvanizing.

All steelwork to be metallized shall, after complete fabrication, be treated in accordance with the current CSA G189. The zinc coating shall not be less than 0.3 mm in thickness.

421.43 Shop Painting - The Design and/or the Contract shall specify whether the structure is to be painted, or what parts of a structure are to be painted. This subsection applies to those parts of the steelwork which are to be painted.

For weathering steel bridges, unless specified otherwise in the Contract, all structural steel shall be painted for the larger of the following two distances from deck joint locations:

- 3000 mm; or
- 1.5 times the superstructure depth (including girder, haunch and slab thickness).

Coating work shall be in accordance with DBSS 216 unless noted otherwise in DBSS 421.

All steelwork, which is to be painted, shall be given three shop coats of paint - primer, stripe coat and midcoat. Paint shall be chosen from DBSS 308 System SS1. Paint shall be supplied by the Contractor.

The topcoat may be applied in the shop or in the field. The topcoat coat shall be chosen from either DBSS 308 System SS1 or SF2. If the topcoat is to be applied in the shop, then the Quality Control Program shall specifically address the integrity of the topcoat through to project completion.

Surfaces surrounding bolt holes at connection locations shall receive the prime coat only and shall be masked off so that no stripe coat, midcoat or topcoat paint will be under the bolt heads, washers or nuts. These masked off areas shall have the stripe coat, midcoat and topcoat paint applied in the field after installation of the bolts.

Faying surfaces shall receive the prime coat only, as per DBSS 421.31.06. Faying surfaces shall not be coated with the stripe coat, midcoat or topcoat paint.

Paint shall be applied in a covered area in accordance with the manufacturer's specifications and DBSS 216.

All edges, corners, crevices, bolts, nuts, protrusions and welds (unless ground flush) shall be stripe painted by brush for a width of 50 mm with the midcoat paint before the midcoat coat is applied. Stripe coating paint shall be applied as per SSPC-PA1 and may be applied by spray, but shall be brushed in. Stripe painting shall be allowed to cure before the midcoat coat is applied.

Unless a different coating is called for on the Design, the exposed steel surfaces of bearings shall be cleaned and painted as structural steelwork.

Surfaces shall be cleaned to "near-white" per SSPC-SP10 / NACE No. 2 and 50 μm to 75 μm (2 to 3 mils) sharp/angular profile.

The midcoat shall be applied to all surfaces including tops and sides of the top flanges, except faying surfaces and surfaces surrounding bolt holes. The midcoat shall not be applied until the primer and stripe coat are accepted by the Quality Manager to be sufficiently cured.

Any surfaces inaccessible after erection, except faying surfaces and tops and sides of top flanges, shall be given in addition to the three shop coats, one coat of the topcoat paint appropriate for the paint system being used.

If the topcoat is to be applied in the shop, then the topcoat shall be applied after the midcoat is accepted by the Quality Manager to be sufficiently cured.

The colour of the topcoat will be selected by the Ministry. For weathering steel, unless noted otherwise, the topcoat colour shall match the expected colour of the oxidized surfaces. The proposed colour shall be subject to the acceptance of the Ministry Representative.

421.44 Marking and Shipping - Each member shall be

marked by a method agreed to by the Quality Manager and Ministry Representative with an erection mark, corresponding to the mark shown on the erection diagram. Each member with a mass of over one tonne shall also be marked with the mass.

Members shall be loaded on trucks or cars in such a manner that they can be transported to and unloaded at their destination without being damaged.

After steelwork has been delivered to Site it shall be inspected by the Quality Manager. The Contractor shall clean the steelwork after it has arrived at Site of any dirt, road salts, slush or other contaminants accumulated during transport and shall carry out any other surface preparation work necessary to meet the specified surface preparation requirements.

421.45 Field Assembly - The parts shall be accurately assembled as shown on the Design and any matchmarks shall be followed. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Field connections shall have one half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before final bolting. Fitting-up bolts shall be the same nominal diameter as the high tensile bolts, and cylindrical erection pins shall be 1 mm larger.

421.46 Straightening Bent Material after Fabrication - The straightening of plates and angles or other shapes shall be done by methods that will not produce fracture or other injury. The metal shall not be heated unless permitted by the Designer and the Ministry Representative, in which case the heating shall not be to a higher temperature than that producing a "dark cherry red" colour. After heating, the metal shall be cooled as slowly as possible.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture, and if necessary, replaced or repaired to the satisfaction of the Designer and the Ministry Representative.

421.47 Misfits - For all primary connections, and secondary connections having eight or more bolts, 85% of the holes shall accept bolts without reaming. The remaining 15% may be reamed to accept the designed diameter bolts. The diameter of the reamer shall be the same as the drilled hole.

Holes in plates showing more than 5 mm of offset shall be cause for rejection of that plate. New plates, if necessary, shall be field drilled using the hole pattern in the senior member as a template.

421.48 Erection Tolerances - Unless otherwise specified, the misalignment of members after erection shall be within the dimensional tolerances specified in CSA W59-M, but not over 50 mm.

Misalignment shall be measured from vertical lines in the case of columns or towers, and from lines joining the ends of any test length of a member.

Joints, which are required on the Design to be milled to bear, shall have at least 75% of the entire contact area in full bearing. The separations of any remaining portions shall not exceed 0.25 mm except locally at toes of flanges where a separation of 0.60 mm is permissible.

Where joints are not milled, the opening shall not exceed 13 mm.

421.49 Field Painting - This section applies to those parts of the steelwork which are to be painted. Coating work shall be in accordance with DBSS 216 unless noted otherwise in DBSS 421. After the completion of all deck and overhead concrete work, steelwork shall be thoroughly cleaned of all rust, dirt, dust, oil and other foreign materials. Non-visible salts shall meet the SSPC-SP12 / NACE No. 5 NV-2 levels. The shop coats of paint shall be touched up as necessary.

421.49.01 Field Touch-up - Bare, rusty or damaged areas shall be cleaned to SSPC-SP11, Power Tool Cleaning to Bare Metal. Feather edges into the existing coating and build the coating as per DBSS 216. Build the coating using coatings from the specified DBSS 308 System. The coating system shall be from the same manufacturer as the shop coating system on the steel.

After installation, Type 3 bolts, nuts and washers in the areas to be painted shall be cleaned to SSPC-SP11, Power Tool Cleaning to Bare Metal. These bolts, nuts and washers shall then receive the prime coat, stripe coat, midcoat and topcoat paint.

The masked off surfaces surrounding the bolt holes at connection locations shall be cleaned and shall receive the stripe coat, midcoat and topcoat paint.

421.49.02 Topcoat - The topcoat coat shall be chosen from either DBSS 308 System SS1 or SF2.

If the topcoat has not been applied in the shop, then the steelwork shall be given one topcoat coat of paint applied in accordance with the manufacturer's specifications and DBSS 216.

The colour of the finish coat will be selected by the Ministry. For weathering steel, unless noted otherwise, the topcoat colour shall match the expected colour of the oxidized surfaces. The proposed colour shall be subject to the acceptance of the Ministry Representative.

At the completion of the contract, all steelwork, painted or unpainted, shall be cleaned of concrete spatter, mud, oil and other foreign materials.

421.50 Unpainted Weathering Steel - In the case of unpainted weathering steel, the outer faces of the girders and stringers and any other surfaces mentioned in the Design shall present a uniform surface free of mill scale

and, if necessary, shall be power washed and/or sandblasted prior to installation. Concrete splatter adhering to the steel surfaces after the construction of the deck shall be removed and the steel surfaces cleaned.

421.51 Touch-up of Galvanizing and Metallizing - All field welds and other damage in galvanized and metallized coatings shall be touched up as follows:

If the Design calls for touch-up by metallizing, the damaged areas shall be locally sandblasted to "near white" per SSPC-SP10 / NACE No. 2. All dry abrasive blast cleaned areas shall be metallized in accordance with CSA G189, to provide a zinc coating not less than 0.3 mm in thickness.

Otherwise, the damaged areas shall be thoroughly cleaned and painted with two coats of Ministry-approved organic zinc-rich paint.

QUALITY CONTROL PROGRAM

421.61 Quality Control Program - These Subsections describe the general Quality Control Program required for any Fabricator undertaking the fabrication of permanent steel bridges and steel bridge components. The Quality Control Program shall be part of the overall Quality Management Plan for the project. The term "Quality Control" defines those activities that the Fabricator performs to conform to the Contract.

The term "Quality Assurance" defines those activities that the Quality Manager performs to ensure conformance to the Contract.

The term "Quality Audit" defines those activities that the Ministry performs to provide confidence that the QC and QA processes and resulting products satisfy the Contract.

These Subsections contain statements of the Quality Objectives and Policies that the Ministry considers essential for successful and economical quality management. They also outline the Procedures and Documentation to implement and confirm that objectives are met.

The provisions of the Quality Control Program set forth in these Subsections shall apply to all steel bridges and bridge components required as part of the Work.

These Subsections require the establishment of a Quality Management Team with the responsibility for the successful and timely implementation of all necessary Quality Control and Quality Assurance activities. Some positions shown in the Suggested Organization Chart may be held by the same individual. For example, the General Manager may also be the Contract Administrative Manager and the Purchasing Manager. The Plant Superintendent may also be the Receiver and the Welding Supervisor.

421.62 Quality Objectives and Policies

421.62.01 Quality Objectives - The Quality Objectives of the Ministry cover all steel bridges and steel bridge components produced under this Contract to the Ministry, as follows:

- a) Completed products shall conform fully to the governing Codes and Specifications stipulated in the Design and the Contract.
- b) The Quality Control Program shall be fully integrated into the ongoing manufacturing activities of the Fabricator.

421.62.02 Quality Policy - The Quality Policy ensures that the product meets the Quality requirements of the Contract and is delivered on time.

The Quality Control Program applies to all stages of the design, drafting, procurement, manufacturing and testing of the product.

A Fabricator's Quality Control Manager shall be appointed with defined responsibilities in resolving quality matters and shall report to a senior management level. At each hold point, the Fabricator's Quality Control Manager shall:

- Document the successful completion of each stage as it progresses through fabrication and erection;
- Identify and report nonconforming components;
- Initiate or recommend disposition of nonconforming components;
- Verify corrections.

Any persons assigned to perform quality control inspections shall be other than those performing or directly supervising the work and they shall not report directly to immediate supervisors responsible for producing the work.

The Quality Control Program is not subordinate to any design, drafting, procurement, manufacturing or testing activities.

421.63 Scope of the Quality Control Program - The Quality Control Program governs the fabrication of steel bridges and bridge components for the Work. The Suggested Organization Chart is shown in Figure 1

The Fabricator's General Manager shall be responsible for:

- adhering to the Quality Control Program in all respects.
- ensuring that completed bridges or bridge components shall conform fully to the Design and to the fabrication and welding requirements stipulated in the Contract.
- ensuring that all required documentation is produced according to the Quality Control Program.

421.64 Range of Capability - The Fabricator shall

provide the necessary knowledge, skill (in-house or on a contract basis) and equipment to perform the following work on steel bridges and bridge components:

- Design of connections and joints not shown on Design;
- Preparation of shop fabrication drawings;
- Preparation of bills of material;
- Preparation of material requisitions and purchase orders;
- Receiving, checking and storing materials for bridges;
- Layout, cutting, forming and fitting of parts;
- Assembly, tacking and welding;
- Dimensional checking and verification;
- Resolution of non-conformances;
- Documentation of all stages of work with capability of tracking all major components;
- Cleaning, painting, storing and shipping;
- Erection of bridges and bridge components .

421.65 Drawings and Specifications - The Fabricator's Chief Draftsperson shall:

- obtain the latest revision of the Design and specifications for the Work;
- submit shop drawings and erection drawings to the Designer and Ministry Representative before commencement of the work;
- prepare material requisitions containing a full description of the material sizes, material specifications, and certifications required for conformance to the contract;
- deliver the material requisitions to the Fabricator's Purchasing Manager in ample time to permit ordering, delivery and documentation without delaying the work;
- issue requisitions for all sub-contracted drafting work and shall ensure that all conditions of the Contract are part of such sub-contracts.

The Fabricator's Chief Design Engineer shall be responsible for the design of any connections or joints not shown on the Design; and for the design of the erection procedures and any special erection equipment needed, if required.

421.66 Material Control - All materials for bridges and bridge components shall be ordered by the Fabricator's Purchasing Manager in full conformance with the material requisitions provided by the Fabricator's Chief Draftsperson.

The Purchase Orders shall contain all information

necessary to ensure that materials purchased will comply fully with the terms of the Contract. Where mill certificates and test reports are required, it shall be so stated on the Purchase Order. Instructions shall state when the certificates and reports are to be delivered to the Fabricator.

If a supplier proposes a substitute for any material, the Fabricator's Purchasing Manager shall refer the proposed substitution to the Fabricator's Chief Design Engineer for review. If the substitute is acceptable to the Designer and the Ministry Representative, the Fabricator's Chief Draftsperson shall amend all drawings and requisitions, withdraw old issues, and issue the new versions.

The Fabricator's Receiver shall:

- inspect all materials on arrival for conformance with the Purchase Orders;
- confirm that mill certificates and test reports are provided and that they correctly identify the materials delivered;
- arrange with the Fabricator's Plant Superintendent to store all materials for the Contract in segregated areas. Clear identification with the Contract shall be provided;
- issue a non-conformance report covering overage, shortage or damage to the materials, and copies of the report shall be provided to the Fabricator's Purchasing Manager and the Fabricator's Quality Control Manager.

The Fabricator's Purchasing Manager shall deliver all documentation to the Fabricator's Quality Control Manager for inclusion in the Quality Control file for the Contract.

421.67 In-Progress Inspection and Reporting - The Fabricator's Quality Control Manager shall ensure that only documented materials are used for the Contract.

All materials intended for incorporation into the Work shall be examined after cutting to size, forming and rolling. The Fabricator's Chief Inspector shall ensure conformance with the detailed shop drawings, shall report any non-conformance to the Fabricator's Quality Control Manager and shall order all work affected by the non-conformance to stop, pending approval of remedial action.

Before assembling any plate girders or complex parts, the surfaces of all materials shall be examined for imperfections revealed during previous fabrication operations. The joint edge preparation for all groove welds shall be verified as conforming to the Fabricator's CWB-approved welding standards and shall be within the acceptable tolerances.

After assembly of any plate girders or complex parts, and before commencing the strength welding, the assembly shall be checked for dimensional conformance. The

Fabricator's Welding Supervisor shall ensure that the fit-up of all welded joints conforms to the approved welding standards.

The Fabricator's Quality Control Manager shall file a written report of verification with the Fabricator's General Manager and report any non-conformance.

421.68 Correction of Non-conformance When a non-conformance is encountered, the Fabricator's Quality Control Manager shall determine a recommended disposition and obtain the Quality Manager and Ministry Representative's approval as quickly as possible.

If there is non-conformance to the material specification stipulated in the Purchase Order, the Fabricator's Purchasing Manager shall immediately find out the reasons for the delivery of non-conforming material. If the material is of a grade superior to that ordered, the Fabricator's Quality Control Manager and the Fabricator's Chief Engineer shall be notified. They shall verify that the material is an acceptable alternative in all respects, and this verification shall include consultation with the Quality Manager and Ministry Representative. If the material is of a grade inferior to that ordered, it shall be rejected and the correct material or a superior material shall be obtained.

If there is non-conformance of material delivery that will delay production, the Fabricator's Contract Administration Manager and the Fabricator's Plant Superintendent shall be notified immediately. They shall be given revised delivery dates for the adjustment of production scheduling. The Fabricator's General Manager shall determine the alternatives available and shall notify the Quality Manager and the Ministry Representative.

If there are non-conformities in material preparation, assembly, joint edge preparation and fit-up before strength welding, the Fabricator's Quality Control Manager and the Fabricator's Welding Supervisor shall immediately review the non-conformance and notify the Fabricator's Chief Design Engineer who may require further investigation prior to submitting corrective action to the Quality Manager and Ministry Representative for approval. If the necessary corrective action will result in delay to production, the Fabricator's General Manager shall be notified for adjustment to the production schedule. The Fabricator's Plant Superintendent shall inform the Fabricator's Quality Control Manager when the corrective actions are being done so that conformance can be verified and the non-conformance report cancelled.

421.69 Welding - All welding on structural and mechanical components shall be done by the company certified to CSA W47.1 (Division 1 or 2), W47.2-M (Division 2.1 or better) and W186-M as applicable, and shall be done in accordance with the Fabricator's CWB-approved welding standards.

The edge preparations for all groove welds shall conform to the dimensions established in the approved welding

standards.

If the joint is to be welded from one side only without back-gouging, the root gap and root face shall be checked to ensure conformance with the required geometry so that the root pass can be successfully completed.

The strength level and chemical composition of all filler materials used in structural and mechanical assemblies shall conform to the approved shop drawings.

All welding consumables shall conform to the approved welding standards and shall be received, stored and conditioned according to the applicable welding standards.

Any preheat required before welding shall be according to the approved welding standards.

The welding procedure followed in welding any joint in a structural or mechanical component shall conform to the applicable Data Sheet in the approved welding standards.

All welders and welding operators welding on structural or mechanical contracts shall be qualified under the requirements of the CSA Standard governing certification.

421.70 Heat Treatment - This covers any post-weld heat treatment necessary to conform to the approved welding standards.

The Fabricator's Chief Design Engineer shall:

- determine whether any structural or mechanical components shall receive post-weld heat treatment to conform to the Design or Contract or to the applicable Codes and Standards.
- inform the Fabricator's Chief Draftsperson of any such requirements so that they may be incorporated on to the approved shop drawings.

Any heat treatment stipulated on the approved shop drawings or contained in the approved welding standards shall be carried out at the appropriate time and according to the approved documents.

The Fabricator's Plant Superintendent shall ensure that any heat treatment stipulated is done according to the established procedures, shall obtain all documentation and reports, and shall deliver them to the Fabricator's Quality Control Manager.

421.71 Non-destructive Testing - The Quality Manager will test welds by non-destructive testing methods, as described in DBSS 421.06. The Ministry may test any weld by non-destructive testing methods, as described in DBSS 421.06

The Fabricator's Plant Superintendent shall schedule the manufacturing operation to facilitate non-destructive testing.

If non-destructive testing of welded joints reveals imperfections that are marginally more than the acceptance standards, the Fabricator's Quality Control Manager shall

consult with the Designer and the Ministry Representative regarding the location and nature of the imperfections. The effects of leaving minor defects in place shall be assessed in relationship to the loads carried by the joint and the possible adverse effects of making an unnecessary repair.

Weld repairs shall conform to the approved welding standards.

421.72 Calibration of Measurement and Test

Equipment - All measurement and testing equipment owned by the Fabricator and used in the Quality Control Program shall be calibrated and re-calibrated at the intervals and in the manner stipulated in the Manufacturer's Instruction Manuals. Any adjusting devices shall be sealed or otherwise protected from unauthorized adjustment or tampering.

421.73 Records Retention - The Fabricator's record file for each Contract shall contain the pertinent drawings, purchase orders, bills of material, material mill certificates, test reports, Quality Control documents, NDT reports and certificates of compliance.

The Fabricator's record file shall be made available to the Quality Manager and the Ministry Representative upon request.

Items in the Fabricator's record file shall be retained as per company policy.

The Fabricator's Quality Control Manager shall ensure that each file is complete in all respects before it is placed in the Company archives.

421.74 Hold Points - In planning the work flow, the Fabricator shall coordinate with the Quality Manager and Ministry Representative to decide "hold" points for inspection or non-destructive testing. A list of hold points shall be drawn up by the Fabricator, Quality Manager and Ministry Representative at a prefabrication meeting. The Quality Manager and Ministry Representative shall be informed of progress so that delays are minimized.

The "hold" points will typically include some of, but not be limited to, the following:

- verification of materials
- after plate is prepared for splicing
- after splicing of plates
- after web to flange weld
- after stiffeners are applied
- camber of girders
- shop assembly
- cleaning and coating
- bearing plate attachment

- shipping arrangements
- subassemblies.

Work shall not proceed past a "hold" point until it has been signed off by Quality Control and Quality Assurance. Reports shall be completed promptly.

421.75 Transportation and Installation Procedures -

Transportation and installation procedures shall be prepared and submitted for review before any installation takes place on Site. The procedures shall be sealed by a professional engineer experienced in bridge erection and registered with the APEGBC. Consideration shall be given to the following items during the preparation of the procedures:

a) Girder Transportation

- i)** Brief description of hauling equipment;
- ii)** Location of girder support points;
- iii)** Engineering backup if supports vary from the Design.
- iv)** Details of coating protection during loading transporting and erection.

b) Installation Drawings

- i)** Bridge site plan showing piers, abutments and access roads;

ii) Crane make, crane chart, boom length(s) and crane locations;

iii) Mass of girder and access to crane(s);

iv) Special installation equipment such as a launching truss, head frames and falsework.

c) Commentary

i) Brief point form description of installation sequence.

d) Bearings

i) Placement and temperature setting procedure for bearings to be included for multiple span continuous girders.

e) Traffic Control

i) Any arrangements that will be made for road and/or rail traffic.

f) Utilities

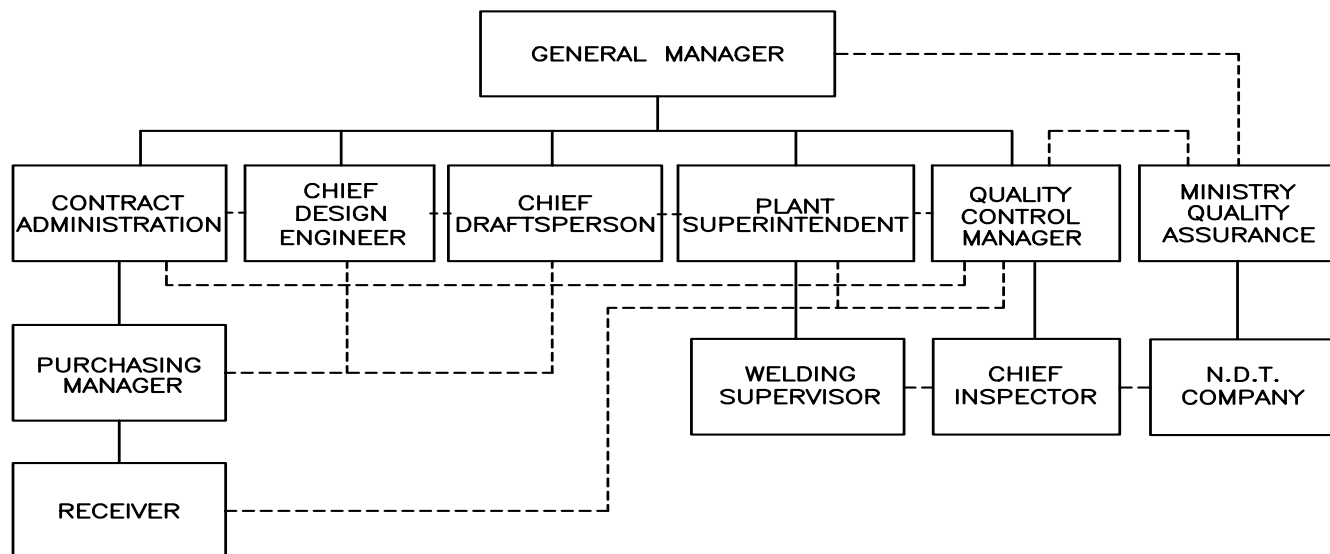
i) Safety and protection.

g) Fall Protection

i) Method and date of installation as required in specifications.

Figure 1

SUGGESTED ORANIZATION CHART



Direct Functional Reporting _____

Quality Control Reporting - - - - -

Signed _____
General Manager

Date _____

[illegible]

NON-CONFORMANCE REPORT

SECTION 421**STRUCTURAL STEELWORK**

BRIDGE NAME: _____

BRIDGE NUMBER: _____

JOB NUMBERS: _____

IDENTIFICATION DETAILS: _____

DESCRIPTION OF NON-CONFORMITY:

_____ 20____

Date

Signature

CORRECTIVE ACTION:

ACTION AGREED UPON: _____

Quality Control Supervisor

Quality Assurance Inspector

DATE COMPLETED: _____ 20____

Signature

HOLD REMOVED BY: _____ 20____

Date

QUALITY CONTROL SUPERVISOR: _____ 20____

Date

QUALITY ASSURANCE INSPECTOR: _____ 20____

Date

SAMPLE FORM #3

Steel Fabrication Compliance Check List

BRIDGE NAME: _____ BRIDGE NO. _____

MARK NUMBER/S: _____

		Q.C.	Q.A.
Material:	Mill Certificates	_____	_____
	(Physicals, Chemicals, Impact Category)	_____	_____
	Identification on materials check	_____	_____
	Heat number transferred and recorded	_____	_____
Welding:	Procedures approved for each process	_____	_____
	Consumables checked	_____	_____
	Date Completed	_____	_____

SAMPLE FORM #4

Steel Fabrication Compliance Check List

BRIDGE NAME: _____ BRIDGE NO. _____

MARK NUMBER/S: _____

		Q.C.	Q.A.
Welding:	Weld preparation and fit up	_____	_____
	Welding within parameters	_____	_____
	Identification on materials check	_____	_____
	Shear studs	_____	_____
	Visual Inspection	_____	_____
	NDT outside agency results	_____	_____

		Q.C.	Q.A.
		Req'd	Actual
			Verified
Dimensions:	Flanges Top Width 1	_____	_____
	Width 2	_____	_____
	Flatness	_____	_____
	Tilt	_____	_____
	Bottom Width 1	_____	_____
	Width 2	_____	_____
	Flatness	_____	_____
	Tilt	_____	_____
	Web Depth	_____	_____
	Section Length	_____	_____
	Bearing Ctr. Length	_____	_____
	Sole Plate Contract	_____	_____
	Camber	_____	_____
	Sweep Tolerance (1/1000)	_____	_____
	Splicing Camber	_____	_____
	Alignment	_____	_____
	Holes	_____	_____
	Date Completed	_____	_____

Coating Compliance Check List

BRIDGE NAME: _____ BRIDGE NO. _____

MARK NUMBER/S: _____

		Q.C.	Q.A.
Coating:	WHMIS Safety Data Sheets	_____	_____
	Technical Spec. Sheets	_____	_____
	Surface Preparation	_____	_____
	Ambient Conditions - Req'd	_____	_____
	- Actual	_____	_____
	Application	_____	_____
	Test Results	_____	_____
	Date Completed	_____	_____

SAMPLE TAG #6

(Front Side)

© HOLD

(Back Side)

Reason for Hold

© _____

Q.C. Manager _____
Date _____

SECTION 422

MISCELLANEOUS STEELWORK

DESCRIPTION

422.01 Scope - This Section covers steelwork apart from major structural steel elements (see DBSS 421).

422.02 Adherence to Drawings - Steelwork items shall be fabricated in strict accordance with the Design and the Contract.

422.03 Working Drawings - The working drawings shall show all information necessary for the fabrication of the steelwork.

Working drawings shall be in the same system of units as the Design.

Working drawings shall be on D size sheets approximately 560 mm (22") by 865 mm (34"), (one drawing per sheet). Lettering for notes and dimensions shall be at least 2.5 mm and 4 mm for headings. Drawings shall be legible when half-sized or microfilmed.

In the case of simple items, where the Design is complete enough to be used for fabrication, the Contractor may, with approval of the Quality Manager and Ministry Representative, dispense with working drawings. The Contractor shall notify the Quality Manager and Ministry Representative of such intention in writing.

In addition to the drawings submitted to the Quality Manager, the Contractor shall submit to the Ministry Representative four sets of all working drawings, for the Ministry's information only, two weeks prior to the fabrication of the steelwork.

422.04 Inspection - The Contractor shall notify the Quality Manager and Ministry Representative at least 14 days before fabrication. The Contractor shall allow the Quality Manager and Ministry's Representative's access to all parts of the work, and shall supply such information and assistance as is required. When the Ministry requests, the Contractor shall provide samples of any materials. Review by the Ministry shall not relieve the Contractor from obligation to perform the work in accordance with the Contract.

Any welding work found to be unacceptable shall be corrected in accordance with CSA W59-M, Section 5.10.

422.05 Rejections - The Quality Manager or Ministry Representative may reject any items which do not comply with the requirements of the Contract.

MATERIALS

422.11 Materials - Structural steel, except where shown otherwise on the drawings, shall conform to CAN/CSA-G.40.21-M, Grade 300W or better.

Chemical composition of steel to be galvanized shall be in accordance with DBSS 422.36 – Galvanizing.

The quality and care of electrodes shall conform to the requirements of the latest CSA W59-M.

422.12 Storage of Materials - Structural material shall be stored above ground. It shall be kept free from dirt and other foreign matter, and shall be protected as far as practicable from corrosion. Long members shall be supported on skids placed near enough together to prevent injury from deflection.

CONSTRUCTION

422.31 Welding - All welding shall be done in accordance with procedures approved by the Canadian Welding Bureau (CWB) and reviewed by the Quality Manager. All welded fabrication shall be done to the requirements of the latest CSA W59-M.

Welding shall be undertaken by a company approved by the CWB to the requirements of CSA W47.1, Division 3 or better.

422.32 Welders and Welding Operators - The Contractor shall produce evidence that all welders and welding operators to be employed on the work are currently qualified by CWB in the processes in which they are to be employed.

422.33 Flame Cutting - Steel may be flame cut, using a mechanical guide, provided a smooth surface is secured. Flame cutting by hand shall be done only where approved by the Designer and Quality Manager, and the surface shall be made smooth by planing, chipping or grinding. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than 10 mm. Edges of tension members shall be ground to a radius of 2 mm.

All exposed corners of members, which are to be painted, shall be ground to a radius of 2 mm.

422.34 Bent Plates - Plates to be bent shall be taken from the stock plates so that the bend line will be at right angles to the direction of rolling. The inside radius of the bend shall not be less than the thickness of the plates. Before bending, the corners of the plate shall be ground to a radius of 2 mm throughout the part to be bent.

422.35 Shop Painting - This subsection applies to those parts of the steelwork which are to be painted.

Coating work shall be in accordance with DBSS 216 unless noted otherwise in DBSS 422.

All steelwork, which is to be painted, shall be given three shop coats of paint - primer, stripe coat and midcoat. Paint shall be chosen from DBSS 308 System SS1. Paint shall be supplied by the Contractor.

The topcoat may be applied in the shop or in the field. The

topcoat coat shall be chosen from either DBSS 308 System SS1 or SF2. If the topcoat is to be applied in the shop, then the Quality Management Program shall specifically address the integrity of the topcoat through to project completion.

Faying surfaces shall receive the prime coat only, as per DBSS 421.31.06. Faying surfaces shall not be coated with the stripe coat, midcoat or topcoat paint.

Paint shall be applied in a covered area in accordance with the manufacturer's specifications and DBSS 216.

All edges, corners, crevices, bolts, nuts, protrusions and welds (unless ground flush) shall be stripe painted by brush for a width of 50 mm with the midcoat paint before the midcoat coat is applied. Stripe coating paint shall be applied as per SSPC-PA1 and may be applied by spray, but shall be brushed in. Stripe painting shall be allowed to cure before the midcoat coat is applied.

Surfaces shall be cleaned to "near-white" per SSPC-SP10 / NACE No. 2 and 50 μm to 75 μm (2 to 3 mils) sharp/angular profile.

The midcoat shall be applied to all surfaces including tops and sides of the top flanges, except faying surfaces. The midcoat shall not be applied until the primer and stripe coat are accepted by the Quality Manager to be sufficiently cured.

Any surfaces inaccessible after erection, except faying surfaces, shall be given, in addition to the three shop coats, one coat of the topcoat paint appropriate for the paint system being used.

If the topcoat is to be applied in the shop, then the topcoat shall be applied after the midcoat is accepted by the Quality Manager to be sufficiently cured.

The colour of the topcoat will be selected by the Designer. The proposed colour shall be subject to the acceptance of the Ministry Representative.

422.36 Galvanizing (if required) - All steelwork to be galvanized shall be galvanized after complete fabrication to the requirements of CAN/CSA-G164-M. The galvanizer shall safeguard against embrittlement as required in CAN/CSA-G164-M, Appendix A. Galvanized members shall be subject, at the discretion of the Quality Manager or the Ministry Representative, to the tests for embrittlement outlined in CAN/CSA-G164-M, Section 5.5.

The chemical composition of steel being galvanized shall be as follows:

- Carbon less than 0.25%
- Phosphorus less than 0.05%
- Manganese less than 1.35%
- Silicon less than 0.03% or between 0.15% and 0.25%

For steel not meeting these chemical composition requirements, special galvanizing techniques shall be developed by the galvanizer to ensure that the specified coating thickness and adherence is achieved. A detailed description of the special techniques shall be submitted to the Designer and Ministry Representative for review 2 weeks prior to galvanizing.

422.37 Metallizing (if required) - All surfaces to be metallized shall be treated after complete fabrication in accordance with CSA G189. The zinc coating shall not be less than 0.3 mm in thickness.

422.38 Installation - Steelwork shall be installed as shown on the Design.

Railings and fences shall be adjusted to produce uniform height and smooth alignment.

Field welding will be permitted only as shown on the Design.

422.39 Field Painting (if required) - This section applies to those parts of the steelwork which are to be painted.

Coating work shall be in accordance with DBSS 216 unless noted otherwise in DBSS 422.

All steelwork shall be thoroughly cleaned of all rust, dirt, dust, oil and other foreign materials. Non-visible salts shall meet the SSPC-SP 12 / NACE No. 5 NV-2 levels. The shop coats of paint shall be touched up as necessary.

422.39.01 Field Touch-up - Bare, rusty or damaged areas shall be cleaned to SSPC-SP11, Power Tool Cleaning to Bare Metal. Feather edges into the existing coating and build the coating as per DBSS 216. Build the coating using coatings from the specified DBSS 308 System. Coating system shall be from the same manufacturer as the shop coating system on the steel.

422.39.02 Topcoat - The topcoat coat shall be chosen from either DBSS 308 System SS1 or SF2.

If the topcoat has not been applied in the shop, then the steelwork shall be given one topcoat coat of paint applied in accordance with the manufacturer's specifications and DBSS 216.

The colour of the finish coat will be selected by the Designer. The proposed colour shall be subject to the acceptance of the Ministry Representative.

422.40 Touch-Up of Galvanizing and Metallizing - All field welds and other damage in galvanized and metallized coatings shall be touched up as follows:

If the contract documents call for touch-up by metallizing, the damaged areas shall be locally sandblasted to "near white" per SSPC-SP10. All sandblasted areas shall be metallized in accordance with CSA G189, to provide a zinc coating not less than 0.3 mm in thickness.

Otherwise, the damaged areas shall be thoroughly cleaned, and painted with two coats of Ministry-approved organic zinc-rich paint.

422.41 Clean-up - At the completion of the contract, all miscellaneous steelwork shall be cleaned of concrete spatter, mud, oil and other foreign materials.

SECTION 501

HOT MIXED ASPHALT PAVEMENT

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

PART A - GENERAL

501.01 Preliminary and General - This Section describes the materials, equipment and quality of work required for the construction of hot mixed, hot laid asphalt pavement.

501.02 General Description of Work - Generally, the work consists of:

- a) Supplying, screening, crushing or any other method of processing, and improving aggregate to produce asphalt mix aggregate.
- b) Priming or tack coating the prepared surface.
- c) Heating the asphalt mix aggregate and mixing it with asphalt cement to produce asphalt mix.
- d) Hauling, placing and finishing the asphalt mix to produce a high quality asphalt pavement.

501.03 Asphalt Pavement Classifications - The Class of asphalt pavement required under the contract will be stated in the Special Provisions and will be generally designated as follows:

- Class 1 - Highways for Heavy Traffic
- Class 2 - General Highways

Pavement Classification as Determined by ESAL

Class 1 pavements shall be utilized where the estimated Equivalent Single Axle Load (ESAL) is greater than 1,000,000 based on a twenty year life span of the pavement structure and an average 4% annual traffic growth rate.

Class 2 pavements shall be utilized where the ESALs are less than 1,000,000 based on the same premise.

PART B - MATERIALS

All types of hot mix material produced under this section shall be paver laid and of high quality and carefully controlled.

Asphalt mix referred to in this text means any and all of the asphalt cement bound mixes listed in this section.

501.11 Definitions

BC – MOT

501.11.01 Hot Mix Asphalt Cement - penetration grade asphalt used in the asphalt pavement.

501.11.02 Cutback Asphalt - penetration grade asphalt which has been blended with light petroleum distillates.

501.11.03 Emulsified Asphalt - penetration grade asphalt that has been blended with water and emulsifying agents to form aqueous emulsions, including anionic type, cationic type and High Float type.

501.11.04 Aggregate - the crushed or screened gravel.

501.11.05 Asphalt Mix Aggregate - the processed crushed aggregate just prior to the addition of asphalt cement.

501.11.06 Asphalt Base Course Mix Aggregate - the processed crushed 25 mm minus aggregate just prior to the addition of asphalt cement.

501.11.07 Recycled Asphalt Mix Aggregate - the processed crushed aggregate for blending with reclaimed asphalt pavement just prior to the addition of asphalt cement and reclaimed asphalt pavement.

501.11.08 Supplementary Aggregate - a crushed or uncrushed aggregate of specified gradation, which, when added to aggregate meeting the requirements of DBSS 501.15.01 through DBSS 501.15.03 will produce asphalt mix aggregate required by the asphalt mix design.

501.11.09 Asphalt Mix (AM) - hot plant mixture of asphalt cement and dense graded high quality aggregate.

501.11.10 Asphalt Levelling Course (LC) - asphalt mix used to improve crossfall, level, and strengthen existing pavements.

501.11.11 Asphalt Pavement (AP) - paver laid asphalt mix compacted to uniform density.

501.11.12 Additives - solid or liquid materials to enhance the properties of the liquid asphalt cement or mix.

501.11.13 Reclaimed Asphalt Pavement (RAP) - asphalt pavement that has been milled with a cold milling machine.

501.11.14 Asphalt Base Course Mix (ABC) - a hot plant mix of asphalt cement and asphalt base course aggregate with lower asphalt cement content than conventional mixes.

501.11.15 Recycled Asphalt Mix (RAM) - a carefully controlled, hot plant mix of asphalt cement, graded high quality aggregate and reclaimed asphalt pavement.

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501.11.16 Recycled Asphalt Base Course Mix (RABC) - a hot plant mix of asphalt cement, reclaimed asphalt pavement and asphalt base course aggregate.

501.11.17 Reject Mix - mix that is deemed unacceptable for use in the project by the Quality Manager or Ministry Representative.

501.12 Supply and Handling of Asphalt Materials

501.12.01 Asphalt Cement and Liquid Asphalt Cutback and Emulsion -, the Contractor will supply the asphalt cement and liquid asphalts required for the work.

501.12.02 Labour and Equipment - The Contractor shall supply all labour and equipment to remove asphalt cement and liquid asphalts from tank trucks

501.13 Standard Tests

501.13.01 Asphalt Mix Aggregates - The asphalt mix aggregates will be tested in accordance with the listed tests in Table 501-A.

TABLE 501-A TESTS FOR ALL ASPHALT MIX AGGREGATES AND SUPPLEMENTARY AGGREGATES

ASTM TEST DESIGNATION	TITLE OF TEST
C - 136	Sieve Analysis (Dry)
C - 117	Sieve Analysis (Wash)
C - 127	Relative Density & Absorption - Coarse Aggregate
C - 128	Relative Density & Absorption - Fine Aggregate
C - 88	Aggregate Soundness (Magnesium Sulphate) Tests Granular Surfacing & Base Aggregates
D - 2216 C - 566	Moisture Content Determination
C-142	Clay Lumps and Friable Particles
D - 2419	Sand Equivalent Test
D6928-03	Micro Deval Abrasion Loss Test
D - 421	Preparation of Samples for Atterberg Limit
D - 4318	Liquid Limit
D - 4318	Plastic Limit
D - 5821	Fracture Count for Coarse Aggregate - by mass - retained on the 4.75 mm sieve

501.13.02 Asphalt Mix and Asphalt Pavement - The asphalt mix and asphalt pavement will be tested in accordance with the listed tests in Table 501-B.

TABLE 501-B TESTS FOR ASPHALT MIX AND ASPHALT PAVEMENT

ASTM	TITLE OF TEST
D - 2172	Quantitative Extraction of Asphalt from Bituminous Mixes
D - 1188	Degree of Compaction of Insitu Asphalt Mix Using Cored Samples
D - 2950	Degree of Compaction of Insitu Asphalt Mix by Nuclear Method

501.13.03 Granular Shoulder Materials and Constructed Shoulders - The granular shoulder materials and the constructed shoulders will be tested in accordance with the listed tests in Table 501-C.

TABLE 501-C TESTS FOR GRANULAR SHOULDER MATERIALS AND CONSTRUCTED SHOULDERS

ASTM	TITLE OF TEST
D - 698	Moisture Density Relation Determination, Standard Proctor
D - 2922 D - 3017	Field Density Test using Nuclear Gauge

501.14 Asphalt Mix Aggregate Requirements - The crushing of all paving aggregate shall conform to the requirements of DBSS 202.09.

Asphalt mix aggregate shall have a maximum Micro Duval abrasion loss factor of 18 when tested in accordance with ASTM D6928-03.

501.14.01 Coarse Aggregates:

- shall be all mineral matter retained on the sieve designated for each individual test.
- shall consist of crushed stone, crushed gravel, or combination thereof, or materials naturally occurring in a fractured condition, or materials naturally occurring of highly angular nature or rough texture.
- shall be free from coating of clay, silt or other deleterious material, and shall meet the requirements

listed in Table 501-D.

TABLE 501-D REQUIREMENTS FOR COARSE AGGREGATES

REQUIREMENTS	PAVEMENT CLASSES	
	1	2
Maximum water absorption: % by mass	2	2
Maximum % by mass of clay balls and friable particles	1.0	1.5
2 Fractured Faces: Minimum % by Mass retained on the 4.75 mm sieve	85	70

501.14.02 Fine Aggregate:

- i) shall be all mineral matter passing the sieve designated for each individual test.
- ii) shall be clean, tough, durable, moderately sharp, and free from coatings of clay, silt, or other deleterious material, and shall contain no clay balls or other aggregations of fine material.
- iii) Not Used

- iv) shall have a sand equivalent value of not less than 40.

501.14.03 Mineral Filler and Mineral Dust

- i) The Mineral filler shall consist of all mineral matter passing the 0.600 mm sieve and the mineral dust shall consist of all mineral matter passing the 0.075 mm sieve.
- ii) Mineral filler and mineral dust shall be free from organic matter.
- iii) Mineral filler shall be non-plastic mineral filler when tested in accordance with ASTM D 4318.

501.15 Asphalt Mix Design

501.15.01 Gradation Limits - The Contractor shall supply aggregates falling within the grading limits as specified in Table 501-E. .

501.15.02 Gradation Refinements - If the gradation of the aggregate supplied by the Contractor does not fall within the gradation limits specified, such refinements will be made to the gradation as are necessary to comply with the said gradation limits at the Contractor's expense.

501.15.03 Grading Curve - Once the grading curve is established within the above limits, the maximum permissible variation of the mean of any four consecutive

TABLE 501-E GRADATION LIMITS FOR AGGREGATES

SIEVE SIZE (mm)	PERCENTAGE BY MASS PASSING				
	COARSE ASPHALT MIX	MEDIUM ASPHALT MIX	FINE ASPHALT MIX	ASPHALT BASE COURSE MIX	ASPHALT BOUND OPEN GRADED BASE MIX
37.5	100	---	---	---	---
25.0	80 - 100	---	---	100	100
19.0	60 - 92	100	---	80 - 94	75 - 100
12.5	50 - 85	84 - 95	100	---	---
9.50	40 - 80	73 - 90	90 - 100	50 - 84	30 - 60
4.75	30 - 65	50 - 75	55 - 80	25 - 55	5 - 30
2.36	20 - 50	35 - 57	32 - 64	20 - 45	0 - 10
1.18	15 - 35	26 - 45	24 - 51	15 - 35	---
0.600	8 - 30	18 - 34	17 - 40	---	---
0.300	6 - 22	10 - 26	13 - 29	5 - 20	0 - 8
0.150	3 - 15	6 - 17	8 - 18	---	---
0.075	1 - 7	3 - 7	4 - 10	0 - 5	0 - 4

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tests from the grading curve shall be within the tolerance specified in Table 501-F.

TABLE 501-F MAXIMUM PERMISSIBLE TOLERANCE OF AGGREGATE FROM THE GRADING CURVE

SIEVE SIZE(mm)	MAXIMUM PERMISSIBLE TOLERANCE % PASSING BY MASS (TEST BCH I - 1 AND 2)
25.0 and larger	± 5.0
4.75 to 19.0	± 4.5
1.18 and 2.36	± 4.0
0.600	± 3.5
0.300	± 2.5
0.150	± 1.5
0.075	± 1.0

These tolerances do not waive the requirement that the running average of four consecutive tests must be maintained at all times inside the limits specified in DBSS 501.15.01. Should the Contractor be unable to maintain the grading curve within the limits specified in DBSS 501.15.01, the Contractor shall, at the Contractor's cost, carry out refinements as required to shift the grading curve away from the limits of DBSS 501.15.01 so as to ensure that a variation cushion, as specified by the maximum permissible tolerances shown in Table 501-F, is effected within the limits of DBSS 501.15.01.

501.15.04 Asphalt Mix Design - The Contractor will carry out the asphalt mix design with the aggregate supplied by the Contractor.

The asphalt mix design will establish the design grading curve which will define the proportional amounts of coarse, fine and supplementary aggregates required in the mix.

501.15.05 Not Used

501.15.06 Requirements - All ingredients supplied by the Contractor for incorporation into the asphalt pavement shall meet all the applicable requirements of DBSS 501 and DB SS 951.

The asphalt mix design, meeting the appropriate Marshall Design requirements of Appendix A, will be performed by the Contractor.

The Contractor shall provide the Ministry Representative

with the following at least seven days prior to commencement of the paving:

- i) , Type of aggregate, source and stockpile location.
- ii) Asphalt cement source showing type and grading classification information supplied by the refinery.
- iii) A stockpile gradation showing daily test results and stockpile average

501.16 Asphalt Mix Requirements

501.16.01 Test - Asphalt Mix Aggregate - During all phases of the construction of asphalt pavement, the gradation of the asphalt mix aggregate will be determined.

- i) Samples for this test can be obtained at the asphalt plant prior to addition of the asphalt cement, or after extraction of the asphalt cement from the asphalt mix, or obtained from samples taken at the roadway before or after compaction.

- ii) Not Used

501.16.02 Test - Asphalt Mix - The asphalt mix will be tested and the measured asphalt cement content shall not vary from the design asphalt content by more than 0.3 kg/100 kg of aggregate.

501.16.03 Mixing Temperature - The mixing temperature of the asphalt mix will be selected by the Contractor. . (It will normally be within the temperature range which corresponds to a kinematic viscosity of 150 to 300 mm²/s of the asphalt cement.)

501.16.04 Temperature Behind Screed - The asphalt mix temperature immediately behind the screed shall not be more than 15°C lower than the mixing temperature.

501.16.05 Residual Moisture Content - The residual moisture content of the asphalt mix taken in the loaded truck, at the point of loading, shall not exceed 1% by mass. Should foaming or bubbling persist, even below the allowed percentage of moisture, the Contractor shall modify the operations accordingly.

501.17 Asphalt Pavement

501.17.01 In-place Density - The in-place density of the asphalt pavement will be obtained at random locations and the Degree of Compaction will be computed from the formula:

$$\text{Degree of Compaction} = \frac{\text{In-Place Density of Sample}}{\text{Plant Briquette Density}} \times 100$$

The Degree of Compaction of the mean of any five consecutive tests shall be greater than 97%.

501.17.02 Smoothness Rating - The smoothness rating of the finished asphalt pavement will be determined by the Ministry by using a Class 1 profiler and the accurate determination of the International Roughness Rating (IRI) will be measured. A lot is 1 lane km of new pavement (See DBSS 502). The Contractor shall achieve a smoothness of an average minimum value of 1.2 IRI for each lot. The Contractor will have an opportunity to remediate the pavement and the remediation methods shall be approved by the Ministry Representative.

501.17.03 Finished Pavement - All finished pavement shall be free from depressions, bumps, or other irregularities exceeding 5 mm over a 3 m straight edge, placed in any direction.

501.17.04 Requirements - The pavement shall be homogeneous, free from segregation and shall be uniform with respect to surface texture. **501.17.05 Remedial Work** - Areas failing to meet the requirements of Subsections DBSS 501.17.01 through 501.17.04 shall be corrected by the Contractor.. Remedial procedures may be selected by the Contractor subject to approval by the Quality Manager and the Ministry Representative.

The remedial work shall meet all specification requirements and criteria intended for the original work.

PART C - EQUIPMENT AND PLANT

All equipment, plant and instrumentation shall be capable of performing the work in accordance with this section.

The provisions in DBSS 501.21 to DBSS 501.28 are recommended guidelines only, and as such are not mandatory.

501.21 Requirements for the Pressure Distributor and Liquid Asphalt Storage

501.21.01 Pressure Distributor - The pressure distributor shall be provided with at least the following equipment:

- i) A quick opening gate in the dome.
- ii) An external, readily visible depth gauge, indicating the quantity of asphalt in the tank to the nearest 50 ℓ and:
 - a dipstick calibrated in 20 mm increments and a calibration chart showing the volume for each 20 mm of depth, or;
 - the manufacturer's calibrated dipstick and chart.
- iii) A means of heating the asphalt material uniformly to any temperature up to 175°C and maintaining the contents constantly at any selected temperature, without any local overheating.

iv) A heavy duty, industrial type thermometer or remote reading dial thermometer.

v) Rear mounted spray bars and nozzles set parallel to the surface to be sprayed and capable of vertical and lateral adjustment.

The spray bars to be capable of adjustment to provide a uniformly sprayed surface from a minimum of 0.6 m to a maximum of 6 m.

The spray bars to be capable of producing double coverage at one pass.

The feed to the spray bars to be so arranged that there is a constant circulation of hot asphalt material to the bars to ensure a constant pressure of the liquid asphalt at each nozzle during spraying operations.

The feed manifolds to the spray bars to be provided with adequate filtration to prevent clogging of bars and nozzles.

Spray bar nozzles to be of the same type, size and manufacture and set to produce uniformly fan-shaped sprays without atomization.

Spray nozzles to be provided with valves capable of instant full opening and positive cut-off.

vi) A connection to a circulating pressure manifold to which a hose may be attached for a single nozzle hand operated outlet.

vii) A pressure pump capable of applying the asphalt material at a minimum rate of 180 ℓ per minute per metre of spray bar.

viii) A pressure gauge accurate to within 15 kPa and a meter calibrated in litres per minute, shall be readily visible.

ix) A fifth wheel tachometer, calibrated in metres per minute and readily visible.

501.21.02 Liquid Asphalt Storage - The Contractor may provide a minimum 40 000 ℓ capacity of on site storage for primer materials.

501.22 Requirements for all Mixing Plants

501.22.01 Uniformity - Plants to be capable of producing a uniform and homogeneous asphalt mix, as specified.

501.22.02 Equipment - Preparation of Asphalt Cement

i) The Contractor to supply a minimum of two insulated

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tanks for the storage of asphalt cement. The tanks to be equipped with means for heating the material under effective control at all times to the temperatures required, and to have a total minimum storage capacity equivalent to 10 hours of plant actual maximum production capacity.

The tanks to be connected to the circulating system such that each tank can be separately isolated from the system, without interfering with the circulation of asphalt cement to the plant.

Each tank to be provided with its own calibrated dipstick and chart.

ii) Asphalt cement to be supplied to the mixing plant by a force feed pump placed at the outlet manifold from the storage tank.

iii) The asphalt circulating system to conform to the requirements indicated on SS Drawings SP501-01 through SP501-03.

iv) All pipe lines, valve boxes, pumps, meter weigh buckets, other containers or flow lines to be provided with a suitable means of heating or insulation to prevent heat loss and to maintain the asphalt cement at the specified temperature between storage tank and mixer.

501.22.03 Dust Collectors

i) The Contractor to provide and install such systems of dust collection as may be required to meet all existing regulations.

ii) Provisions to be made to re-use the collected material, if required.

501.22.04 Asphalt Cement Control Unit

i) Satisfactory means to be provided to measure the amount of asphalt cement to be added to the mix with all measuring devices being accurate to $\pm 2\%$.

ii) A readily accessible totalizer meter to be provided to record the total asphalt cement delivered to the mixer during mixing operations.

iii) Mix production from plants equipped with volumetric metering devices to stop whenever the temperature of the asphalt cement passing through the devices fluctuates by more than $\pm 5^{\circ}\text{C}$ from the temperature established by the mix Design and for which the metering device has been calibrated. Mixing to only resume when the temperature of the asphalt has been brought within the permissible operating range.

501.23 Requirements for Batch Plants and Continuous Plants

501.23.01 Screens - Screens to be capable of screening all aggregate to the sizes required for accurate proportioning and to have a designed capacity slightly in excess of the full operating capacity of the mixer.

501.23.02 Plant Bins

i) The plant to be provided with hot aggregate storage bins of sufficient size to ensure uniform and continuous operation of the plant at its rated capacity. There should be at least three bins. All bins to normally be utilized for gradation control of the aggregate.

A minimum number of two bins may be used if the variation in the crusher gradation analyses conforms to the maximum variation allowances described in DBSS 501.15.03.

The bins to be arranged to ensure separate and adequate storage of the required fractions of aggregate. Each bin to be provided with an overflow chute of such size and at such location as to prevent backing up of material into other bins. Overflow material to be wasted.

ii) An adequate additional dry storage bin to be provided for additives when required, and satisfactory provision made for proportioning into the mix.

iii) Bins to be provided with electronic type telltales which register on an indicator board plainly visible to the plant operator. When the bins empty to the lower third a red lamp to light up and mixing shall stop immediately.

iv) Convenient means to be provided for obtaining truly representative samples from each bin.

501.23.03 Thermometric Equipment

i) An accurate multipoint continuous recording pyrometer or other approved instrument having a temperature range of 50°C to 200°C subdivided into 2°C graduations to be centrally situated in a protected position where it is readily visible to the plant operator.

ii) Premium grade thermocouples or resistance thermometer bulbs to be properly installed and protected at the following reference points:

- In the dryer exhaust manifold between the exhaust fan and the primary dust collector.
- In the dryer discharge chute.
- In the fine aggregate bin, not higher than the bottom quarter point of the bin and as near to the bin discharge point as practicable. The temperature reference point must protrude

sufficiently into the aggregate stream flow and be protected by a small diameter tube to prevent the build up of a coat of fine material.

- In the asphalt circulating main pipe at the nearest elbow or junction to the spray bars or asphalt bucket.
- In each asphalt storage tank, to register the true temperature of the asphalt cement at the level of the tank outlet without sensing temperature effects from the tank heating coils or external conditions.

501.24 Special Requirements for Batch Plants

501.24.01 Plant Scales - Scales for any weigh box or hopper may be either standard beam or springless dial type accurate to 0.5% of the maximum indicated load.

Scales shall be tested as often as necessary to ensure their accuracy. The Contractor to provide and have at hand a satisfactory number of standard weights for frequent testing of all scales. For each scale, a suitable cradle or platform to be provided for applying the test load so that the load is uniformly distributed. The test weights to be kept clean and stored near the scales.

501.24.02 Time Lock and Batch Counter - The mixer to have an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer, until the closing of the mixer gate at the completion of the cycle. The mixer gate is to be locked throughout the dry and wet mixing periods.

The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the application of asphalt cement; the wet mixing period is the interval of time between the application of asphalt cement and the opening of the mixer gate.

The control of the timing to be flexible and capable of being set at intervals of not more than two seconds throughout cycles up to three minutes. A mechanical batch counter to be installed as part of the timing device and be designed to register only completely mixed batches.

501.25 Special Requirements for Continuous Plants

501.25.01 Calibration of Asphalt Pumps and Aggregate Feed

- i) The plant to provide a means of calibrating gate openings and volumetric pumps by means of mass test samples.

The asphalt mix aggregate fed through individual bin orifices to be capable of being diverted into a suitable test box with separate compartments for each aggregate size.

The test box to be equipped to handle conveniently such test samples varying between 100 kg and 250 kg. The plant to be equipped with an accurate revolution counter mounted on the aggregate feed apron to the mixer.

- ii) In order to calibrate the volumetric proportioning of asphalt cement, the section of the asphalt flow line between the circulating return valve and the spray bar to be provided with a valve and outlet suitable for bypassing the flow from the volumetric proportioning device into containers capable of holding not less than 2500 ℓ. The sampling line to be fitted with nozzles equal in type and quantity to the pugmill spray bar. The operating pressure, as registered by the gauge installed upstream of the asphalt meter, for a selected pump setting is not to vary during mixing.

- iii) A platform scale to be provided by the Contractor for determining the mass of test samples of aggregate and asphalt cement.

501.25.02 Aggregate - Asphalt Cement Interlock - Synchronization of aggregate and asphalt cement feeds to be provided to allow interlocking control between the flow of aggregate from the bins and the flow of asphalt cement from the meter or other proportioning source.

501.25.03 Asphalt Mix Aggregate Sampling - An efficient and satisfactory method to be provided for obtaining truly representative samples of the total aggregate being fed into the pugmill.

501.26 Special Requirements for Drum Mixers

501.26.01 Plant Generally

- i) The drum mixer to be a parallel flow or counter flow type and of approved manufacture.
- ii) The drum mixer to be used in conjunction with a hot storage silo meeting all requirements of this Section.

501.26.02 Cold Aggregate Feeders and Bins

- i) The Contractor to provide sufficient cold feed bins or feeders to allow for the accurate blending of all materials, including supplemental aggregate(s), required to meet the Marshall Mix Design
- ii) Each bin to be equipped with a variable speed feeder, adjustable gate and other devices ensuring uniform flow of material.
- iii) All feeders to be quick adjusting and interlockable and maintain a constant and uniform flow throughout their range of calibration.

iv) The total flow of asphalt mix aggregate to be metered by an electronic belt scale interlocked with a variable asphalt feed system, so that the proportions of asphalt cement and aggregate entering the drum remain constant.

v) The main feed belt to have a vibrating scalping screen, with openings as required to prevent the feeding of oversize or deleterious material.

vi) A readily accessible device shall be provided for obtaining samples from the main feed belt.

vii) Feed bins to be equipped with bin level tell-tale lights which are visible to the plant operator. When the bins empty to the lower third, a red lamp to light up and mixing shall stop immediately.

viii) The Contractor to provide and have at hand a satisfactory number of standard weights for frequent scale testing.

501.26.03 Calibration - The asphalt cement and asphalt mix aggregate feed systems to have provisions to enable easy calibration.

501.26.04 Monitors, Recorders and Controls - The drum mixer control console to have at least the following monitors, recorders and controls:

- Individual variable quantity feed belt controls which govern the output from each feed bin.
- Master variable quantity feed control which governs the combined output from the bin feeders in their proper predetermined ratios.
- Belt scale totalizer showing accumulated mass of wet aggregate delivered to the dryer drum mixer.
- Moisture content input control for changing internally the system's wet mass to dry mass.
- Indicator showing the computed total mass per hour of dry aggregate delivered to the drum mixer.
- Control for setting the required percentage of asphalt cement based on the mass of dry asphalt mix aggregate.
- Totalizer for accumulated litres of asphalt cement delivered to the drum.
- Master switch to start and stop the asphalt cement and asphalt mix aggregate feeds.

501.26.05 Thermometric Equipment

i) An accurate multipoint continuous recording pyrometer or other approved instrument having a temperature range of 50°C to 200°C, subdivided into 2°C graduations, to be centrally situated in a protected position where it is readily visible to the plant operator.

ii) Premium grade thermocouples or resistance bulb

thermometers to be installed:

- in the asphalt cement circulating main at the nearest elbow or junction to the supply manifold
- in each asphalt cement storage tank to measure the true temperature of the stored asphalt at the level of the tank outlet without sensing temperature effects from the tank heating coils or external conditions
- in the drum discharge chute
- in the hot storage silo, not higher than the bottom quarter point.

501.27 Requirements for Hot Storage Silos - Hot storage silos to be enclosed and be of a design that will not cause segregation in the asphalt mix. The conveyor to discharge into an automatically controlled batching device having a minimum capacity of 1.8 t, mounted on top of the hot storage silo. However, should segregation be detected, the Contractor is to modify the operation immediately.

The silo to be equipped with a remote indicator light, visible to the plant operator, indicating when silo is less than one quarter full.

The silo to be set up so as to allow enough room for the haul trucks to pass below the discharge hopper thus allowing direct discharge into the trucks. Loading the haul trucks with the use of a conveyor system will not be allowed.

501.28 Requirements for Mixing Plants Producing Sulphur Extended Asphalt Mix

501.28.01 General - Equipment normally in contact with sulphur to be thoroughly heat jacketed. All those parts, which may be invaded by sulphur, should also be jacketed.

501.28.02 Pipe Lines

i) Sulphur lines smaller than 25 mm in diameter are not permitted.

ii) Pipe systems should be kept full of liquid sulphur all the time to prevent severe corrosion.

501.28.03 Valves - Steam jacketed valves, lubricated or non-lubricated plug valves are accepted. Steam jacketed gate, globe, check and relief valves are also accepted.

A sampling valve to be installed in the emulsion feed line immediately after the blender.

501.28.04 Pumps - Sulphur to be supplied to the mixing plant by a positive displacement pump, placed at the outlet manifold from the storage tank.

501.28.05 Storage Tanks

i) Storage tanks to be insulated. Coils to be able to maintain the sulphur at a temperature of 127°C to 137°C. Temperature indicators and controllers to be installed.

ii) Sulphur storage tank to have a minimum storage capacity equivalent to 20 hours of maximum plant capacity.

iii) Storage tanks to be grounded.

PART D - CONSTRUCTION

501.31 Spray Prime Coat and Tack Coat

501.31.01 Prepared Granular Bases and Old Pavements

- All prepared granular bases or old pavements which are to be paved shall be prime coated or tack coated at specified rates.

501.31.02 Liquid Asphalt - Prime Coat or Tack Coat -

The liquid asphalt for prime coat or tack coat shall be applied when surface and weather conditions are favourable and when the air temperature is above 10°C and rising.

501.31.03 Tack Coating - Surface - The surface to be tack coated shall be cleaned of dirt and other foreign material by brooming or other acceptable methods.

501.31.04 Liquid Asphalt - Spray Temperature - The liquid asphalt shall be sprayed at a designated temperature within the temperature range which corresponds to a kinematic viscosity of 100 to 150 mm²/s.

501.31.05 Vertical Surfaces - The vertical surfaces of roadway appurtenances shall be hand sprayed with liquid asphalt to the top of the new pavement only. Over spraying shall be cleaned.

501.31.06 Spray Overlapping - The liquid asphalt spray

$$E = \frac{\text{Material that Passed the Splitting Screen}}{\text{Total Aggregate Material Smaller than the Splitting Screen}} \times 100$$

shall not be excessively overlapped.

501.31.07 Spraying Faults - Any spraying faults resulting from the Contractor's method of operation shall be corrected.

501.31.08 Excess Liquid Asphalt - Any excess liquid asphalt remaining unabsorbed shall be blinded with sand or fine aggregate.

501.31.09 Traffic - Traffic shall not be permitted on tack coat until it has cured and on prime coat until the primer has

been absorbed into the granular surfacing.

Where it is not possible to keep the traffic off the treated surface, the surface shall be blinded with sand or fine aggregate prior to allowing traffic.

501.31.10 Prime Coat and Tack Coat - Curing -

Normally prime coats shall be allowed to cure for a minimum of 24 hours prior to the placing of asphalt mix. No asphalt mix shall be placed on fresh tack coat that has not had a minimum of 30 minutes to cure.

501.31.11 Prime Coat - Maintenance - The Contractor shall, maintain the prime coat and/or tack coat.

501.31.12 Tack Coat - Application - Tack coat shall not be applied on sections of roadway longer than can be covered by one day of asphalt plant production.

501.32 Stockpiling Aggregates

501.32.01 Aggregates - The Contractor shall supply all aggregates for the work from approved sources. Ministry of Transportation pits may be used provided they are developed and worked in accordance with DBSS 202 Part C and the pit development plan. Deviation from the pit development plan will require the approval from the Ministry Representative. No guarantee is given or implied that aggregate from Ministry pits will meet the Specification requirements or provide requisite quantities.

501.32.02 Not Used

501.32.03 Stockpile Construction - Stockpiles shall be constructed as specified in DBSS 202.21. For drum mixer or continuous or batch plant using cold feed gradation control the Contractor will be required to split the aggregate into coarse and fine stockpiles.

The method and screen size used to split the aggregate will be as follows:

Generally, the screen size separating the coarse from the fines shall be 6.3 mm.

- Screening efficiency is calculated as follows:
- Allowable operating variation in screening efficiency shall be 5%.
- Screening efficiency shall in no case be less than 85%.
- The percentage split for each stockpile shall be provided to the Ministry Representative by the Contractor by the time that 25% of the paving aggregate is placed in stockpile(s). This information is to be provided in writing. From the start of production until 25% of the material is in stockpile the contractor shall have a maximum carry-over on the splitting screen of 15% and at no time shall vary by more than $\pm 2.5\%$.

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501.32.04 Crushed Aggregates - Aggregates crushed during the plant-mixing operation shall be stockpiled in such a manner as to avoid their direct feeding into the mixing plant.

501.32.05 Stockpiles - Stockpiles of different types of material shall be located and constructed in such a manner as to prevent intermingling of the types.

501.32.06 Supplementary Aggregate - Prior to the commencement of the plant mixing the total estimated quantity of supplementary aggregate shall be stockpiled at the plant site.

501.33 Mixing Plant Operation

501.33.01 Mixers

i) With pugmill mixers the asphalt mix aggregate shall be dry mixed for a minimum period of ten seconds. The wet mixing time of the asphalt mix shall be a minimum period of 30 seconds, although this period will be increased, if required, to ensure that a uniform, evenly coated mixture is produced.

ii) With drum mixers, the mix retention period shall be dictated by the time required to ensure complete coating.

501.33.02 Rejection and Disposal - All asphalt mix failing to meet the requirements of this section will be rejected and shall be disposed of at the Contractor's expense as approved by the Ministry Representative and shall meet all environmental requirements.

501.33.03 Residual Coating of Particles - Asphalt mix aggregate particles shall not be coated with residue from improper fuel combustion.

501.33.04 Lubrication - Lubrication of conveyor belts with diesel fuel will not be permitted.

501.34 Hauling the Asphalt Mix

501.34.01 Hauling Vehicles - General - The hauling vehicles shall have tight smooth metal boxes cleaned of all accumulations of asphalt mix and foreign materials. Prior to loading, the truck box may be lightly lubricated with a heat resistant asphalt releasing emulsion, having a maximum silicone content of 1 part per 1000 parts of diluted emulsion. Lubrication with diesel fuel will not be permitted.

501.34.02 Insulation - All vertical sides of truck boxes shall be adequately insulated.

All haul vehicles shall be equipped with and use at all times an insulated tarpaulin of such size so as to completely protect the asphalt mix from the weather.

501.34.03 Mechanical Condition - Haul vehicles shall be in sound mechanical condition and free from oil and fuel leaks.

501.34.04 Not Used

501.34.05 Delivery - Asphalt mix shall be delivered to the paver at a constant rate sufficient to allow continuous placement.

501.35 Placing the Asphalt Mix

501.35.01 - When in the vicinity of an operating paver, workers and inspectors shall stand in full view of the paver operator, clear of side arms and screed, and never in front of the machine hopper.

501.35.02 - Asphalt mix shall only be placed on clean dry surfaces free from all foreign materials, when weather and conditions are suitable.

All lifts of asphalt mix shall only be placed on a dry surface when the ambient air temperature is 5°C and rising and in addition, the top lift shall not be placed when the average surface temperature is below 10°C. The temperature shall be taken in the centre of the travelled lane being paved.

501.35.03 Pick-up Machines - When this type of equipment is utilized, the Contractor will only place the equivalent of two tandem loads of mix on the roadway at any given time.

501.35.04 Asphalt Levelling Course - Prior to the placement of an asphalt pavement overlay, sections of the existing pavement may require a levelling course of asphalt mix to correct superelevation and to level the roadway as required.

501.35.05 Asphalt Levelling Course - Requirements - Asphalt levelling course shall be the class of asphalt pavement as stated in the Contract and shall meet all the requirements of this Section.

501.35.06 Paving Machine - The asphalt mix shall be placed by a self-propelled paving machine equipped with an activated screed and strike-off that are heated. The machine shall be capable of spreading the mix to the thicknesses and widths as indicated in the Contract and the Design. A lift thickness shall be not less than 2.0 times nor more than 3.5 times the maximum designated aggregate size of the mix.

501.35.07 Paving Machine - Equipment - The paving machine shall be equipped with an automatic grade control device capable of controlling the spreading of the asphalt mix to the desired longitudinal grade and to the designated transverse slope within 1.5 mm/m.

501.35.08 Speed

- i) The speed of the paver shall be adjusted to achieve a continuous lay-down operation producing a smooth homogeneous mat, which meets the requirements of this section. All efforts shall be made to ensure a smooth continuous paving operation with minimal paver stops.
- ii) When paver speed is in excess of 300 m per hour, the Contractor shall be required to have two qualified joint rakers raking the joint.

501.35.09 Processing - During the processing of asphalt mix windrowed in front of pick-up machines the temperature loss between the haul vehicle and the paver hopper shall not exceed 8°C in any part of the windrow.

501.35.10 Placing - Other Methods - When it is impractical to spread and finish the asphalt mix by paving machine, it may be placed and spread by other methods consistent with prevalent construction practices.

501.35.11 Hydraulic Screed Extension - Hydraulic screed extension duplicating the effectiveness of the main screed may be used for narrow pavement widenings. If it is determined that the screed extension is affecting the ride of the finished pavement, it shall be removed from the paving machine.

501.35.12 Longitudinal Joints - Longitudinal joints in the top lift of asphalt pavement will only be permitted where lane dividing lines are to be painted.

Longitudinal joints in a lift shall be offset at least 150 mm from joints in the underlying lift.

Longitudinal joints in underlying lifts shall not be offset more than 150 mm from lane dividing lines.

501.35.13 Traffic - Traffic shall be minimized over an unmatched longitudinal.

501.35.14 Longitudinal Edge - At places where the unprotected longitudinal edge of previously placed mat has been damaged by traffic or equipment it shall be trimmed to provide a standard abutting face against which new mix can be placed and compacted.

501.35.15 Contact Edge - The contact edge of abutting cooled pavements shall be thoroughly painted with a thin uniform coat of emulsified asphalt supplied by the Contractor.

501.35.16 Paving Adjoining Parallel Mats - When paving an adjoining parallel mat there shall be at least a 50 mm overlap onto the previously paved surface. This overlap shall be properly "raked" to form a homogeneous bond

between the two mats.

501.35.17 Raking - Any material that is "raked" from the joint shall be placed in a wheelbarrow and deposited and immediately levelled on the shoulder where it can be covered by shoulder aggregate, for all lifts of paving, unless otherwise directed by the Ministry Representative. At no time shall "raked" material be placed in front of the paver.

501.35.18 Discontinued Paving - When paving is discontinued in any lane on a traffic bearing roadway, the asphalt pavement shall be tapered down at a maximum slope of 25:1. From the location of the tar paper letdown there shall be at least 1.0 m of pavement that follows the profile and grade of the pavement prior to the start of the 25:1 taper (see SS Drawing SP501-04).

When paving resumes and the tar paper letdown is lifted it shall be loaded out for disposal as it is removed. Disposal shall be in an environmentally sound manner.

When paving resumes, the temporary taper shall be cut back to provide a straight vertical face at the transverse joint, which shall be heated and painted as specified in DBSS 501.35.15.

501.35.19 Contact Faces - Contact faces of curbs, gutters, manholes, catchbasins, headers, etc., shall be painted as specified in DBSS 501.35.15 before placing the asphalt pavement.

501.35.20 Fixed Structures - After compaction, the pavement surface adjacent to gutters, manholes, headers or other fixed structures shall be slightly higher than the surface of such structures, but never exceeding 6 mm.

501.36 Compacting the Asphalt Mix

501.36.01 Compaction - The asphalt mix shall be compacted to a minimum density consistent with the requirements of DBSS 501.17.

The Contractor shall supply compaction equipment of specific types to ensure a uniform degree of compaction and surface finish consistent with the requirements of this section. However, one rubber tired roller having a minimum mass of 15 t and capable of providing one complete coverage equal to the rolling width of the machine in one pass, will be required on every project.

Once the compacting effort required to obtain the specified degree of compaction and surface finish is ascertained, the compacting effort and procedure shall not be changed without the written permission of the Quality Manager.

501.36.02 Equipment - Compaction equipment shall be capable of producing the required density and surface finish.

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501.36.03 Wheels - The wheels of compaction equipment in contact with the asphalt mix shall be clean. In addition, compactors shall be equipped with mats.

All wheels shall be moistened by water or by an approved diluted asphalt release agent to prevent pickup

501.36.04 Operation - Compaction equipment shall normally be operated with the drive roll or wheels nearest the paving machine.

501.36.05 Longitudinal Joints - Longitudinal joints shall be rolled immediately behind the paving operation, after which rolling shall begin longitudinally at the lower edge of the mat proceeding toward the higher edge of the mat overlapping on successive passes by at least one half of the effective roller width.

501.36.06 Roller Speed - The speed of the roller shall not

$$\text{Degree of Compaction} = \frac{\text{In-Place Dry Density}}{\text{Maximum Dry Density}} \times 100$$

exceed 8 km/h.

501.36.07 Rollers - Rollers shall not be driven on to, or off, the unprotected longitudinal edge of the unfinished mat, nor will rollers be allowed to park on the mat prior to complete cooling.

501.36.08 Vibrating Tampers and Hand Rollers - Along curbs, manholes, headers and similar structures which are not accessible to rollers, thorough compaction shall be obtained by use of vibrating tampers and hand rollers.

501.36.09 Traffic - Traffic will not be permitted on the finished pavement until it has cooled to such a temperature as to ensure that no deformation or excess flushing of the surface will occur.

501.37 Shouldering - The materials, equipment and work practice required for the construction of granular shoulders shall be as follows:

- a) The gradation of the crushed aggregate supplied for granular shoulders shall be within the limits set for medium mix under DBSS 501.15.01 and

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DBSS 501.15.02, or as specified by the Ministry Representative, and the aggregate quality shall meet all the requirements of DBSS 202.

The finished surface of the granular shoulder shall be true to grade and cross section, and be free from ruts, ravel, segregation or other irregularities.

b) Shouldering machines shall comply with the following minimum requirements:

- The machine shall travel on the adjacent asphalt pavement on pneumatic tires or rubber tracks.
- The machine may be self-propelled, towed or pushed.
- The speed of the aggregate feeder shall be adjustable and the feeder shall have sufficient power to feed required quantities of aggregate.
- The machine shall have an adjustable strike-off and cut-off plate to regulate the depth, width and cross slope of the deposited shoulder aggregate.
- The machine shall be capable of spreading material from widths of 0.5 m to 2.5 m.
- All granular shoulder materials shall be handled in such a manner that segregation does not occur.

c) If necessary for compacting, water shall be applied to the granular shoulders.

The in-place dry density of the granular shoulders will be obtained at random locations, after completion of final rolling.

The Degree of Compaction of each in-place density test will be computed from the formula:

The average Degree of Compaction of the granular shoulder shall be greater than 98%.

d) If the adjacent asphalt pavement is damaged during the shouldering operation, the damage shall be repaired.

e) For safety reasons, when a roadway with gravel shoulders is used by the travelling public, an intermediate layer of shouldering aggregate shall be placed following final rolling of levelling course or multiple lifts of asphalt pavement thicker than 50 mm, in advance of the main shouldering operation.

APPENDIX A

1) MARSHALL DESIGN CRITERIA

(See DBSS 501.15.06)

PROPERTY OF LABORATORY COMPACTED PAVING MIXTURE	A.M. or R.A.M. PAVEMENT CLASS		A.B.C. or R.A.B.C. PAVEMENT CLASS	
	1	2	1	2
ESALs	$>10^6$	$<10^6$	$>10^6$	$<10^6$
Number of blows each face of test specimens	75	75	75	75
Minimum % Voids in mineral aggregate for maximum particle size: 25.0 mm	---	13	13	13
Minimum % Voids in mineral aggregate for maximum size: 19.0 mm	14	14	---	---
Minimum % Voids in mineral aggregate for maximum size: 12.5 mm	14	14	---	---
Minimum % Voids in mineral aggregate for maximum size: 9.5 mm	16	16	---	---
Percentage of air voids in laboratory compacted mixture for: Coarse Mix	---	3 to 8	4 to 6	3 to 8
Percentage of air voids in laboratory compacted mixture for: Medium Mix	3 to 5	3 to 5	---	---
Percentage of air voids in laboratory compacted mixture for: Fine Mix	4 to 6	3 to 8	---	---
Minimum Marshall Load, N @ 60°C for 80 - 100	9000	7000	8000	7000
Minimum Marshall Load, N @ 60°C for 150 - 200 and 200 – 300	7000	6000	7000	6000
Flow index, units of 0.25 mm	8 to 14	8 to 16	8 to 14	8 to 16
Minimum Index of Retained Stability after immersion in water at 60°C for 24 hours	85%	75%	---	---

SECTION 502

END PRODUCT SPECIFICATION FOR ASPHALT PAVEMENT CONSTRUCTION

PART A - GENERAL

502.01 Preliminary and General – This Section describes the materials, equipment, professional standards and end product requirements for the construction of hot mixed hot laid asphalt pavement.

End Product Specifications contain the acceptance and payment criteria based on the results of specified sampling and testing. Payment for the asphalt pavement product is subject to adjustments upward and downward in accordance to the provisions provided in End Product Specifications (EPS).

502.02 General Description Of Work - Generally, the work associated with the construction of asphalt pavement by EPS consists of the following:

- Preparing a Quality Management Plan before commencing the Work and providing at the production site a testing facility to provide the data needed to implement that plan.
- Supplying, screening, crushing, processing and improving aggregate to produce asphalt mix aggregate.
- Supplying and delivering asphalt cement and spray primer meeting the requirements of DBSS 952.
- Preparing mix designs which, once reviewed and accepted by the Quality Manager, become the basis for the accepted Job Mix Formula.
- Heating the asphalt mix aggregate and mixing it with asphalt cement to produce asphalt mix that meets the Job Mix Formula.
- Hauling, placing, compacting and finishing the asphalt mix.

The Contractor shall provide an end product conforming in quality and accuracy of detail to the dimensional and tolerance requirements of the contract. Where no tolerances are specified, the standard of workmanship shall be in accordance with normally accepted good practice and those identified in DBSS 501. Payment is subject to adjustments based on quality acceptance tests performed by the Ministry Representative and calculations performed by the Contractor with respect to application rate.

502.03 Definitions Relevant To End Product Specification

502.03.01 End Product Specification (EPS) - A specification whereby the Contractor is entirely responsible for quality control of the construction processes, and

whereby the Ministry performs the specified quality audit sampling and testing of the end product for the purpose of determining acceptance/rejection and payment adjustment.

502.03.02 Job Mix Formula - The Job Mix Formula establishes the aggregate proportions, gradation, and the asphalt content to be used for production of asphalt mix. The Job Mix Formula is based on a reviewed asphalt mix design, in accordance with DBSS 502.05.07, or on an accepted variation in accordance with DBSS 502.05.09. In either case, each Job Mix Formula requires an independent evaluation.

502.03.03 Asphalt Content - Asphalt Content means the quantity of asphalt cement in the mix expressed as a percentage by weight of the total dry aggregate in the mix.

Design Asphalt Content - The asphalt content upon which the Job Mix Formula is initially established.

Approved Asphalt Content - The design asphalt content or subsequent adjustment to it, embodied in a Job Mix Formula or revised Job Mix Formula which has been evaluated in writing by the Ministry Representative.

Actual Asphalt Content - Actual asphalt content is the amount of asphalt cement in the mix as determined by the Ministry's Quality Audit Program.

502.03.04 Smoothness - Smoothness is a measure of the longitudinal profile of the pavement surface. The unit for measurement is the International Roughness Index (IRI).

502.03.05 Sample Mean - The Sample Mean is the arithmetic mean of a set of test results constituting the sample.

502.03.06 Stratified Random Sample - A Stratified Random Sample is a set of test measurements taken one each from a number of separate (stratified) areas or Sub-Lots within a Lot in an unbiased way.

502.03.07 Lot - A Lot is a portion of the work being considered for acceptance and for the determination of payment. A Lot is defined as follows.

For the application of the contract requirements for:

- Density,
- Asphalt Content,
- Aggregate Gradation, and
- Material Application Rate,

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END PRODUCT SPECIFICATION FOR ASPHALT PAVEMENT CONSTRUCTION

A Lot shall be one day's scheduled production of at least 7 hours plant production where no changes have occurred to criteria such as but not limited to:

- accepted Job Mix Formula,
- the specific lift that is being placed,
- the required material application rate.

A change in any above criteria may require a new Lot designation.

One day's production of less than 7 hours will be dealt with as follows:

- the material will be added to the next Lot that has the same criteria, as described above, except that if a test indicates that this production is subject to a payment adjustment or to rejection, or if no further material will be produced with the same criteria, this production will be designated as a separate Lot,

A Lot shall be no more than two days total production even if the above criteria have not changed or been met.

For application of the contract requirements for:

- segregation, and
- smoothness,

A Lot shall be one kilometre length of top lift pavement for each driving lane.

502.03.08 Sub-Lots for Density, Asphalt Content, Gradation, and Smoothness - For the application of the contract requirements for:

- density, asphalt content, and gradation, each Lot shall be divided into three equal Sub-Lots, defined by lineal metres of production.
- smoothness, each Lot shall be divided into 100 metre Sub-Lots.

502.03.09 Driving Lane - A driving lane shall mean a single lane in any area of the pavement other than a shoulder or a barrier flare.

502.03.10 Not Used

502.04 Quality Control

502.04.01 General - Quality Management, by the Contractor, is the sum total of activities by the Contractor to ensure that a product meets contract specification requirements. Quality Management includes material handling and construction procedures, calibration and maintenance of equipment, production process control and any sampling, testing and inspection that is done for these

purposes.

The Contractor is responsible for all Quality Management under this specification. The Ministry Representative will audit and monitor the Contractor's operations and the implementation of the Contractor's Quality Management Plan.

The Ministry will not take samples for quality control or quality assurance testing and will in no manner assist in any degree or in any aspect of the Contractor's operation in the production of asphalt pavement, beginning from the production of aggregate through the compaction of asphalt mix.

The Ministry Representative may issue a Stop Work Order to the Contractor if the Contractor fails to adhere to the Quality Management Plan. The Ministry Manager will not issue a Resume Work Order until the Contractor has given the Ministry Representative satisfactory assurance that it has in place adequate capacity to fulfil the requirements of the Quality Management Plan.

502.04.02 Quality Management Plan - The Contractor shall prepare a detailed written Quality Management Plan that fulfils or exceeds the requirements of Appendix 1 and functions integrally with any other Quality Management provisions of the Contract. The Contractor's Quality Management Plan shall be submitted to the Ministry Representative not less than five working days before the production of paving aggregate is started. The Ministry Representative will review the plan for approval based on whether or not it meets the Quality Management Requirements and Guidelines, and will respond, in writing, within five days. Any subsequent change to the Contractor's Quality Management Plan must also be submitted to the Ministry Representative, for approval, not less than twenty-four hours before such change is implemented.

The Contractor's Quality Management Plan shall include a description and schedule of the intended sampling, testing and reporting. The Quality Management Plan must also include a detailed description of the means by which the Contractor shall use the quality management test results to ensure that the asphalt materials, aggregate, mix production, paving and pavement compaction processes will be controlled to keep the end product within the specified limits. The Quality Management Plan must clearly show the flow of information from the laboratory to the individuals who shall make the actual adjustments to the processes and equipment to affect this control. The plan will show time allowance for each step, the names and positions of all the people involved, and a clear description of the responsibilities of each.

TABLE 502-A-1 – STANDARD SAMPLING AND TESTING PROCEDURES FOR AGGREGATES

All aggregate tests shall use the following sieve sizes:

37.5mm, 25mm, 19mm, 16mm, 12.5mm, 9.5mm, 4.75mm, 2.36mm, 1.18mm, 0.600mm, 0.300mm, 0.150mm, and .075mm.

Item	Procedure	Test Reference No.
1	Sieve Analysis of Fine And Coarse Aggregates	ASTM C-136
2	Materials Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregate by Washing	ASTM C-117
3	Specific Gravity and Absorption of Coarse Aggregate	ASTM C-127
4	Specific Gravity and Absorption of Fine Aggregate	ASTM C-128
5	Determining the Percentage of Fractured Particles in Coarse Aggregate	ASTM D-5821
6	Total Moisture Content of Aggregate by Drying	ASTM C-566
7	Standard Practices for Sampling of Aggregates	ASTM D-75

TABLE 502-A-2 – STANDARD SAMPLING AND TESTING PROCEDURES FOR ASPHALT CEMENT

Item	Procedure	Test Reference No.
1	Penetration of Bituminous Materials	ASTM D-5
2	Viscosity of Asphalt by Vacuum Capillary Viscometer	ASTM D-2171

502.04.03 Quality Management Testing and Inspection -

The Contractor shall provide and maintain equipment and qualified personnel to perform all laboratory testing, field testing and inspection necessary to determine and monitor the characteristics and properties of all the materials produced and incorporated into the work. They shall also monitor the workmanship of the final product in accordance with the Quality Management Plan as most recently submitted.

The Contractor's Quality Management testing and inspection shall be done under the direction of the Quality Manager.

The Contractor shall provide a testing facility(s) that meets the requirements necessary to carry out all the test procedures listed within this Section. The facility(s) must have the equipment specified under the appropriate test

designation to perform the tests. The Ministry shall have access at all times to the quality control facility(s).

502.04.04 Quality Management Records - The results from quality testing shall be reported on test logs and plotted on charts immediately after each test is completed. The Contractor shall report all test results on Ministry supplied forms available from the Ministry Representative. Reports and charts shall be available for viewing to the Ministry Representative, within 24 hours of the end of each shift.

For the purposes of confirming delivery of asphalt mix to the road and the calculation of material application rates, the Contractor shall consolidate the Road Checker's Summary and the weigh tickets for each load received at the paving operation at the end of each shift. The Road Checker's Summary shall include, but not be limited to, the following information:

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- a) Truck Number
- b) Weigh Ticket Number and Net Weight of load
- c) Time and location by station of delivery
- d) Material Application Rate Dimensions and Calculations. Calculation frequency minimally shall be for every 10 loads.
- e) Notes pertaining to the paving of any appurtenances (letdowns, intersections, tapers, etc.)

ASTM test procedures are to be followed.

All equipment and the laboratory shall be well maintained and in good working condition. All testing equipment shall be calibrated and evidence of the calibration shall be provided when requested by the Ministry Representative. For the purpose of obtaining accurate and consistent results between the Contractor's Quality Management testing and the Ministry's Quality Audit testing, correlation of the Marshall hammer and ignition ovens to be used on the project shall be performed during the verification of the Job Mix Formula.

TABLE 502-A-3 – STANDARD SAMPLING AND TESTING PROCEDURES FOR ASPHALT MIX AND PAVEMENT

Item	Procedure	Test Reference
1	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures	ASTM D-2726
2	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens	ASTM D-1188
3	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	ASTM D-1559
4	Effect of Water on Compressive Strength of Compacted Bituminous Mixtures	ASTM D-1075
5	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures	ASTM D-2041
6	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures	ASTM D-3203
7	Calculating Percent Asphalt Absorption by the Aggregate in an Asphalt Pavement Mixture	ASTM D-4469
8	Sampling Compacted Bituminous Mixtures for Laboratory Testing	ASTM D-5361
9	Determining Asphalt Content by Ignition Method	ASTM D-6307
10	Combining Loose Mix for the purpose of Determining Asphalt Content and Gradation	<u>APPENDIX 2</u>

TABLE 502-A-4 – TEST SAMPLE SOURCE LOCATIONS

Test	Sample Source:
Density	100mm dia. road cores; 150mm dia. Road cores for Superpave
Asphalt Content	Loose Mix Samples
Smoothness	<u>Centre of the Lane</u>
Aggregate Gradation	Loose Mix Samples
Segregation	Roadway Pavement

502.04.05 Final Quality Management Testing Reports -
Prior to the issuance of a Completion Certificate, the Contractor shall provide the Ministry Representative with:

- a summary of all aggregate quality test results;
- copies of all quality test results for asphalt mix properties and compaction; and
- copies of all quality charts.

502.04.06 Minimum Acceptable Construction Practices -
Good construction practices shall be considered as standard construction procedures to be followed and shall include but not be limited to the procedures described below.

Tack Coating - The surface to be tack coated shall be cleaned of dirt or other foreign material.

Vertical Surfaces – Vertical surfaces of roadway appurtenances shall be hand sprayed to the top of the new pavement only.

Tack Coat – Application – Tack coat shall not be applied on sections of roadway longer than will be covered by one day of asphalt plant production.

Stockpiles – Stockpiles of different types of material shall be located and constructed in such a manner as to prevent intermingling of the types and to prevent segregation.

Haul Vehicles – Lubrication of the truck boxes with diesel fuel will not be permitted. All vehicles shall have adequately insulated truck boxes and shall be equipped with an insulating tarpaulin of such size as to completely protect the asphalt mix.

Longitudinal Joints – Longitudinal joints in the top lift of asphalt pavement will only be permitted where lane dividing lines are to be painted. Longitudinal joints in a lift shall be offset at least 150 mm from joints in the underlying lift.

Longitudinal Edge – Where an unprotected longitudinal edge has been damaged by traffic or equipment it shall be trimmed to provide a vertical abutting face.

Contact Edge – The contact edge of abutting cooled asphalt pavement shall be thoroughly painted with a uniform coat of emulsified asphalt.

Paving Adjoining Mats – When paving an adjoining parallel mat there shall be at least a 50-mm overlap onto the previously paved surface. This overlap shall be properly constructed to form a homogeneous bond between the two mats.

Raking – Any material that is raked from the joint shall not be placed on the new mat or placed in or in front of the

paver. The Contractor shall dispose of the material in an environmentally acceptable manner.

Discontinued Paving – When paving is discontinued in any lane on a traffic bearing roadway, the asphalt pavement shall be tapered down at a minimum slope of 25:1. When paving resumes this letdown shall be cut back so as to form a vertical face that matches the required depth being paved. Material removed from the taper shall be disposed of in an environmentally friendly manner.

Rollers – Rollers shall normally operate with the drive wheel nearest the paver and at a speed not in excess of 8 km/h. They shall not be driven on to or off, the unprotected longitudinal edge of the unfinished mat and shall not be allowed to park on the mat prior to complete cooling.

502.05 Supply Of Aggregates, Asphalt Materials, Asphalt Mix Design And Job Mix Formula

502.05.01 Work in Ministry Pits or Quarries - When operating in a Ministry pit or quarry, the Contractor shall comply with all provisions of DBSS 145.26.

502.05.02 Supply of Aggregates, Aggregate Production and Characteristics -The Contractor shall not produce paving aggregate until the Contractor has received written notification that their Quality Management Plan is in accordance with DBSS 502.04.02, and has in place testing facilities for aggregate production that are in accordance with the Quality Management Plan.

For the production of Asphalt Mix Aggregate, within Ministry pits, the Contractor shall provide crushing equipment such that all aggregate which will pass through 375 mm x 450 mm slotted openings shall be used for the production of crushed aggregate. Rocks, which will not pass through these openings, shall be stockpiled to the satisfaction of the Ministry Representative. Crushing and screening equipment shall be provided with adequate facilities and capacity to be able to bleed off reject aggregate and remove any excess fine aggregate, dust or objectionable aggregate coatings, to make it generally acceptable for use. No portion of the products from crushing or screening plants that can be used shall be wasted, but shall be stockpiled or used to the satisfaction of the Ministry Representative.

Where the Ministry has available any test result information on the properties shown in Table 502-B, for a Ministry pit or other source, the Ministry Representative will upon request, provide that information to the Contractor. Otherwise, sampling and testing to determine and demonstrate the compliance of paving aggregate with the requirements of this Section shall be the responsibility of the Contractor.

Paving aggregates shall meet the following requirements:

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a) Coarse Aggregates

- i) shall be all mineral matter retained on the sieve designated in the test procedures for each individual test.
- ii) shall consist of crushed stone, crushed gravel, or combination thereof, or materials naturally occurring in a fractured condition, or materials naturally occurring of highly angular nature or rough texture.
- iii) shall be free from coating of clay, silt or other deleterious material, and
- iv) shall meet the requirements listed in Table 502-B.

b) Fine Aggregate

- i) shall be all mineral matter passing the sieve designated in the test procedure for each individual test.
- ii) shall be clean, tough, durable, moderately sharp, and free from coatings of clay, silt, or other deleterious material, and shall contain no clay balls or other aggregations of fine material.
- iii) shall have a maximum mass loss after five cycles of not more than 18% and 23% for pavement Class 1 and 2 respectively when tested in accordance with ASTM Test C-88.
- iv) shall have a sand equivalent of not less than 40 when tested in accordance with ASTM Test D-2419
- v) shall have a minimum value of 45 when tested

according to the AASHTO Test T 304, Method "A", - Uncompacted Void Content of Fine Aggregate when determining Fine Aggregate Angularity.

c) Mineral Filler and Mineral Dust

- i) Mineral filler shall consist of all matter passing the 0.600-mm sieve and mineral dust shall consist of all mineral matter passing the 0.075-mm sieve.
- ii) Mineral filler and mineral dust shall be free from organic matter.
- iii) Mineral filler shall be non-plastic when tested in accordance with ASTM Test D-4318.
- iv) determination of aggregate properties and gradation for Superpave

d) For the purposes of the mix design for Superpave, the gradation of the design mix and the subsequent Job Mix Formula, shall be of the properties and the gradation limits as specified below and in accordance with the SHRP Standards for a Superpave Level I Mix Design contained in the Asphalt Institute's Superpave Series Publication - Superpave Level I Mix Design SP-2. Changes and/or variations from these limits shall be outlined within the Contract Special Provisions.

- i) 90% fractured aggregate with a 12.5mm nominal maximum size, including sufficient manufactured fines to provide fine aggregate angularity. The aggregates must meet all the requirements for angularity, toughness, soundness, deleterious materials, clay content and thin, elongated particles. Design ESALs will be as specified in the

TABLE 502-B – REQUIREMENTS FOR COARSE AGGREGATES

TEST REF. #	PROCEDURES	PAVEMENT CLASSES		
		Super pave	1	2
ASTM C-127	Maximum Water Absorption: % by mass	2	2	2
ASTM C-88	Soundness of Aggregate Maximum loss after 5 cycles	15	15	20
ASTM C-142	Maximum % by mass of clay balls and friable particles	1.0	1.0	1.5
ASTM D-6928	Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	17	17	17
ASTM D-5821	2 Fractured Faces: Minimum % by Mass retained on the 4.75 mm sieve	90	85	70

Contract, or if not specified, 30 million.

ii) A dense graded gradation with a 19.0mm maximum size aggregate restricted to the following:

1) Passing below the following boundaries of the aggregate restricted zone:

PERCENT PASSING BOUNDARIES for 12.5mm Nominal Max. Aggregate Size		
SIEVE SIZE	Minimum	Maximum
2.36mm	39.1	39.1
1.18mm	25.6	31.6
0.600mm	19.1	23.1
0.300mm	15.5	15.5

2) The design gradation shall be within the following specified control points:

CONTROL POINT (PERCENT PASSING)		
SIEVE SIZE	Minimum	Maximum
0.075mm	2.0	10.0
2.36mm	28.0	58.0
9.5mm	-	90.0
Nominal Maximum (12.5mm)	90.0	100.0
Maximum (19.0mm)	100.0	-

502.05.03 Supply of Asphalt Cement and Spray Primers

- The Contractor shall supply the types and grades of asphalt cement and spray primers as specified in the Contract and in accordance with DBSS 952. The supply of these materials includes, but is not limited to, ordering, scheduling delivery of, receiving, handling, storing, sampling, and testing of the materials and other related work.

The Contractor shall, upon request, supply the Ministry Representative with copies of the asphalt supplier's weigh-bill and records of all asphalt materials received on a daily basis.

502.05.04 Responsibility for Asphalt Mix Design -

Preparation and submission of the project asphalt mix designs for review by the Quality Manager is the responsibility of the Contractor. All costs incurred in mix design formulation are the responsibility of the Contractor.

The Contractor shall utilise a qualified registered member of the Association of Professional Engineers and Geoscientists of British Columbia or a qualified, registered member of the Applied Science Technologists and Technicians of British Columbia who shall sign off the asphalt mix design. The Contractor shall also utilise a qualified testing laboratory meeting the requirements of DBSS 502.04.03 and acceptable to the Quality Manager, to assess the aggregate material proposed for use and to carry out the asphalt mix designs.

502.05.05 Requirements for Asphalt Mix Design - The asphalt mix design for Class 1 and Class 2 pavements shall be carried out under the design criteria for Marshall design using the designated equipment and procedures as contained in the Asphalt Institute's Mix Design Methods for Asphalt Concrete MS-2, latest edition.

Asphalt mix designs, Job Mix Formulas and field adjustments made in accordance with DBSS 502.05.09, must all be based on an aggregate gradation meeting the requirements of Table 502-C-1.

The divergence limits, as defined in Table 502-G, when applied to the gradation of the Job Mix Formula, shall not result in a gradation that is outside of the limits as shown in Table 502-C-1.

The Superpave asphalt mix design shall be carried out in accordance with the Superpave Level I Mix Design contained in the Asphalt Institute's Superpave Series Publication - Superpave Level I Mix Design SP-2.

Asphalt mix designs shall be performed using asphalt cement of the penetration grade described in the Contract and Design and which is from the same refinery contracted to supply the asphalt cement for the duration of the project.

Any subsequent change in the asphalt cement supplied by the Contractor will require a new asphalt mix design unless permitted otherwise by the Ministry Representative.

Marshall asphalt mix designs shall be performed to meet the criteria specified in Table 502-C-2 for the class of pavement specified in the Contract and Design.

The asphalt cement content shall be selected such that all aspects of the design criteria are met. After the design asphalt cement content is selected by the Contractor, the Ministry retains the right at the sole discretion of the Ministry, to bump or increase the design asphalt cement content by 0.2 %.

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TABLE 502-C-1 – AGGREGATE GRADATION LIMITS

SIEVE SIZE (mm)	PERCENTAGE PASSING BY MASS			
	COARSE ASPHALT MIX	MEDIUM		FINE ASPHALT MIX
		19 mm ASPHALT MIX	16mm ASPHALT MIX	
37.5	100	---		---
25.0	80 – 100	---		---
19.0	60 – 92	100		---
16.0	---	---	100	
12.5	50 – 85	84 – 95	90 – 100	100
9.50	40 – 80	73 – 90	73 – 90	90 – 100
4.75	30 – 65	50 – 75	50 – 75	55 – 80
2.36	20 – 50	35 – 57	35 – 57	32 – 64
1.18	15 – 35	26 – 45	26 – 45	24 – 51
0.600	8 – 30	18 – 34	18 – 34	17 – 40
0.300	6 – 22	10 – 26	10 – 26	13 – 29
0.150	3 – 15	6 – 17	6 – 17	8 – 18
0.075	1 – 7	3 – 7	3 – 7	4 – 10

TABLE 502-C-2 – MARSHALL DESIGN CRITERIA

PROPERTY OF LABORATORY COMPACTED PAVING MIXTURE	PAVEMENT CLASS	
	1	2
Number of blows each face of test specimens	75	75
Minimum % Voids in mineral aggregate for maximum particle size: 25.0 mm	--	13
Minimum % Voids in mineral aggregate for maximum particle size: 19.0 mm	14	14
Minimum % Voids in mineral aggregate for 16 mm Asphalt Mix	14.5	14.5
Minimum % Voids in mineral aggregate for maximum particle size: 12.5 mm	15	15
Minimum % Voids in mineral aggregate for maximum particle size: 9.5 mm	16	16
Percentage of air voids in laboratory compacted mixture for: Coarse Mix	--	3 to 6
Percentage of air voids in laboratory compacted mixture for: Medium Mix	2.5 to 4.5	2.5 to 4.5
Percentage of air voids in laboratory compacted mixture for: 16 mm Mix	2.5 to 4.5	2.5 to 4.5
Percentage of air voids in laboratory compacted mixture for: Fine Mix	4 to 6	4 to 6
Minimum Marshall Load, N @ 60°C for 80 – 100 Pen.	9000	7000
Minimum Marshall Load, N @ 60°C for 150 – 200 and 200 – 300 Pen.	7000	6000
Flow index, units of 0.25 mm	8 to 14	8 to 16
Asphalt Film Thickness	Min. 7.5 microns	Min. 7.5 microns
Minimum Index of Retained Stability after immersion in water at 60°C for 24 hours	85%	75%

502.05.06 Asphalt Mix Design Submittals - The Contractor shall submit each asphalt mix design to the Quality Manager for review that it complies with the requirements of the Contract, and shall not proceed until the review is received in writing from the Quality Manager. Also, the Mix Design shall be submitted to the Ministry Representative for information. The Contractor's submissions shall include the following information:

- The gradation of each aggregate to be used in each mixture.
- The percentage by mass of each aggregate to be used in each mixture.
- The design gradation of the combined aggregate for each mixture.
- All asphalt mix design data used in arriving at the final mix designs.
- The design asphalt content expressed as a percentage of the dry weight of the aggregate.

502.05.07 Review of Asphalt Mix Design - The mix design must be reviewed by the Quality Manager prior to commencement of pavement construction.

When the Quality Manager has confirmed in writing that the Contractor's asphalt mix design has been accepted, the accepted asphalt mix design becomes the Job Mix Formula for the start of production.

502.05.08 - Verification of Job Mix Formula -

Verification of the Job Mix formula will be carried out by the Contractor during the course of production of the first Lot. The Contractor will provide a Job Mix Formula with supporting verification data, which shall include all the information, but not limited to, the requirements of DBSS 502.05.05 and DBSS 502.05.06.

502.05.09 Field Adjustment of Job Mix Formula - A field adjustment to the Job Mix Formula is defined as a change in the asphalt cement content of the mix, aggregate

gradation and/or proportioning of various aggregate sizes, within the specified limits as shown in Table 502 - D without review and acceptance of a new asphalt mix design.

The proposed field adjustment shall be submitted in writing together with supporting documentation to the Quality Manager. The Quality Manager will review the field adjustment for conformance with the contract requirements and notify the Contractor whether or not it is acceptable.

The Contractor's field adjustment to the Job Mix Formula must comply with the Asphalt Mix Design requirements of DBSS 502.05.05 and DBSS 502.05.06. The Contractor shall provide all supporting verification data

After the Job Mix Formula has been established in accordance with DBSS 502.05.09, no field adjustment to that Job Mix Formula will be permitted without prior written acceptance by the Quality Manager. A maximum of two (2) field adjustments may be made to the Job Mix Formula originally derived from the laboratory mix design.

No field adjustment will be acceptable if it results in a change from the Job Mix Formula, for any property, in excess of the maximum adjustment for that property permitted in Table 502-D.

PART B - PAYMENT ADJUSTMENTS

502.11 Density

502.11.01 Coring - The Contractor shall be responsible for providing all core samples for quality testing and payment adjustment purposes. For payment adjustment purposes, the randomly selected locations for the cores shall be supplied by the Ministry Representative to the Contractor, and the cores shall be taken within a 300 mm radius of the specified location. The Contractor shall provide 100mm diameter cores for these purposes. For projects utilizing a Superpave

TABLE 502-D – FIELD ADJUSTMENT OF JOB MIX FORMULA

Job Mix Formula Property	Maximum Field Adjustment
Asphalt cement content, percent	± 0.2
Percentage passing 25.0 mm, 19.0 mm, and 16.00 mm sieves	± 2.0
Percentage passing 12.5 mm and 9.5 mm sieves	± 2.0
Percentage passing 4.75 mm and 2.36 mm	± 1.5
Percentage passing 1.18mm and 0.600mm	± 1.5
Percentage passing 0.300mm and 0.150mm sieves	± 1.5
Percentage passing 0.075 mm sieve	± 0.50

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product, 150mm diameter cores shall be required. The Contractor shall prepare the cores prior to the submission by removing all material not representative of the pavement lift to be tested. The Contractor shall deliver these cores to the Ministry Representative on site, within 24 hours of being provided the locations for the coring.

The Contractor shall fill and compact the core holes immediately after the extraction of the cores.

502.11.02 Percent Density - The average in-place density will be determined from core samples of the completed lift of pavement.

One random core sample will be obtained from each Sub-Lot and the test results for the three Sub-Lots will be averaged to determine the percent density for the Lot.

Marshall Mixes

$$\frac{\text{Marshall Percent Density}}{\text{Density}} = \frac{\text{In-Place Density of Sample}}{\text{Plant Briquette Density}} \times 100$$

For the determination of Mix Briquette Density, the Contractor shall obtain the samples as outlined in Appendix 2 for each Sub-lot.

From each Sub-lot sample, the Contractor will form three briquettes as per the procedure identified in Table 502-A-3 and tested, and the test results will be averaged to obtain the test value for that sample.

The Mix Briquette Density for a Lot is the average of the test results from the three Sub-lots. The Mix Briquette Density value for the Lot shall be provided to the Ministry Representative prior to the provision of the coring locations to the Contractor.

At the discretion of the Ministry Representative, the Ministry may at any time, perform and use the Ministry results in accordance with procedures as outlined above, to obtain the value for Mix Briquette Density which will replace the values achieved under the Contractor's Quality Management Testing.

Should the initial test results in any Sub-Lot be lower than 92.0%, one additional core will be taken and tested, and that result shall replace and be averaged with the initial result to determine the percent density for the Sub-Lot.

Superpave Mixes

$$\frac{\text{Superpave Percent Density}}{\text{Density}} = \frac{\text{In-Place Density of Sample}}{\text{Maximum Theoretical Density (ASTM D-2041)}} \times 100$$

The average in-place density will be determined from 150mm diameter core samples of the completed lift of pavement.

The Maximum Theoretical Density for a Lot is the value calculated defined as the average of the test results from the three sub lots. The Maximum Theoretical Density value for the Lot shall be provided to the Ministry Representative prior to the provision of the coring locations to the Contractor.

502.11.03 Payment Adjustments - The payment adjustment for percent density will be the amount shown in Table 502-E-1 and 502-E-2 for the Sample Mean of the test results for the Lot.

502.11.04 Rejection Limit - The rejection limit for percent density is the limiting value of the Sample Mean as shown in Table 502-E-1 and 502-E-2, beyond which the Sub-Lot is rejected and not paid for.

Acceptance or rejection will be determined for each Sub-Lot. One opportunity will be provided to the Contractor, using non-destructive test methods, to isolate the area of low density and conduct additional compaction providing no damage is incurred to the new pavement. After re-compaction, one additional core will be taken randomly in the area of low density and will replace the core with previous low density and a new value will be calculated. The Ministry Representative shall be advised as to the scheduling of the re-compaction effort prior to the work taking place.

Where the Lot average density is less than 96%, the Contractor shall either overlay or remove and replace the previously placed mix. If the test result for density of a Sub-Lot is outside the acceptance limits, the Sub-Lot is rejected automatically regardless of the values of other acceptance parameters. To minimize the cost of rejection to the Contractor, the Contractor will be provided the opportunity to isolate the area of low density within the Sub-lot. The limits of the low density area must be verified and approved by the Quality Manager, and accepted by Ministry Representative, before remedial work proceeds.

TABLE 502-E-1 – PAYMENT ADJUSTMENTS FOR DENSITY – MARSHALL

% Density Lot Average	Payment Adjustment (\$ Per Tonne) for Design Lift Thickness
98.6 Plus	+\$1.00
98.1 – 98.5	+\$0.75
97.6 – 98.0	+\$0.50
97.0 – 97.5	+\$0.25
96.6 – 96.9	-\$0.50
96.0 – 96.5	-\$1.00
Less than 96.0%	Reject

If any Sub-Lot has a density below 96%, the Sub-Lot shall be considered rejectable, and, subject to the Contractor's opportunity to increase the density as described in DBSS 502.11.04, shall be rejected.

TABLE 502-E-2 – PAYMENT ADJUSTMENTS FOR DENSITY - SUPERPAVE

% Density Lot Average	Payment Adjustment (\$ Per Tonne) for Design Lift Thickness
95.0 Plus	+\$1.00
94.0 – 94.9	+\$0.75
93.0 – 93.9	+\$0.50
92.0 – 92.9	+\$0.25
91.6 – 91.9	-\$0.50
91.0 – 91.5	-\$1.00
less than 91.0 %	Reject

If any Sub-Lot has a density below 91%, the Sub-Lot shall be considered rejectable, and, subject to the Contractor's opportunity to increase the density as described in DBSS 502.11.04, shall be rejected. Percent Density is based on a comparison to the Maximum Theoretical Density.

Where the Lot average density is less than 91%, the Contractor shall either overlay or remove and replace the previously placed mix.

502.11.05 Payment for Rejected Work Made Acceptable

The payment adjustment for density will be based on testing of the replacement or overlay material where applicable. Where replacement or overlay material does not cover the entire Lot or Sub-Lot, prior tests of the uncovered area will be averaged with new tests on the corrective work.

502.12 Asphalt Content

502.12.01 Determination of Asphalt Content - The asphalt content of the asphalt mix will be determined from loose mix samples obtained from each Sub-Lot (3 per Lot) and tested in accordance with ASTM test procedures listed in Table 502-A-3.

One random sample will be obtained from each Sub-lot as per Appendix 2. The asphalt content of the asphalt mix will be determined using the average of the results obtained from all of the Sub-lot samples. The Actual Asphalt Content of the Lot will be compared to the Job Mix Formula Asphalt Content and the deviation will be used for payment adjustment purposes.

502.12.02 Payment Adjustments - The payment adjustment for asphalt content will be the amount shown in Table 502-F.

502.12.03 Rejection Limit - Rejection limits for asphalt content are the limiting values of the Sample Mean as shown in Table 502-F, beyond which the Lot is rejected and not paid for.

If the asphalt content of a Lot is outside the acceptance limits, the Lot is rejected automatically regardless of the

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values of other acceptance parameters.

502.12.04 Payment for Rejected Work Made Acceptable

- The payment adjustment for Asphalt Content will be based on testing of the replacement or overlay material where applicable. Where replacement or overlay material does not cover the entire Lot or Sub-Lot, prior tests of the uncovered area will be averaged with new tests on the corrective work.

502.13 Aggregate Gradation

502.13.01 Determination of Aggregate Gradation - Table 502-C-1, Aggregate Gradation Limits specifies the aggregate gradation limits which asphalt mix design, Job Mix Formulas, and field adjustments made in accordance with DBSS 502.05.09, must be based.

Table 502-G shows the limiting values for acceptance and for the determination of payment adjustments. These limits are expressed as departures, on each specified sieve size, from the percentage of material passing that sieve according to the Job Mix Formula. Aggregate gradation will be determined for each Lot from loose mix samples of the completed lift of pavement. One random sample will be obtained from each Sub-lot, and the aggregate gradation for the Lot will be determined by using the average of the 3 sub-lot tests to determine the Sample Mean.

Divergence from the job mix formula gradation shall not vary outside of the limits identified in Table 502-C-1.

502.13.02 Payment Adjustments -

a) Where the Sample Mean for every specified sieve size falls within the applicable limiting value prescribed in Column 3 of Table 502-G, the Lot will be accepted with a payment adjustment of + \$0.75 per tonne.

b) Where the Sample Mean for every specified sieve size falls within the applicable limiting value prescribed in Column 2 of Table 502-G, but the Lot is not eligible under (a) above, the Lot will be accepted with no payment adjustment.

c) Where the Sample Mean for every specified sieve size falls within the applicable limiting value prescribed in Column 1 of Table 502-G, but the Lot is not eligible under either (a) or (b) above, the Lot will be accepted with a payment adjustment of -\$1.50 per tonne (a deduction of \$1.50 per tonne).

502.13.03 Rejection Limit - Rejection limits for aggregate gradation are the limiting values of the Sample Mean for any one, or more, of the specified sieve sizes, as shown in Column 1 of Table 502-G.

If the Sample Mean value for any specified sieve size exceeds the values shown in Table 502-G, or the divergence of the job mix formula gradation is outside the limits of Table 502-C-1, the Lot will be rejected and not paid for, regardless of the values of other acceptance parameters.

Where the Ministry Representative considers it acceptable, a

TABLE 502-F – PAYMENT ADJUSTMENTS FOR ASPHALT CONTENT

Deviation of the Actual Asphalt Content from the Approved Asphalt Content (either above or below) kg/100kg of Dry Aggregate	Payment Adjustment for Asphalt Content \$ per tonne	
	Top Lift	Lower Lift
From 0 to 0.15	\$0.50	\$0.50
From 0.16 to 0.30	\$0.00	\$0.00
From 0.31 to 0.35	-\$1.00	-\$1.00
From 0.36 to 0.40	-\$2.00	-\$2.00
From 0.41 to 0.45	-\$3.00	-\$3.00
From 0.46 to 0.50	-\$4.00	-\$4.00
From 0.51 to 0.55	Reject	-\$5.00
0.56 and greater	Reject	Reject
For top lift deviations of more than 0.50 the Contractor shall either overlay or remove and replace the Lot.		
For lower lift deviations of more than 0.55, no payment will be made and the Ministry Representative will determine whether removal and replacement is necessary.		

TABLE 502-G – ACCEPTANCE AND PAYMENT ADJUSTMENTS FOR AGGREGATE GRADATION

Sieve Size mm	Divergence from job mix formula grading curve Percentage passing by mass ASTM C-117 and C-136		
	COLUMN 1 Limiting Values for Acceptance Conditional Upon a Payment Adjustment of - \$1.50 per tonne of mix (a deduction of \$1.50 per t)	COLUMN 2 Limiting Values for Acceptance with No Payment Adjustment	COLUMN 3 Limiting Values for Acceptance with a Payment Adjustment of + \$0.75 per tonne of mix
12.5	±7.0	±4.5	±3.5
4.75	±6.0	±4.5	±3.0
0.600	±4.0	±3.5	±2.0
0.075	±1.5	±1.0	±0.75

Any material with a gradation outside the limits set out in Column 1 is reject and the Contractor shall either overlay or, remove and replace the previously placed mix. Reject Bottom Lift shall remain in place, however no payment will be made for this material under the applicable Items

Lot in rejection may be accepted at a minimum deduction of \$40 per tonne.

502.14 Material Application Rate

502.14.01 Determination of Material Application Rate -

Asphalt mix shall be applied to the roadway at the rate or rates specified in the Design, in conformance with the Contract. Material Application Rates will be determined by the tonnage delivered to the paver as recorded by weigh tickets generated by automated scales, divided by the area covered by the Lot after allowance has been made for entrance letdowns and/or intersections. The Contractor shall provide the material application rate calculations to the Quality Manager at the end of each shift.

502.14.02 Payment Adjustments - The payment adjustment for material application rate will be applied as shown in Table 502-H.

502.14.03 Acceptance and Rejection Limits - The acceptance limit for material application rate is the limiting value of the actual material application rate, expressed as a percentage of the specified material application rate, for the Lot, below which the Lot is rejected, as shown in Table 502-H.

If the application rate of a Lot is outside the acceptance limit, the Lot is rejected automatically regardless of the values of other acceptance parameters.

502.15 Surface Segregation

502.15.01 Determination of Surface Segregation - The

finished pavement shall be homogeneous, free from segregation and shall be uniform with respect to surface texture. A segregated area is defined as an area within the driving lanes of the pavement wherein the texture differs visually from the texture of the surrounding pavement.

Due to the nature of variation in asphalt mixes and their compactive characteristics, the definition of degrees of segregation will be established on a project by project basis. The Contractor and the Ministry Representative shall establish through the use of photographs or other mutually agreed tools, the definition of slight, moderate and severe segregation. The Ministry Representative and the Contractor shall evaluate the first two Lots upon completion of the second Lot, after opening to traffic, to confirm the “agreed to” guidelines. Segregation will then be evaluated only when all paving is complete.

The Quality Manager and the Ministry Representative, will observe the finished pavement to evaluate the existence, severity and extent of segregation and other surface defects. The evaluation will be completed prior to the issuance of the Completion Certificate

The rating system for categorizing the severity of top lift surface segregation, and repair methodology is shown in Table 502-I-1.

502.15.02 Payment Adjustments - The payment adjustment for top lift segregation will be the applicable amount shown in Table 502-I-2.

502.15.03 Repair - On the final driving pavement surface,

TABLE 502-H – PAYMENT ADJUSTMENTS FOR MATERIAL APPLICATION RATE

Actual Application Rate Expressed as % of Specified Application Rate	Assessment for Application Rate \$ per tonne	
	Bottom Lift or Single Lift	Top Lift of Multiple Lifts
110 +	-\$6.00 for all material in the Lot up to 110% and no payment for product in excess of 110.0%	No payment
106.0 – 109.9	-\$4.00 for all material in the Lot	-\$6.00 for all material in the Lot up to 106% and no payment for product in excess of 106.0%
105.0 – 105.9		-\$4.00 for all material in the Lot
104.0 – 104.9	\$0.00	-\$2.00 for all material
96.0 – 103.9	+\$0.50	+ \$0.50
94.0 - 95.9	-\$1.00	-\$1.00
92.0 - 93.9	-\$2.00	-\$2.00
90.0 - 91.9	-\$3.00	-\$3.00
85.0 – 89.9	-\$5.00	-\$5.00
84.9 or lower	Rejected, Mill and Fill, and/or rejected with no remedial work required at the discretion of the Ministry Representative	Rejected, Mill and Fill, Overlay, and/or rejected with no remedial work required at the discretion of the Ministry Representative

all segregation shall be repaired according to Table 502-I-1. The Lot will not be re-evaluated for segregation payment adjustments. The Lot will be re-evaluated for acceptance. Repair shall be to the neat lines and dimensions of the segregated area using a sand cement slurry. The Ministry Representative shall provide the formula for the slurry to the Contractor.

The Contractor shall be responsible for all costs associated with the repair of segregated areas.

Remedial work is required for any occurrences of segregation.

502.16 Smoothness

502.16.01 Determination of Pavement Smoothness - The finished pavement surface shall be tested by the Ministry using a Class I precision rolling profile measuring

instrument, to determine the longitudinal profile and compute the International Roughness Index (IRI) in each driving lane. Profiles shall be measured and the IRI calculated in the centre of the lane for each Sub-Lot.

For any Sub-Lot between 50 m and 100 m in length, the IRI value shall be considered representative of a complete Sub-Lot. For any Sub-Lot less than 50 m in length, the IRI value will be combined with the proceeding Sub-Lot IRI value.

The profile shall be measured over the entire length of the pavement exclusive of structures and shoulder areas. Acceleration, deceleration and turning lanes are considered part of the driving lanes and shall be tested in accordance with this provision. For the measuring process, the Contractor shall provide the Ministry Representative a chalk guide line in the centre of the lane immediately prior to measurement.

502.16.02 Auxiliary Lanes - For smoothness testing, sections of the driving lanes that do not fall within the continuous through lanes, such as acceleration lanes, deceleration lanes and turning lanes, and lanes which are less than 1 km in length, shall be treated as follows. The ratio of the section length to the standard Lot length of 1 km shall be determined and the payment adjustment shall be pro-rated on this basis as in the following example:

*Length of segment, i.e. 565 metres = 0.565 times the
Standard Lot Length of 1000m.*

Hence the applicable payment adjustment is 0.565 times the payment adjustment for a 1-km Lot as determined from Table 502-J.

502.16.03 Acceptance Limits – The acceptance limit and payment adjustments applicable to a road for smoothness are

as shown in Table 502-J or when so indicated in the Contract, Table 502-J-2. The International Roughness Index (IRI) value, calculated for each Sub-Lot, will be used to determine if the Lot will be accepted, and if so whether it will be subject to any payment adjustment.

502.16.04 Payment Adjustments - Acceptance of any Lot for payment will occur if it contains no obvious defects as per DBSS 502.22 and in the case of top lift pavement only, the pavement smoothness, as reported by the International Roughness Index (IRI) meets the following requirements:

- No Sub Lot shall have a value greater than the “Acceptance Limit” as shown in Table 502-J or when so indicated in the Special Provisions, Table 502-J-2

TABLE 502-I-1 – SEGREGATION – TOP LIFT ONLY – REMEDIATION METHODOLOGY

Segregation Severity	Visual Appearance	Repair Procedures
None	Completely uniform surface texture	N/A
Slight	Matrix of asphalt binder, coarse and fine aggregate exists; visually increased presence of stone sizes	sand cement slurry
Moderate	Significantly more stone than surrounding pavement; matrix of asphalt binder and coated sand particles is reduced	seal coat or sand cement slurry patch or neat hot mix patch or mill and fill patch
Severe	Appears as an area of very stony mix - stone against stone - little or no matrix	remove and replace or overlay to limits defined by Ministry Representative

TABLE 502-I-2 – SEGREGATION – TOP LIFT ONLY – PAYMENT ADJUSTMENTS

Payment Adjustment	Category		
	Slight	Moderate	Severe
+\$1,000 per lane km. (If the criteria in all three adjacent columns are met)	0 – 3	0	0
+\$500 per lane km. (If the criteria in all three adjacent columns are met)	4-5	0	0
No payment adjustment	6 – 10	0 – 1	0
-\$500 per lane km. (If the criteria in any one or more of the adjacent columns applies)	11 – 15	2 – 5	0 – 1
-\$1,000 per lane km. (If the criteria in any one or more of the adjacent columns applies)	16+	6+	2+

**TABLE 502-J – LOT ASSESSMENT AND
PAYMENT ADJUSTMENTS FOR SMOOTHNESS**

For the final surface course only, the following payment adjustments shall apply to each Lot.

Lot IRI (m/km)	Payment Adjustment
≤ 0.80	+\$2,000
0.81 to 0.90	+\$1000
0.91 to 1.00	+\$500
1.01 to 1.10	+\$200
1.11 to 1.20	0
1.21 to 1.30	-\$100
1.31 to 1.40	-\$250
1.41 to 1.50	-\$600
1.51 to 1.60	-\$1,400
1.61 to 1.70	-\$2,000
1.71 to 1.80	-\$3,000
1.80	<u>ACCEPTANCE LIMIT.</u> <u>Reject or corrective work</u> <u>required above this level</u>

The Lot IRI is the average IRI value calculated for the Sub-Lots within the Lot.

**TABLE 502-J-2 – LOT ASSESSMENT AND
ALTERNATIVE PAYMENT ADJUSTMENTS FOR
SMOOTHNESS**

For the final surface course only, and only where specifically invoked by the Contract, the following payment adjustments shall apply to each Lot on a road designated by the Ministry for application of alternative smoothness payment adjustments

Lot IRI (m/km)	Payment Adjustment
<1.00	+\$2000
1.01 – 1.10	+\$1000
1.11 – 1.20	+\$500
1.21 – 1.30	+\$250
1.31 – 1.40	0
1.41 – 1.60	-\$300
1.61 – 1.80	-\$750
1.81 – 1.90	-\$1500
1.90 – 2.00	-\$2500
2.00	<u>ACCEPTANCE LIMIT.</u> <u>Reject or corrective work</u> <u>required above this level</u>

The Lot IRI is the average IRI calculated for the Sub-Lots within the Lot

502.16.05 Rejection Limit - When there are one or more Sub-Lots with an IRI greater than the Acceptance Limit shown in table 502-J or when so indicated in the Special Provisions, Table 502-J-2, the Sub-Lot or Sub-Lot is rejected, subject to DBSS 502.16.06. A Sub-Lot for calculation of smoothness is defined in DBSS 502.03.08.

502.16.06 Remedial Work - If the test results on a Sub-Lot of pavement indicate a payment reduction or rejection because of smoothness, the Contractor may propose remedial work to improve the smoothness. Such proposals are subject to the approval of the Quality Manager and the Ministry Representative, but such approval does not imply that the proposed remedy will be successful, and does not reduce the Contractor's responsibility for meeting the acceptance requirements. Grinding may be acceptable, but an overlay may be required. Only one attempt may be made to improve smoothness, and this must be completed within ten (10) calendar days from the time the Contractor receives notification of the original smoothness test results for that Sub-Lot.

Following any attempt to improve the smoothness of a Sub-Lot or Sub-Lots, the Ministry Representative will retest the Sub-Lot or Sub-Lots, and the new results will replace the previous data for the purposes of determining acceptance and payment.

502.16.07 Smoothness Deficiencies - Smoothness deficiencies (bumps and dips) less than 8mm over 3m will not have remedial work required. Individual deficiencies between 8mm and 12mm over 3m will result in a penalty of \$200.00 each. Deficiencies exceeding 12mm over 3m will require remedial work.

PART C - ACCEPTANCE AND REJECTION

502.21 Acceptance At Reduced Or Adjusted Payment - Acceptance of any Lot at reduced payment will occur if it contains no obvious defects as per DBSS 502.22, and if:

- the test results for acceptance parameters are such that the Lot or Sub-Lot meets the requirements for acceptance at a reduced payment; and
- the Lot or Sub-Lot is approved in respect of all other requirements; and if
- the Contractor has not notified the Ministry Representative in writing that it will exercise its option to either repair or remove and replace the work, at its own cost, with work meeting the requirements for acceptance at full or increased payment.

502.22 Rejection For Workmanship Defects - The finished surface of any lift shall have a uniform "closed" texture and be free of visible signs of poor workmanship.

Any obvious defects as determined by the Quality Manager or Ministry Representative such as, but not limited to the following, will be cause for automatic rejection of asphalt pavement regardless of the values of any other acceptance parameter:

- individual bumps and dips that exceed 12mm over 3m;
- areas of excess or insufficient asphalt;
- improper matching of longitudinal and transverse joints;
- roller marks;
- tire marks; or
- cracking or tearing.

When asphalt pavement is rejected by reason of obvious defects, the minimum area of rejection will be the actual length of the defect for the full width of the driving lane in which the defect exists.

Rejected work shall be promptly repaired, remedied, overlaid, or removed and replaced in a manner acceptable to the Quality Manager and Ministry Representative. The Contractor shall be responsible for all costs including materials.

No payment will be made for work in any Lot or Sub-Lot, which has been rejected, until the defects have been remedied.

502.23 Appeal Testing

502.23.01 Density, Asphalt Content and Gradation - The Contractor may appeal the results of acceptance testing for density, asphalt content and/or aggregate gradation for any Lot only once. Appeals will only be considered if quality control results support an appeal and can be presented.

Contractor Quality management test results for density which are provided to the Ministry Representative subsequent to the Contractor's receipt of the Ministry's quality audit test results for that Lot will not be considered (when evaluating evidence) for an appeal. The appeal shall be for all tests within the Lot, and there will be no appeal allowed for single tests within a Lot.

Any attempt to improve density on the appealed Lot after the Ministry Representative has tested the Lot for acceptance shall void the appeal and the original test results will apply.

The following procedures will apply for an appeal:

- For Density, Gradation and Asphalt Content, the Contractor shall serve notice of appeal to the Ministry Representative, in writing, within two working days of receipt of the test results;

- The Ministry Representative will arrange for an independent testing laboratory to perform the appeal testing. The personnel employed or testing laboratory retained by the Contractor for quality control testing on the project will not be used for appeal testing;
- The Contractor will sample the pavement and provide the core samples to the independent testing laboratory. The Ministry Representative shall observe the sampling process.
- For density appeals, the original core test results will be discarded and a new sample mean will be obtained from 5 random cores. The appeal agency shall prepare new briquette densities from the previously taken companion samples as per Appendix 2.
- For asphalt content and gradation, the original test results will be discarded. A new sample mean for three new test results will be determined using the companion samples and will be used for acceptance and payment adjustments.

502.23.02 Smoothness - The Contractor may appeal acceptance test results of a Lot only once.

The Ministry Representative will perform, and the Contractor will be given the opportunity to witness, the appeal testing and the new results will be binding on the Contractor and the Ministry.

502.23.03 Segregation - Appeals of segregation ratings will first be handled by a joint review with the Contractor. If consensus cannot be reached then the Ministry Representative shall engage the Joint Committee, comprised of representatives from the Ministry and B.C. Roadbuilders, to assess the area(s) in question.

502.23.04 Application of Appeal Testing Results - For density, gradation and asphalt content appeals, the original test results will be discarded.

For density, five (5) new random cores will be tested within the next three (3) site occupancy days to establish a new Sample Mean and used for acceptance and payment adjustment.

For gradation and asphalt content appeals, companion samples prepared as per Appendix 2 shall be used to establish a new Sample Mean and used for acceptance and payment adjustment.

The new values, thus determined, in all cases, will be binding on the Contractor and the Ministry.

502.23.05 Payment for Appeal Testing - If the new results indicate a change in the payment adjustment in the Contractor's favour, then sampling and testing costs incurred during the appeal procedures for that Lot will be

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borne by the Ministry.

If the new results verify that any payment reduction or rejection remains valid for that Lot, then the costs of testing (plus 10% mark-up) incurred during the appeal procedure will be charged to the Contractor.

502.23.06 Time Limits For Appeal Of Test Results – All appeals shall be in writing and submitted within three (3) days of receipt of the applicable test results.

502.24 Overlays As A Corrective Measure - If an overlay is used as a corrective measure on a defective Lot or Sub-Lot, the overlay thickness will be subject to the approval of the Quality Manager and Ministry Representative, but shall not be less than 40mm. In all other respects, the whole overlay will be subject to the same specifications as the pavement being overlaid. Where an overlay is used as a corrective measure in any lane, adjacent lanes shall also be overlaid whether acceptable or not.

Whether the overlay is applied as a corrective measure or is placed over otherwise acceptable pavement in order to match an adjacent lane, acceptability and payment will be determined as follows:

- acceptability, and eligibility for either positive or negative payment adjustment, will be determined entirely on the results of testing and observations conducted on the overlay, regardless of test results that have been obtained on the underlying, overlaid lift of pavement; but
- the quantity to which any payment adjustment is to be applied, will be derived from the tonnage of mix in the underlying, overlaid lift.

PART D - PAYMENT

502.31 General - Applicable payment adjustments (Additions or subtractions as applicable) shall be applied to payments due the Contractor in accordance with Part B of this Section.

The first 1,000 tonnes of asphalt mix production and placement will not be subject to bonus/penalty payment adjustments but will be required to meet minimum Specification requirements for quality and workmanship. The location where this material is to be placed shall be defined in the Contract or as proposed by the Contractor and accepted by the Ministry Representative.

502.31.01 Not Used

502.31.02 Not Used

502.31.03 Not Used

502.31.04 Payment for Acceptable Work - The following end product properties of asphalt pavement will be measured for acceptance:

- Density
- Asphalt Content
- Aggregate Gradation
- Smoothness
- Material Application Rate
- Segregation

502.31.05 Payment for Rejected Work Made Acceptable - When defects have been remedied in Lots or Sub-Lots which had been rejected, payment will be made subject to payment adjustments and penalty assessments and subject to DBSS 502.24.

502.31.06 Payment Adjustment - Payment adjustments resulting from the application of this Section will be effected on each progress payment as follows:

a) For each Lot paid for by the tonne (t), the applicable payment adjustment derived from Tables 502-E (Density), 502-F (Asphalt Content), and 502-G (Gradation), in dollars per tonne, will be expressed as positive in the case of increases and negative in the case of decreases. The algebraic sum of these unit adjustments will then be applied to the payment quantity for the Lot. The resulting amount, in dollars, will be the net payment adjustment, positive or negative, for that Lot.

Payment Adjustments from Table 502-H (Application Rate) shall be computed for each Sub-Lot and then aggregated for the Lot.

The algebraic sum of the net payment adjustments for all such Lots for which payment is authorized on the current progress payment, computed in dollars, shall be the total payment adjustment for density, asphalt content, aggregate gradation, and material application rate for the current progress payment.

b) For each Lot (km) with payment adjustments based on kilometre, the applicable unit adjustment derived from Table 502-I-2 (Segregation) and Table 502-J or 502 J-2 (Smoothness), in dollars per Lot (\$/lane km), will be expressed as positive in the case of increases and negative in the case of decreases, and will be the payment adjustment, positive or negative, for that Lot.

The algebraic sum of the payment adjustments for all such Lots for which payment is authorized on the current progress payment, computed in dollars, shall be the total payment adjustment for segregation for the current progress payment.

c) The algebraic sum of the total payment adjustments for density, asphalt content, aggregate gradation, material

application rate, segregation and smoothness, derived in accordance with a) and b) above, shall be the total payment adjustment, positive or negative, in dollars, for all attributes for the current progress payment. This amount shall be added, if positive, or subtracted, if negative, by a single entry in computing the current progress payment.

d) The process set out in a) to c) above will be used in computing each progress payment to which it is applicable.

502.32 Surplus Aggregate In Stockpile – Surplus aggregates in stockpile in Ministry pits is the property of the Ministry and no additional payment will be made.

APPENDIX 1

QUALITY CONTROL REQUIREMENTS AND GUIDELINES

1.01 GENERAL

This Appendix titled “Quality Control Requirements and Guidelines” sets out the requirements and guidelines for the Contractor’s Quality Control Plan, in addition to those set out in DBSS 101, DBSS 502.04 and the Contract. Quality Assurance requirements are per the Contract and DBSS 101.

1.02 QUALITY CONTROL PLAN

The Contractor shall prepare and submit a Quality Control Plan for evaluation. The Plan may be operated wholly or in part by a qualified Subcontractor or an independent organization/agency. However, the Quality Control Plan, including compliance with the Plan and its modifications, must remain the responsibility of the Contractor.

The Plan shall address all elements that affect the quality of the hot mix, hot laid asphalt pavement, including but not limited to the following:

- Supply of Asphalt Materials
- Identification of source and proof of quality of aggregates to be supplied;
- Aggregate production and its gradation control;
- Quality of aggregate components;
- Stockpile management;
- Mix Design(s);
- Asphalt plant calibration and proportioning of aggregate components;
- Mixing including asphalt cement content control;
- Process temperature controls;
- Material application rates, placing and finishing;
- Joints;
- Compaction;
- Smoothness;
- Segregation;

The plan shall also include the following:

- The name of the Quality Control testing agency and its proven capability to provide the specific services required for the project.
- The list of dedicated technical staff, if available, (including names, qualifications and relevant experience) and their proposed roles.
- The list of testing equipment available for project work.

The Quality Control Plan shall include the designation of specific personnel to be responsible for specific quality control duties.

- There shall be a Quality Control Manager (QCM) who will be responsible for the development and management of the Quality Control Plan. This person shall be qualified as per the requirements identified in DBSS 502.04.03. This individual shall also be responsible for the signing off of Quality Control Testing and Inspection records. This individual shall also be responsible for approving all quality control staff, implementing and documenting any changes or improvements to the Quality Control Plan.
- There should be a designated Process Control Technician (PCT), with 5 years of related experience, who will ensure that laboratory test results and other quality control practices are used to control the quality of aggregates and other mix components, and to adjust and control mix proportions to meet the mix design(s). The PCT is responsible for ensuring that testing equipment, utilized for proportioning and mixing are calibrated and in good working order. The Plan shall describe how the PCT’s duties, including sampling methods and responsibilities are to be accomplished and documented. The Plan should also describe the criteria to be used by the PCT to correct or reject unsatisfactory materials.
- There should also be a Pavement Quality Control Technician (PQT), with 5 years of related experience, who will ensure that delivered materials meet the requirements of the specifications. In addition, the PQT shall be responsible for periodically inspecting all equipment used in placing, finishing, and compacting to assure its proper operating condition and to assure that placing, application rate, finishing, joint construction, and compaction is in conformance with this specification and the contract requirements.

1.03 CONTRACTOR’S RECORD OF QUALITY
CONTROL TESTING

Test results should be made on specified forms or charts immediately after completion of each test. These test results are to be made available to the Ministry Representative upon request.

Records of gradation control, both during aggregate production and also during the asphalt mixing operation, should be kept on the form H-295 - Mechanical Analysis of Aggregates.

1.04 MATERIAL APPLICATION RATE

The Contractor shall control the Material Application Rate by monitoring the amount of asphalt mix delivered to the

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road against the area covered by checking the application rate minimally every ten loads.

The Contractor shall advise the Ministry Representative in writing on an ongoing basis, and upon request, of the application rate.

1.05 DENSITY

The Contractor should take core samples to determine actual pavement density. At the start of paving, the Contractor should take a minimum of two pavement cores from each Sub-Lot. The Contractor may employ a nuclear densometer to ensure intermediate density control. Two nuclear densities may be determined for each Sub-Lot, based on job

mix densities obtained from the most recent plant briquettes.

1.06 OTHER QUALITY CONTROL PROCEDURES

The Contractor may initiate other Quality Control procedures as necessary for ensuring production of a quality product and include them in the Quality Control Plan. Procedures may also be introduced after the start of work as necessary as amendments to the Quality Control Plan.

1.07 QUALITY CONTROL TESTING FREQUENCY

Recommended test frequency requirements for Quality Control are described in the following table:

TABLE 1 – TEST FREQUENCY GUIDELINES

	Test	*Minimum Frequency
Tests During Aggregate Production	ASTM C-136, Dry Sieve Analysis of Aggregate	- Split Stockpiles: 1 for each stockpile for every 2 hours of production. - One main stockpile: for every 300 tonnes. - Blend Sand: 1 for every 100 tonnes during stockpiling. - Natural filler: 1 for every 50 tonnes during stockpiling.
	ASTM D-5821 Determining the Percentage of Fractured Particles in Coarse Aggregate	Every second coarse aggregate sieve test.
	ASTM C-117 Sieve Analysis of Aggregates by Washing (Field Lab)	1/shift on reduced sample obtained from combined samples from the crusher
Tests During Asphalt Plant Mixing	ASTM 136, Dry Sieve Analysis of Aggregate	1 of combined aggregate (off the belt) every 300 tonnes.
	ASTM C-566 & D-2216, Moisture Content	Aggregate: 2 tests/Lot Asphalt mix: 1 on first Sub-Lot and every second day.
	ASTM C-117 Sieve Analysis of Aggregates by Washing (Field Lab)	1/shift on reduced sample obtained from combined samples from the plant cold feed
	ASTM D-5581, Resistance to Plastic Flow Using Marshall Apparatus.	One set of three briquettes for 1,200 tonnes or Lot, whichever is less.
	Asphalt Extraction Test ASTM D-6307 Ignition Method	One/Lot.
	Penetration of Bituminous Materials ASTM D-5	One per Manufacturer's Batch. Samples should be taken for every 3000 tonnes of mix production
	Viscosity ASTM D-2171	Contractor's Option
Asphalt Products Tests	Tack and Prime	Contractor's option.
Test During Asphalt Paving for Density Testing	ASTM D-2726, D-1188 and D-2041 Test to obtain Briquettes from Asphalt Mix	One 15 kg sample for every Sub-Lot or minimum 1/day for field testing
	Core Samples	At start, two cores for each Sub-Lot. After rolling pattern established, only one core for each Sub-Lot. All cores to be a minimum of 100mm diameter; Superpave mixes shall require minimum 150mm diameter cores

* These are the recommended minimum frequencies and the Contractor is responsible to assess the need to increase testing frequency, where aggregate source is not uniform or any other condition exists that may warrant it.

APPENDIX 2

LOOSE MIX SAMPLE PREPARATION

1. 3 samples per Sub-Lot shall be obtained by the Contractor from the paver augers, at locations and times chosen by the Ministry Representative. The first sample shall be used by the Contractor for Quality Control, the second sample by the Ministry for Quality Audit, with the third retained by the Ministry for potential appeal testing.
2. The samples taken shall meet the requirements of ASTM D-979 Sampling of Bituminous Mixtures, Table 1, Size of Sample
3. The sample size shall be reduced to required laboratory sample size for Marshall and Superpave gyratory briquettes, asphalt content and hot mix gradation determination as outlined below:
 - I. The sample shall either be reduced using a Riffle splitter or shall be quartered into four approximately equal portions. The two diagonally, opposite quarters shall be combined resulting in two samples. Identify and designate one of the samples as the Quality Companion Sample and set aside. Identify and designate the other resulting sample as the Quality Control Sample. Use the Quality Control Sample for testing.
 - II. The Quality Control Sample shall be weighed to ensure that the sample so obtained meets the minimum mass required for the ignition test. If the sample does not meet the minimum mass requirements, then the additional materials will be obtained and added to the Quality Control Sample from the Companion Sample. This will be achieved by quartering the Quality Companion sample and adding one quarter of the Quality Companion Sample to the Quality Control Sample.
 - III. This process is to be repeated for each sample to provide the Quality Audit and Appeal Samples.
4. The third sample for appeal purposes shall be set aside and retained in a Contractor-supplied, suitable container labeled with sample location, date sampled, and project information. These shall be delivered to the Ministry Representative for storing.
5. The areas sampled shall be filled with mix immediately after sampling, and shall receive the same compactive effort as the rest of the mat.

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BASE PREPARATION AND BASE PROCESSING

503.01 Base Preparation - The work shall consist of shaping and compacting the existing granular base course to the designated grade and cross-section.

The existing base course material shall be watered, graded and compacted to provide a non-segregated, tightly-knit surface which conforms to the line, grade and cross sections, as per the Design, to an accuracy of ± 10 mm.

If necessary, the existing surface shall be scarified and bladed to achieve this. Imported materials may be incorporated into the work to aid the Contractor in achieving lines and grades and to backfill failed areas.

a) Failed Areas - Where a failed area is present in the existing base, the Contractor shall excavate and dispose of the material, and backfill using crushed granular base or surfacing aggregate or road-mix (in thicknesses corresponding the excavated depths of like materials) and compacted to the same density as the rest of the base course.

b) Compaction - If watering is required to attain compaction or for any other reason, it shall be applied uniformly from a distributor of the pressure type, equipped with a spray bar mounting nozzles similar to those used on asphalt distributors. The distributor must be provided with a satisfactory means for accurately measuring the quantity of water sprayed. The final surface of the base course shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698.

c) Surplus Aggregate - All surplus loose aggregate arising from the base preparation shall be bladed clear into windrows on the shoulder for later incorporation into the shouldering aggregate or bladed to the side slope and trimmed.

503.02 Base Processing - Where, the base is so deformed, rutted or unsuitable, that it cannot be adequately prepared for priming, the Contractor shall reconstruct the base to the satisfaction of the Designer and Quality Manager.

SECTION 504

PAVEMENT DRAINAGE

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

DESCRIPTION

504.01 Scope - This Section covers the provision of pavement drainage with the construction of necessary asphalt curbing and drainage outlets using cast iron catch basins or asphalt spillways together with pipe or paved outfalls. Concrete curbs, concrete and corrugated steel catch basins, cast iron grates and frames where applicable are specified by DBSS 582.

MATERIALS

504.11 Materials

The Contractor will supply all materials as required in the Contract.

CONSTRUCTION

504.31 Asphalt Curbs

504.31.01 Integral Asphalt Curb - Where specified in the Contract or the Design, asphalt concrete curb integral with the asphalt concrete highway pavement shall be constructed to the dimensions indicated on Drawing SS SP504-01.

504.31.02 Machine-Laid Asphalt Curb - Where specified, machine laid (extruded) asphalt concrete curbs shall be constructed in accordance with Drawing SS SP504-01 and as follows:

- i) The type of curb to be placed (Type "A" or Type "B") will be as specified by the Designer.
- ii) Prior to construction of the curb, the affected pavement area shall be dry and cleaned of loose or deleterious materials. A tack coat of liquid or emulsified asphalt shall be uniformly applied at a rate of from 0.25 to 0.5 ℓ/m^2 , to a width 0.1 m wider than the proposed curb.
- iii) The production and transportation of asphalt mix for curb construction shall be in accordance with DBSS 501 and DBSS 951 and shall meet the requirements for Class 1 Fine Mix.
- iv) The machine for constructing the curb shall be self-propelled extrusion-type equipment with a material hopper, distributing screw and adjustable curb forming devices capable of placing and compacting the asphalt

mix to the required alignment, grade and cross-section in an even homogeneous manner free of surface defects. The asphalt concrete mix shall be handled to provide a smooth, uniform finished curb alignment. Where handforming of curb is required, the finished curb shall conform to all dimensions, alignment, density and finish requirements for machine-laid curb.

504.32 Location of Drainage Outlets - On completion of pavement and curb construction and in conjunction with the installation of any precast concrete barriers, the Contractor shall install or construct drainage outlets at the low point of curves in the vertical alignment and at such other locations designated by the Designer.

Note: The exact low point on the pavement may be determined by allowing water to flow along the surface to the actual lowest point on the pavement adjacent to the curb or barrier. This low point shall be clearly marked on the pavement.

504.33 Excavation - At the locations designated by the Designer, the asphalt pavement and any curbing shall be accurately cut away and the highway shoulder excavated to the dimensions consistent with the installation of Cast Iron Catch Basins (Drawing SS SP504-03) or the construction of Asphalt Spillways (Drawing SS SP504-02). The excavation shall, as nearly as possible, have vertical sides and shall be so done as to cause minimum disturbance of the adjacent compacted base and pavement structures. The outside dimensions of the excavation shall be the smallest compatible with the efficient construction of the drainage facility, as any excess or irregular excavation will be required to be repaired with asphalt mix.

Where applicable, appropriate trench excavation shall be performed to permit the installation and embedment of outlet pipe and associated fittings.

504.34 Drainage Outlets

504.34.01 Cast Iron Catch Basins - Mortar shall be used for bedding catch basins and the mortar shall be composed of 20 MPa concrete.

Bedding shall be a minimum of 125 mm thick to permit accurate setting of the catch basin in mortar at the correct level true to alignment with curbing, barrier or pavement edge as shown on Drawing SS SP504-03. After securely fixing the adaptor, watertight gasket and connecting pipe, the catch basin shall be surrounded with mortar to the full perimeter of the excavation, and the mortar well tamped and worked around the connecting pipe for 300 mm from the side of the catch basin.

The mortar shall be allowed to set prior to backfilling and further work.

504.34.02 Asphalt Spillways - Asphalt spillways shall be constructed to the general dimensions shown on Drawing SS SP504-02 with the necessary handforming in accordance with DB SS 504.31.02 (iv).

504.34.03 Pipe Outfalls General - Except where paved outfalls are specified, corrugated galvanized metal outlet pipes of the required diameter shall be installed, as shown generally on Drawing SS SP504-03. Should the fill material preclude pipe embedment, the pipe shall be secured to the slope by dual angle iron posts placed at 3 m intervals, as shown. The pipe shall be similarly secured at the bend at the base of the slope and at a point approximately 150 mm from its outlet.

The pipe trench shall be backfilled with excavated material and the fill thoroughly compacted.

Riprap of 200 mm minimum dimension shall be placed at the pipe outlet as shown on Drawing SS SP504-03.

504.35 Dishing, Spillways and Completion - The asphalt pavement adjacent to the drainage outlet shall be constructed to the profile and cross-sections indicated for the type of outlet being installed. The asphalt pavement surface shall be so shaped as to channel all collected water to the outlet orifice and no ridges or other obstructions shall be left which may impede the flow of water to the drainage outlet.

The asphalt paving mix shall be compacted to the density as specified by the Designer to provide an integral and impervious drainage area. Where the asphalt pavement abuts a cast iron catch basin box, the contact face of the box shall be painted with liquid or emulsified asphalt prior to placing the asphalt concrete.

On completion, the area shall be cleared and cleaned up to the satisfaction of the Quality Manager and the Ministry Representative.

SECTION 507

PRODUCTION AND STOCKPILING OF ASPHALT MIX

507.01 General - This Section covers the supply of aggregate, mixing it with a specified asphalt material in a central plant and placing the produced mix in a stockpile.

507.02 Aggregate

- a) The Contractor shall supply aggregate with gradation wholly within the limits listed in Table 507-A when tested in accordance with ASTM C-136 and ASTM C-117 (wash test).

Once a crushed aggregate gradation has been accepted, the maximum permissible variation of the mean of any four consecutive tests from the accepted gradation curve shall be within the limits specified in Table 507-B.

- b) A minimum of 85% by count of all aggregate particles retained on the 4.75 mm sieve shall have at least two fractured faces or shall be naturally angular with sharp edges (ASTM D-5821). If this requirement cannot be met for a specified crushed aggregate type then the Contractor shall, at no additional charge, crush aggregate to the next smaller size or such intermediate size.

- c) All aggregates shall be free from coatings of clay, silt or other objectionable matter and shall contain no clay lumps or other aggregations of fine-grained materials.

- d) Crushed aggregate shall conform to the following requirements:

- The sand equivalent value shall not be less than 40.
- Micro Deval maximum abrasion loss shall not be greater than 17% as tested under ASTM D6928-03.

- e) For testing purposes, fine aggregate shall be all mineral matter passing the 4.75 mm sieve including mineral fillers. It shall consist of natural and/or manufactured material derived by crushing stone, slag or gravel.

- f) Mineral filler shall:

- consist of all mineral matter passing the 0.425 mm sieve.
- be dry, free from organic matter, clay particles or lumps.
- be non-plastic when tested in accordance with Test ASTM D 423 and ASTM D 424.

- g) Mineral dust shall consist of all mineral matter passing the 0.075 mm sieve.

507.03 Asphalt Material

- a) The type of asphalt material to be used will be specified in the Contract.

- b) The Contractor will supply the Liquid Asphalts or High Float Emulsified Asphalts, which shall meet the requirements of DB SS 951.

TABLE 507-A GRADATION REQUIREMENTS FOR AGGREGATE

SIEVE SIZE (mm)	PERCENT PASSING (BY MASS)	
	PATCH MIX	PAVING MIX
19.0	---	100
16.0	---	100 - 92
13.2	---	100 - 80
9.5	100	90 - 65
4.75	85 - 55	75 - 45
2.36	65 - 40	60 - 30
1.18	50 - 25	45 - 20
0.300	30 - 15	25 - 10
0.150	18 - 8	17 - 5
0.075	12 - 5	9 - 2

TABLE 507-B MAXIMUM PERMISSIBLE VARIATION OF CRUSHED AGGREGATE GRADATION FROM THE GRADATION CURVE

SIEVE SIZE	VARIATION LIMITS % PASSING
4.75 mm and larger	± 5
1.18 mm to 4.75 mm	± 3.5
0.300 mm to 1.18 mm	± 2
0.075 mm to 0.300 mm	± 1

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507.04 Mix Design

- a) Unless otherwise specified, the Contractor will carry out the Asphalt Mix design with the aggregate supplied by the Contractor.
- b) Not Used
- c) Once the design grading curve is established, the maximum permissible variation will be as specified under DB SS 507.02 (a).

507.05 Mixing Requirements

- a) Mixing operations shall be performed in a mixing plant capable of producing the asphalt mix within the required specifications.
- b) The maximum moisture content of the aggregate immediately prior to mixing with liquid asphalt shall not be over 2% by mass of dry aggregate.
- c) The Asphalt storage temperature shall be within the range of 65⁰C to 80⁰C and a mix temperature within the range of 60⁰C to 80⁰C.
- d) The asphalt content in the mix shall not vary from the design asphalt content by more than 0.3 by mass of total aggregate.
- e) The asphalt mix shall not contain more than 1% moisture by mass at the discharge from the plant.
- f) The asphalt mix shall be uniform in appearance with all particles thoroughly coated. The mixing time will be increased if the mix is not completely coated with asphalt.
- g) The Ministry reserves the right to adjust the asphalt content in the mix up to the maximum of 6% by Mass.

507.06 Hauling - When the haul distance from the mixing site to the stockpile is greater than 1 km, the hauling vehicles shall be equipped with and use a tarpaulin of such

PRODUCTION AND STOCKPILE OF ASPHALT MIX

size as to completely protect the asphalt mix from the weather and inhibit premature curing of the mix by aeration.

The tarpaulin shall be double quilted canvas or other approved material treated to prevent absorption of the asphalt.

507.07 Stockpiling

- a) The exact location of the stockpile site will be determined by the Contractor. The Contractor shall place the cold mix within the boundaries of the designated stockpile site.
- b) The Contractor shall prepare the stockpile site, which shall be shaped to a uniform smooth surface and graded to ensure good drainage.
- c) Temporary stockpiling of the mix on the ground or in storage bins will be allowed, however, the Contractor will be required to minimize the handling of the mix to prevent premature curing of the mix.
- d) If conveyor belts are used for temporary stockpiling or final stockpile construction, the free fall distance from the conveyor belt to the stockpile shall not exceed 2 m.
- e) If the stockpile is constructed using a front end loader or end dumping by truck, the mix shall be deposited in layers of approximately 1 m in depth.
- f) Plank or protected runways shall be provided for operating equipment on stockpiles to prevent contaminants being tracked onto the stockpile and to minimize consolidation of the mix.
- g) The final stockpile shall be constructed in such a manner that height is not more than 4 m.
- h) Mixing, hauling or stockpiling will not be permitted during periods of precipitation.

SECTION 508

END PRODUCT SPECIFICATION FOR GRADED AGGREGATE SEAL COAT

PART A – GENERAL

508.01 Preliminary and General - This section describes the materials, equipment, professional standards and the end product requirements for the construction of graded aggregate seal coats. This section shall be read and construed together with all applicable Design Build Standard Specifications. Should this Section conflict with any other Section, this Section shall be take precedence unless otherwise stated in the Special Provisions.

Graded Aggregate Seal shall only be used in the completed Work when explicitly identified in the Contract as an acceptable product.

508.01 General Description of Work - Surface seals shall consist of the application of a selected asphalt emulsion and embedment of the selected aggregate so as to provide a new, uniformly textured surface. This surface shall be impervious to moisture, be skid-resistant and have good riding qualities. There are six classes of Graded Aggregate Seal, as specified in Table 508-A below. These include but are not limited to graded aggregate seals, a coarse or fine sand seal or any other graded aggregate surface treatment outlined in the Contract.

TABLE 508-A GRADATION LIMITS FOR GRADED AGGREGATE SEAL

Sieve size (mm)	% PASSING BY MASS by CLASS					
	A	B	C	Mod C	D	E
19	100	-	-	-	-	-
16	-	100	100	100	-	-
12.5 ¹	60-90	60-90	-	-	100	-
9.5	40-80	35-75	30-70	25-55	30-80	100
4.75	20-60	15-50	25-45	7-30	25-45	0-30
0.600	0-25	0-15	5-20	0-10	5-20	0-10
0.075	0-7	0-5	0-3	0-3	0-3	0-3
Ratio ² (9.5/4.75)	-	-	-	1 - 1.5	-	-

Notes:

¹ The Contractor may use either the 12.5 mm or the 13.2 mm sieve, at the Contractor's option.

² The "Ratio" is the ratio of the mass of material retained on the 9.5 mm sieve, divided by the mass of material retained on the 4.75 mm sieve.

508.02 Definitions

a) Coarse Aggregate – Coarse aggregate is defined as all material retained on or above the 4.75 mm sieve.

b) Fine Aggregate – Fine aggregate is defined as all materials passing the 4.75 mm.

c) Mineral Filler and Mineral Dust – Mineral filler shall consist of all mineral matter passing the 0.600 mm sieve and the mineral dust shall consist of all mineral matter passing the 0.075 mm sieve.

d) Blinding Sand – Fine aggregate used as large aggregate support.

508.03 Graded Aggregate Seal General Usage

- Class A & B - Double seals on gravel highways
- Class B - Low traffic paved roads
- Class C, Mod C, & D - Major Highways
- Class E - Second seals

PART B - SUPPLY OF MATERIALS

508.11 Asphalt Materials - The Contractor shall supply the asphalt emulsion as specified in the Contract and the Design which shall meet the requirements of DBSS 952.

Asphalt(s) to be used on surface seals may be standard rapid curing cutback asphalt; medium curing cutback asphalts; or anionic or cationic emulsions including high float emulsified asphalts. Types and grades of asphalt binder proposed for use on the Project will be specified in the Contract and the Design.

The Ministry Representative or the Designer may require the use of anti-stripping additives or any other materials formulated to improve the coating and adhesive properties of the asphalt binder to the cover aggregate. Instructions concerning the type of additive to be supplied and the method of incorporation with the asphalt binder will be specified in the Contract or in the Design.

508.12 Aggregates

508.12.01 Mineral Aggregate Supply - Mineral cover aggregate meeting the requirements described hereunder shall be supplied by the Contractor unless specifically described otherwise in the Contract.

The Ministry may supply the aggregates. If the Ministry

does supply aggregates, then the Ministry will supply quality control information, if available, to the Contractor. The Contractor must verify and be satisfied that the Ministry supplied aggregates will meet the quantity and quality requirements prior to submitting a bid.

508.12.02 Mineral Aggregate – Test Methods - Mineral Aggregate will be sampled and tested in accordance with the standard ASTM procedures and tests listed in Table 508-B

TABLE 508-B TEST METHODS FOR MINERAL AGGREGATE

ASTM DESIGNATION	NAME OF TEST
D 75	Sampling stone, slag, gravel, sand, and stone block for use as Highway materials
C 136	Sieve Analysis of Aggregates
C 117	Wash Test of Aggregates
C 142	Clay Lumps and Friable Particles in Aggregates
D 6928	Micro-Deval
D 5821	Fracture Count on Coarse Aggregate
D 4791	Flat and Elongated Particles

508.12.03 Test Requirements - Mineral cover aggregate shall consist of clean, sound, hard, durable particles or fragments of sand, gravel or crushed stones or combination thereof; containing a minimum of thin elongated or flaky pieces. It shall be substantially free from loosely bonded aggregations, clay lumps or other objectionable matter and shall not be markedly hydrophilic in character.

The mineral cover aggregate, when tested by the methods listed in Table 508-B, shall meet the following criteria:

- a) Clay Lumps** - Coarse aggregate shall not contain more than 0.5% by mass of clay lumps or other aggregation of fine material.
- b) Micro-Deval** - No individual test shall have a loss factor of more than 20%.
- c) Flat and Elongated Particles** - The percent flat and or elongated particles must be less than 10% using 4:1 ratio.
- d) Fracture** - Contrary to ASTM D 5821, only those particles retained on or above the 4.75 mm sieve with two or more fractured faces shall be measured. The

minimum % by mass, for coarse aggregate shall be as follows:

- Classes A & B = 75%
- Classes C, Mod C, & D = 85%
- Class E = not applicable

508.12.04 Graded Aggregate Seal Gradation.-

.Gradations shall meet the requirements stated in Table 508-A for each Class of graded aggregate seal.

a) Variation Limits – For all Classes of seal except Class E, once the grading curve is established within the above limits, the maximum permissible variation of the mean of any four consecutive tests from the grading curve shall be within the tolerances specified in Table 508-C

TABLE 508-C VARIATION LIMITS

Sieve Size (mm)	Maximum Permissible Tolerance % Passing by Mass
4.75 to 19.0	± 5.0
0.600	± 3.5
0.075	± 1.0

These tolerances do not waive the requirement that the running average of four consecutive tests must be maintained at all times inside the limits specified in Table 508-A. Should the Contractor not be able to maintain the grading within the variation limits specified above they shall be required to construct a second stockpile. This does not alleviate the Contractor from consistently maintaining the grading curve within the tolerances indicated in the gradation curves.

508.12.05 Aggregate Characteristics

a) Coarse Aggregate Coarse aggregate shall consist of crushed stone or gravel, or a combination thereof; or materials naturally occurring in a fractured condition; or materials naturally occurring of highly angular nature or rough texture.

b) Fine Aggregate Fine aggregate shall be clean, hard, durable, moderately sharp, and free from coatings of clay, silt or other deleterious material and shall contain no clay balls or other aggregations of fine material. All aggregate passing the 4.75 mm sieve shall be non-plastic.

c) Mineral Filler and Mineral Dust Mineral filler and mineral dust shall be free from organic matter.

Mineral filler shall be non-plastic.

508.12.06 Blinding Sand - The Contractor shall be responsible for the supply of blinding material meeting the requirements of Table 508-D. That portion of blinding sand aggregate passing the 4.75 mm sieve shall be non-plastic.

TABLE 508-D GRADATION FOR BINDING SAND

SIEVE SIZE (mm)	PERCENTAGE PASSING
4.75	100
2.36	50 - 100
1.18	30 - 80
0.300	10 - 55
0.150	3 - 20
0.075	0 - 3

508.13 Graded Aggregate Seal Design - The Contractor shall provide a graded aggregate seal coat design, professionally prepared by qualified and experienced personnel. For this purpose, the Contractor shall use a qualified registered member of the Association of Professional Engineers and Geoscientists of British Columbia or a qualified registered member of the Applied Science Technologists and Technicians of British Columbia.

This design shall include the asphalt emulsion application rate in litres per square metre, spray temperature and the aggregate spread rate in kilograms per square metre. The design shall be presented to the Ministry Representative for review, at least three (3) days prior to the commencement of work and at any time subsequent changes are made to these rates.

The Contractor shall, upon request, submit to the Ministry Representative four litres of a representative sample of the emulsion(s) and a twenty kilogram sample of the aggregate(s) intended for use on the project. When requested, these samples shall be supplied at least three (3) days prior to the commencement of the work.

PART C – EQUIPMENT

508.20 General The Contractor shall supply plant and equipment necessary for the proper and efficient completion of the work, including clear and effective means of calibration.

508.20.01 The Ministry Representative shall have access

at all times to any plant, equipment or machinery to be used on the Project.

508.20.02 If plant or equipment adjustment is necessary, it shall be done by a competent operator or mechanic or instrument repair technician, as required.

508.21 EQUIPMENT GUIDELINES – The following are guidelines and as such are not mandatory.

508.21.01 Pressure Distributor - The pressure distributor used for applying asphalt materials to consist of a fully insulated tank with a minimum capacity of 5000 ℓ, permanently and rigidly mounted on a truck or fifth wheel trailer provided with pneumatic tires and propelled by a power unit capable of maintaining a constant and uniform speed.

The pressure distributor should be provided with the following equipment:

- a) A quick opening gate in the dome.
 - b) A dipstick calibrated in 20 mm increments and a calibration chart showing the volume for each 20 mm of depth, or provide the manufacturer dipstick and chart. Readily visible external depth gauge indicating the quantity of asphalt in the tank to the nearest 50 ℓ.
 - c) A means of heating the asphalt material uniformly to any temperature up to 125°C and maintaining the contents constantly at any selected temperature without any local overheating.
 - d) A heavy duty, industrial-type thermometer and a remote reading dial thermometer.
 - e) Rear-mounted spray bars and nozzles set parallel to the surface to be sprayed and capable of vertical and lateral adjustment. The spray bars to be capable of adjustment to provide a uniformly sprayed surface from a minimum of 0.6 m to at least 4 m width.
- The spray bars to be capable of producing up to triple coverage at one pass. The feed to the spray bars must be arranged so that there is a constant circulation of hot asphalt material to the bars to ensure a uniform viscosity and constant pressure of the liquid asphalt at each nozzle both before and during spraying operations.
- f) The feed manifolds to the spray bars to be provided with positive filtration to prevent clogging of bars and nozzles.
 - g) Rotary adjustable spray bar nozzles to be of the

same type, correct size and manufacture; and set to produce uniformly fan-shaped sprays without atomization. Nozzles to be inspected daily and any nozzle having nicked or damaged edges should be replaced.

h) Spray nozzles to be provided with valves capable of instant full opening and positive cut-off.

i) A connection to a circulating pressure manifold to which a hose may be attached for a single nozzle hand-operated outlet.

j) A pressure pump capable of applying the asphalt material at a minimum rate of 180 ℓ per minute, per metre of spray bar.

k) A pressure gauge accurate to within 15 kPa and a meter calibrated in litres per minute, should be readily visible.

l) A fifth wheel tachometer, calibrated in metres per minute and readily visible to the operator of the distributor.

m) Vehicle spring "tie-downs" to prevent the change in height of the spray bars due to the reduction of the asphalt load during spraying.

n) Electronic distance measuring device, with print out connected to the transmission, that is capable of measuring each spray length and the total length sprayed during the day.

508.21.02 Mechanical Spreader - Cover aggregate to be spread by means of an efficient, self-propelled spreader mounted on pneumatic tires and capable of continuously and uniformly spreading closely regulated quantities of crushed aggregates at the application rates selected. The loading hopper should be of such a capacity as to ensure continuous operation between dumps of aggregate. Aggregate to be transferred from the loading hopper to the front spreading device in such a manner as to ensure a uniform flow and prevent segregation of particles.

The spreading mechanism to be so designed as to distribute and spread aggregate across the selected width without segregation. Aggregate to be applied to the freshly sprayed surface by use of a comb screen for Class A and B Graded Aggregate Seals so that the largest particles are first placed on the road with the smaller fractions falling on top. The comb screen is to be mounted beneath the discharge openings of the spreader mechanism in such a manner that the angle of the comb screen relative to the road surface can be easily and quickly changed. Reverse flow aggregate spreaders are exempt from this

clause.

Suitable provision to be made to prevent aggregate from rolling on the freshly sprayed surface. The cover aggregate should be applied ahead of the spreader wheels, with sharply defined, straight edges and without any lateral movement of the aggregate after initial application.

The spreader to be designed to apply aggregate at any application width between 2 m and 4.12 m. (Note: a 4.26 m hopper is required).

All joints should be at centreline or lane line.

508.21.03 Rollers - Self-propelled pneumatic tired rollers (minimum mass of 11,000 kg) to be used on the work.

All rollers shall be provided with equipment for spraying water continuously on all tires or wheels, while rolling is in progress, and also be provided with such means as may be required to keep the tires clean and free of adhering asphaltic binder.

508.21.04 Power Brooms - Brooming work to be carried out using rotary power brooms. The brooms to have sufficient width, power and brushing capacity to completely clean the surface of the standard lane to be treated or which has been treated within three coverages.

508.21.05 Water Truck - Water trucks to have a minimum capacity of 9000 ℓ. Water to be applied from a distributor of the pressure type, equipped with a spray bar mounting nozzles similar to those used on asphalt distributors and capable of applying the water accurately and uniformly.

Splash plate type of distributors or those equipped with spray bars that eject fine streams of water will not be permitted.

The distributor to be provided with a satisfactory means for accurately measuring the quantity of water sprayed. Measuring equipment is to be calibrated. The Contractor shall make all necessary arrangements for obtaining water.

508.21.06 Tanks, Mobile Asphalt Heating, & Storage - Insulated liquid asphalt storage tanks should meet the following minimum criteria:

a) A heating system, capable to heat from 10° to 200°C.

b) An automated heating and control system with safety shutdown.

PART D – CONSTRUCTION

508.31 Daylight Hours Only – Construction shall be carried out during daylight hours only.

508.32 Traffic Control and Signing – The Contractor shall submit, for the approval of the Ministry Representative, a Traffic Control Plan at least seven days prior to the pre-construction meeting.

Traffic Control on Seal Coat projects shall be in accordance DBSS 194 as well as the Ministry's publication "Traffic Control for Work on Roadways".

The Traffic Control shall be maintained at all times when in the opinion of Quality Manager or the Ministry Representative, the risk of damage to the mat is likely to become a safety issue or to result in unnecessary vehicular damage from loosened rock. Additional traffic control to protect the quality of the product is also the responsibility of the Contractor.

Traffic through the work zone shall be limited to 50 km per hour, or as directed by the District Manager Transportation, until completion of final sweeping.

Extending traffic control beyond the end of the shift, in order to maintain safety and reduce vehicular damage risks, will not preclude the Contractor from providing and applying blinding material to further reduce these risks.

The Contractor shall, after discontinuing the application of product for the day, continue to maintain flag-person assisted traffic control over the extent of the day's production, for a minimum of 24 hours for work on numbered routes, 2 hours on other routes, or as specified in the Special Provisions.

508.33 Temperature and Weather – Air temperature shall be a minimum of 6°C for application of graded aggregate seals, and application shall cease when the temperature falls below that level.

No application shall take place when the weather is misty or rainy.

508.34 Grade Preparation – Immediately prior to the application of the graded aggregate seal coat on a previously constructed granular surface, the surface shall be watered, graded and compacted and/or broomed to provide a non-segregated, tightly knit surface free from loose rock. Cross-fall will be at 3% or as directed by the Designer and super-elevations developed uniformly and carried consistently through each curve.

508.35 Joints – All joints between adjacent passes of seal

shall be at centreline or lane lines.

508.36 Communications – The flagpeople, pilot car or cars, sign truck, spreader and supervisor's vehicle shall have an effective electronic means of communication so that instructions and information can be quickly and accurately relayed over the total length of the control area.

508.37 Sweeping – Sweeping shall meet the requirements of DBSS 145, and DBSS 165 and the following:

a) Immediately prior to the commencement of the sealing operations, all loose aggregates, dust, dirt, caked clay or foreign materials shall be removed from the width of the surface to be treated by brushing with power brooms supplemented by hand push brooms, shovels or the use of a power grader, and where necessary by flushing.

b) Particular care shall be taken to thoroughly clean to outside edges of the strips to be treated and to ensure that the sweepings are not so deposited on the shoulder as to permit subsequent contamination of the treated surface.

508.38 Repair – Any patching or repair work required, in the opinion of the Designer, Quality Manager or Ministry Representative, before sealing operations begin, shall be done by the Contractor.

508.39 Double Seal, Second Pass – Where the design calls for a double seal, the second pass of the surface treatment shall commence not less than 24 hours after completion of the first pass, subject to acceptable weather conditions as detailed in DBSS 508.33, and as the Quality Manager may direct.

PART E - QUALITY MANAGEMENT

508.41 Quality Management by the Contractor – The contractor shall be responsible for providing all resources required to carry out the quality control and quality assurance on all the constituent materials, processes and products, their testing and inspection, within the construction of the seal coat and the quality of the end product. (See DBSS 508 Appendix E - Quality Control Requirements and Guidelines).

508.41.01 Quality Control Plan – The Contractor shall prepare and submit a Quality Control Plan, in accordance with the Contract requirements, at least 7 days prior to the pre-construction meeting.

508.41.02 Sampling, Testing and Observing – The Contractor shall provide properly maintained equipment, qualified personnel and shall maintain access to a qualified

laboratory so that quality control tests and observations are performed and the results must be reported to the Quality Manager and, when requested, to the Ministry Representative within 48 hours. For asphalt emulsions, the test results must be received within 21 days of sampling.

The Contractor's Quality Control Plan shall provide details of the equipment provided, its calibration, and application methodology to meet the Contract requirements.

508.42 Quality and Quantity Control Records

508.42.01 Emulsion Quality – The Contractor is referred to tests performed on asphalt emulsion (DBSS 508 Appendix A). Quality control tests results for each batch of emulsion supplied to the job site must be made available to the Ministry.

508.42.02 Aggregate Quality–

The Contractor shall assess the supplied aggregate to determine and satisfy themselves as to its suitability regarding quantity and quality for the intended application. Any modifications deemed necessary to ensure a quality product shall be made at the Contractor's expense.

508.42.03 Emulsion Usage – Daily emulsion usage shall be recorded on the Form "Emulsion Usage" (DBSS 508 Appendix C). Information shall be made available to the Ministry Representative within 48 hours.

508.42.04 Aggregate Usage – The Contractor shall monitor the aggregate spread rate on a production day basis and make the results available, in an acceptable format, to the Ministry Representative within 48 hours.

508.42.05 Daily Activity Log – The Contractor's Superintendent or designate shall complete and make available to the Ministry Representative the "Daily Activity Log" (DBSS 508 Appendix D) within 48 hours. This form shall be completed and submitted for all calendar days from the first day of mobilization to the last day of demobilization, for any day on which work was performed on Site.

508.42.06 Emulsion Sampling

- i) The Contractor shall, procure and store a four litre sample of the emulsion from each tanker for use by the Ministry and/or Contractor.

These samples shall be obtained, handled and stored in accordance with ASTM procedure D 140 "Standard Practice for Sampling Bituminous Materials" and also with the manufacturer's recommendations.

- ii) The samples shall be identified and retained by the Contractor until demobilization at which time permission may be granted by the Ministry Representative to discard the samples in an environmentally friendly manner.

- iii) The Ministry Representative may provide the Contractor with a copy of the test results from the Ministry's Quality Management program. The Contractor shall not utilize these tests in place of their own Quality Management Program.

- iv) The absence of Ministry test results shall not relieve the Contractor's obligation to remedy any defect in materials or construction.

508.42.07 Final Quantity Report – The Contractor shall supply to the Ministry Representative, prior to final acceptance of the work, the total amount of emulsion and graded aggregate seal aggregate used on the project.

PART F - END PRODUCT ASSESSMENT

508.51 General - The Contractor shall provide an end product conforming in accuracy and detail as specified by the contract. Payment is based on end product assessment by the Ministry Representative.

508.52 Surface Deficiency Definitions – See DBSS 508 Appendix F "Surface Defects And Photographs" for examples and details of the conditions listed below. For the photographs of the various deficiencies, see SS 508 Appendix F in the *Standard Specifications for Highway Construction*.

508.52.01 Blackening – Blackening is the emergence of excess asphalt onto the finished surface whereby the finished surface becomes discoloured but the coarse surface texture remains. Under this condition, the effective cover stone can still be seen to protrude above the level of the asphalt binder's upward migration

508.52.03 Flushing and Bleeding – Flushing and bleeding is the emergence of excess asphalt and fines onto the finished surface and the significant loss of coarse surface texture, leaving little or no effective cover aggregate visible.

508.52.04 Pock Marks – Pock Marks are indentations in the mat texture, normally less than the thickness of the graded seal layer, evidenced by the absence of effective cover aggregate in a small area. (No photograph available)

508.52.05 Pot Holes – Pot Holes are the loss of all cover aggregate and base material(s) into the underlying asphalt

or gravel base. Pot Holes may develop because of seal and/or base weakness.

508.52.06 Ravelling – Ravelling is a general term for loss of cover aggregate, which can include numerous pock marks.

508.52.07 Streaking – Streaking is a continuous visible absence of effective cover aggregate often seen paralleling a ‘ridge’ of excess cover aggregate, characterized by the narrowness of its width and the significant extent of its length. Where streaking displays an absence of effective cover aggregate, the condition is unlike ravelling in that there was originally little or no effective aggregate in the area.

508.52.08 Washboard – Washboard is a condition of non-uniform surface texture caused by the buildup of transverse ridges within the graded seal layer itself, and characterized by a very rough, vibratory or chattering ride. (No photograph available)

508.53 End Product Evaluation

508.53.01 Lot Definition – A Lot shall be one lane kilometre of highway sealed. Sections of any road/highway remaining which are less than one-half (0.5) kilometres in length, will be included in the previous Lot. Sections remaining which are 0.5 kilometres or greater, but less than one kilometre will receive a Lot designation unique for the road/highway.

508.53.02 Rating Time Criteria – The Ministry Representative will rate each Lot, within thirty (30) days of final brooming.

508.53.03 Performance Rating Criteria – Performance rating will be in accordance with the two tables in DBSS 508 Appendix F: *The Surface Defect Parameters Table* and the *Surface Defects Frequency Definitions*, and the SS 508 photographs.

508.54 Deficiency Repair and Replacement – Any Lot

of sealed surface which is found unacceptable shall be remedied in accordance with the (DBSS 508 Appendix F) “Surface Treatment Repair/Replacement Criteria”, until the whole project has been repaired or replaced as necessary and accepted by the Ministry Representative.

On double seal applications both the lower and upper lifts must be free of deficiencies prior to being accepted.

The sealing Contractor will be responsible to remedy deficiencies attributed to base, base failures and base work done by others.

For any defects being repaired through re-seal, the repair must cover the entire width of the highway (or to a centerline barrier), unless the Contractor can demonstrate that a compliant repair can be achieved at a narrower width without any longitudinal ridging which may adversely affect driver control or trap water adjacent to the edge of the repair.

508.55 Attention to Potential Safety Hazards – If, in the opinion of the Quality Manager or the Ministry Representative, remedial Work is required to correct a potential safety hazard it shall be undertaken immediately.

PART G - MEASUREMENT AND PAYMENT

508.61 Not Used

508.62 Not Used

508.63 Not Used

508.64 Not Used

508.65 Claims for Vehicular Damage - Without in any way limiting the Contractor’s obligations or liabilities herein, during construction and up until final acceptance of the whole project by the Ministry Representative, the Contractor shall be fully responsible for all claims for damages caused by the work and shall address and deal with each claim submitted.

APPENDIX A**Quality Control Tests, to be obtained by the Contractor from the Supplier, for High Float Emulsified Asphalts**

<u>Test ASTM VERSIONS</u>	
ASTM D 140	Standard Practice for Sampling Bituminous Materials
ASTM D88	Saybolt Furol Viscosity
ASTM D-113	Ductility Test for Polymer Modified Emulsions
ASTM D-244 (CAN2-16.5-M84)	Residue by Distillation
ASTM D-5 (CAN2-16.5-M84)	Penetration of Asphalt Materials
ASTM D 4957 (CAN2-16.5-M84)	Absolute Viscosity of Asphalts
ASTM D-139 (CAN2-16.5-M84)	Method of Float Tests for Bituminous Materials

APPENDIX B**HIGH FLOAT EMULSIFIED ASPHALT REPORT (H-539)****Project No:** _____**Refinery:** _____**Contract:** _____**Asphalt Grade:** _____**Location:** _____**Batch No:** _____**Sampling Date:** _____**Testing Date:** _____

REQUIREMENTS	RESULTS	SPECIFICATIONS	
		MAXIMUM	MINIMUM
Residue by Distillation % by mass			
Oil Distillation % by volume			
Saybolt Furol Viscosity (SFS) 50°C			
Penetration 5 s/100 g/25° C			
Viscosity, mK or CM (Pa•s) 60° C			
Ductility, at 4°C			
Float Test (s) 60° C			

APPENDIX C

EMULSION USAGE

Project No: _____

Product: _____

Date: _____

Supplier: _____

Contractor: _____

Supplier Lading No: _____

Emulsion Temp.	Start Litres A	Finish Litre B	Litres Used L = A - B	Spray Width(m) D	Spray Length (m) E	Spray Area (m ²) F = D X E	App Rate(L/m ²) L/F	Location
The undersigned certifies that the quantities placed are as indicated in the information above.								
Name: (Contract Operator): _____ Date: _____								
Checked by (Ministry Representative): _____ Date: _____								
NB: In the "Location" column give station to station or landmark to landmark inventory kilometre and indicate the lane being sealed (e.g. WBSL = west bound slow lane)								

APPENDIX D**DAILY ACTIVITY LOG****1. General**

Contractor_____Address_____

Superintendent_____Phone_____Fax_____

Project No._____Hwy/Road_____

Project Description_____

Emulsion Manufacturer_____Emulsion Type_____

Aggregate Source(s)_____Aggregate Class_____

2. Equipment (e.g.: type, make and model of chip spreader)

3. Weather**at start-up****at shut-down**

Ambient Temperature: _____

Road Surface Temp.: _____

General Conditions: _____

4. Traffic Control**Number/Type****Duration (From/to)**

Pilot Vehicles _____

T.C.P.'s _____

Signs (specify) _____

5. General Remarks (e.g.: weather, dust, traffic volumes, mechanical, materials)

(Contractor's Representative)

(Date)

APPENDIX E**QUALITY CONTROL REQUIREMENTS AND GUIDELINES****1.01 GENERAL**

The Contractor's guidelines for preparing, submitting and adhering to a Quality Control Plan are specified in DBSS 101, DBSS 508 Part E, the Contract and this Appendix.

The QC Manager shall have at a minimum 5 years related experience in Quality Management.

1.02 QUALITY CONTROL PLAN

The Plan shall address all elements that affect the quality of the materials, end product seal coat, including but not limited to the following:

- Supply of Asphalt Materials
- Identification of source and proof of quality of aggregates to be supplied
- Aggregates production and its gradation control
- Quality of aggregate components during production
- Stockpile management
- Sealcoat Design(s)
- Distributor and spreader calibration
- Process temperature controls
- Material application rates
- Joints and tapers

1.03 CONTRACTOR'S RECORD OF QUALITY CONTROL TESTING

Test results should be made on specified forms or charts immediately after completion of each test. These test results are to be made available to the Ministry Representative upon request.

Records of gradation control during aggregate production should be kept on the form H-295 – Mechanical Analysis of Aggregates, or on a similar gradation analysis form acceptable to the Ministry Representative.

1.04 MATERIAL APPLICATION RATE

The Contractor shall control the Material Application Rate by monitoring the amount of emulsion and aggregate delivered to the road against the area covered by checking the application rates of the distributors and spreader.

1.05 OTHER QUALITY CONTROL PROCEDURES

The Contractor may initiate other Quality Control procedures as necessary for ensuring production of a quality product and include them in a Quality Control Plan. Procedures may also be introduced after the start of work as amendments to the Quality Control Plan.

1.06 QUALITY CONTROL TESTING FREQUENCY

Recommended test frequency requirements for Quality Control are described in Table 1 following.

1.07 QUALITY ASSURANCE TESTING FREQUENCY

Quality Assurance test frequency shall be approximately 10% of that described for Quality Control and may vary, in accordance with the Quality Management Plan and the observed effectiveness of Quality Control.

TABLE 1 – TEST FREQUENCY GUIDELINES

	ASTM Test Designation	*Minimum Frequency
Tests Before Aggregate Production	D-75 Sampling Stone, slag, gravel, sand and stone block for use as Highway Materials	When Required
	C-117 Test for Materials Finer than 75 µm (No.200) Sieve in Mineral Aggregates by Washing	1 test (Representative Sample)
	C -142 Test Method for Clay Lumps and Friable Particles in Aggregates	1 test (Representative Sample)
	D 6928 Micro Deval	1 test (Representative Sample)
	D-5821 Fracture Count on Coarse Aggregate	1 test (Representative Sample)
	D-4791 Test Method for Flat Particles, or Flat and Elongated Particles in Coarse Aggregate	1 test (Representative Sample)
Tests During Aggregate Production	C-136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates	- Main Stockpile -1 per each 1.5 hours production.
	D-5821, Determining the Percentage of Fractured Particles in Course Aggregate	- Main Stockpile -1 per each 1.5 hours production.
	C-117 – Test for Materials Finer than 75 µm (No 200) Sieve in Mineral Aggregates by Washing	- 1/shift on reduced sample obtained from combined samples from the crusher.
Tests on Emulsified Asphalt Products	D-244, Residue by Distillation	- minimum 1 per batch
	D-244, Saybolt Furol Viscosity	- minimum 1 per batch
	D-5, Penetration of Bituminous Materials	- minimum 1 per batch
	D-139, Float Test	- minimum 1 per batch
	D-4957, Apparent Viscosity on Residue	- minimum 1 per batch
	D-113, Ductility	- minimum 1 per batch on polymer modified emulsions.
Tests on Application of Sealcoat Materials	Emulsion Pan Test	- 3 per distributor/day. Test procedure, variation limits and actions should be outlined in Contractor's Quality Control Plan.
	Aggregate Pan Test	- 2 per spreader/day. Test procedure, variation limits and actions should be outlined in Contractor's Quality Control Plan.

* These are the recommended minimum frequencies and the contractor is responsible to assess the need to increase testing when required.

APPENDIX F**SURFACE DEFECT AND TREATMENT REPAIR/REPLACEMENT CRITERIA**

SURFACE DEFECTS	SEVERITY	RATING PARAMETERS	REPAIR/REPLACEMENT METHOD
Loss of cover aggregate (Ravelling)	Very good	No noticeable aggregate loss	None
	Good	A few pock marks, less than 5 per 0.1 m ²	None
	Fair	Frequent pock marks closely spaced, more than 5 per 0.1 m ²	Reseal of affected area***
	Poor	Extensive pock marks or few surface disintegrations	Reseal of affected area***
	Very poor	Disintegration with potholes	Reseal of affected area***
Potholes	Very good	Few minor potholes, only involves graded aggregate seal	All potholes to be filled with asphaltic patching material at contractor's expense
	Good	Few deep potholes, involves granular base	All potholes to be filled with asphaltic patching material.(see DBSS 508.54)
	Fair	Intermittent potholes	Patch potholes and reseal affected area*** (see DBSS 508.54)
	Poor	Frequent potholes	Patch potholes and reseal affected area*** (see DBSS 508.54)
	Very poor	Extensive or potholes throughout	Patch potholes and reseal affected area*** (see DBSS 508.54)
Flushing / bleeding	Very good	No/very faint colour change in wheel path	None
	Good	Few sections with asphalt on surface	None
	Fair	Intermittent sections with asphalt on surface	Application of sand blotter
	Poor	Frequent sections with asphalt on surface, has wet look or asphalt on surface throughout	Reseal of affected area. Removal of initial surface treatment at Contractor's option***
	Very poor	Wet look with noise like a wet pavement	Reseal of affected area. Removal of initial surface treatment at Contractor's option***
Total failure	Any	Any condition where the asphalt material softens or disintegrates under traffic and aggregate is picked up or "kicked off" by traffic	Remove and dispose of failed surface treatment in its entirety and apply new surface treatment
Streaking (see raveling)	Any	Absence of cover aggregate caused by too little binder - characterized by long, narrow sections of little or no stone cover	Reseal of affected area
Washboard	Any	Any condition of repetitive build-up across the travel lane	Remove and reseal affected area

NOTE:*** Reseal for these defects shall consist of a new graded aggregate surface treatment, single pass application. Area of the reseal repair/replacement shall not be less than one lane width, 10 metres in length. If there is less than 10 metres between two sections in the application pass designated for repair/replacement, the repair/replacement shall be continuous.

APPENDIX F (Continued)**SURFACE DEFECTS FREQUENCY DEFINITIONS**

DENSITY OF SURFACE DEFECTS**			
SEVERITY	RAVELLING (% LENGTH)	POTHOLE (NUMBER)	FLUSHING/BLEEDING (% LENGTH)
Very Good	<5%	0 - 1	<5%
Good	5% - 20%	2 - 15	5% - 20%
Fair	21% - 50%	16 - 30	21% - 50%
Poor	51% - 80%	31 - 50	51% - 80%
Very Poor	>80%	>50	>80%

Note: ** Based on number of surface defects or percent of surface affected by defect, per Lot as defined in DBSS 508.53.01.

For illustrative photographs of the surface defects, see SS 508 Appendix F in the Ministry's *Standard Specifications for Highway Construction*.

SECTION 511

COLD MILLING

DESCRIPTION

511.01 Scope - This work consists of preparing a foundation for placement of new surfacing by cold milling the existing pavement surface to the depth and width as indicated in the Contract and the Design.

EQUIPMENT

511.21 Milling Machine - The milling machine may be self-propelled, be equipped with automatic longitudinal and transverse grade control and a profiling ski or boom of a recommended minimum 4 m length. The cutting drum shall be totally enclosed. There shall be an effective means of removing the loosened material from the surface and for preventing dust from escaping into the air.

511.22 "Kill" Switch - All pavement milling machines shall be equipped with a "kill" switch installed or approved by the manufacturer of the milling machine. This "kill" switch shall be automatically actuated whenever the operation of the machine is so impeded that a hazardous situation, such as "kick back", would result were that operation to continue. When so actuated the "kill" switch shall instantly shut down the operation of the milling machine.

511.23 Not Used

CONSTRUCTION

511.31 Not Used

511.32 Pavement Removal - The existing pavement shall be removed to the depth and width as specified in the Contract and the Design. The surface shall be free of longitudinal and transverse irregularities. At all times, during the milling operation, the traveled roadway shall be kept clean of all loose materials.

At the end of the milling shift or at the end of each section to be milled, prior to reopening the road to traffic, the pavement shall be cleaned and swept so that all loose material is removed. Also, the transition from the milled

surface to the existing paved surface shall be tapered at a maximum slope of 25:1.

On extensive milling projects no more than one milling lift shall be carried out in any one lane so as to minimize the length of the grade difference between the lanes. At no time, at the end of a shift, shall there be a grade difference that is not at lane dividing lines, centre line. When the milling operation traverses intersecting roads or on and off ramps, the transition from the milled surface to the existing pavement shall be at a maximum slope of 25:1. This transition can be done with the milling machine or by using tar paper letdowns.

If, due to delays between the milling and paving operations, the milled surface starts to pothole or deteriorate, repairs shall be carried out at once using asphalt mix. At no time shall there be a grade difference between lanes of more than 50 mm at the end of a shift. If the milling is carried out to a depth greater than 50 mm, the full width of the driving surface shall be milled or a lift of leveling course shall be constructed to maintain a maximum depth of 50 mm.

The Contractor shall cut drainage channels as required to prevent water from collecting in the milled area.

511.33 Disposal of Materials - The disposal of materials removed under this section which are not recycled and used on the project shall become the property of the Contractor at the point of removal, unless otherwise specified. Materials shall be disposed of outside the limits of the project in a manner that shall meet all environmental requirements. The procurement of a disposal site, if required, shall be the Contractor's responsibility.

511.43 Existing Structures - Care must be taken not to disturb or damage any structures or devices such as manholes, catch basins, valves, boxes and other utilities. Damage to visible, referenced, or plan-indicated manholes, catch basins, valves, valve covers and concrete/asphalt curb, or any other infrastructure shall be repaired. All metal and concrete faces must be cleaned of old pavement and painted with primer, prior to repaving.

SECTION 514

HOT IN-PLACE RECYCLE

DESCRIPTION

514.01 Scope - This Specification describes the equipment, work practice and materials required for carrying out Hot In-Place Recycle operations.

MATERIALS

514.11 Rejuvenating Agent-Requirements - The Contractor shall supply an approved rejuvenating agent that is listed on the Ministry's Recognized Products List, which may be found on-line at:

http://www.th.gov.bc.ca/publications/eng_publications/geotech/rpb.htm

514.12 Asphalt Mix - When the Contract requires the addition of virgin mix to be incorporated into the recycled asphalt mix, it shall meet the requirements as shown in the Contract.

EQUIPMENT

514.21 General - All equipment and instrumentation shall be capable of performing the work in accordance with these specifications.

514.22 Processing Equipment - The equipment shall

have the capability to process the existing pavement to a minimum depth of 50 mm. The equipment shall be capable of heating the existing pavement to a width 100 to 200 mm wider than the width to be processed and to a temperature, behind the screed, of not less than 110°C. The equipment shall be regulated so that excessive heating and burning of the existing asphalt cement does not occur. This will generally require the existing surface to be radiantly heated and no open flame will be permitted.

The scarifying tines or cutting drum(s) shall mill to the specified cross-section and shall be set so as to produce a fully homogenous recycled mixture free of lumps.

The equipment shall have an activated heated screed complete with augers and strike-off device, capable of distributing and placing the reprocessed mix to the full width of the pavement being recycled.

Rejuvenating agents that contain water will not be permitted.

The hot recycling unit shall be equipped and capable to add and homogeneously blend any specified proportion of virgin Asphalt Mix into the reclaimed material and shall be equipped with a means to introduce a rejuvenating agent homogeneously into the reclaimed mixture.

The Contractor's compaction equipment shall conform to

TABLE 514-A SPECIFICATIONS

BCH Test	ASTM Test	TITLE OF TEST	SPECIFICATION
II-1	D-2726	Bulk Relative Density of Compacted Bituminous Mixtures using Saturated Surface Dry Method	
II-2	D-1188	Bulk Relative Density of Compacted Mixes Using Paraffin Coated Method	
II-3	D-1559	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	
III-4	D-2170	Kinematic Viscosity @ 60°C	200-500 mm ² /sec
III-7	D-70	Specific Gravity	0.98-1.02
III-11	D-92	Flash Point by Cleveland Open Cup	204°C Min.
	D-1160 (10 mm Hg)	Volatility - IPB - 2%v. - 6%v.	150°C min. 190°C min. 210°C min.
	D-2007	Saturates, %w	28 max.
	D-2006-70	Asphaltenes, %w	1.5 max.
	D-2006-70	Chemical Composition (PC+A ₁)/(S+A ₂)	0.4-0.8

SECTION 514

DBSS 501.36 in its entirety.

Individual pre-heating and reprocessing units shall be equipped in such a way that the operator and other workers are not exposed to any hazardous fumes or gases produced from the equipment operation, the heated pavement or from the addition of the rejuvenating agent, in accordance with all applicable regulations.

514.23 Rejuvenating Agent Equipment - To accurately proportion the rejuvenating agent into the scarified mixture the equipment shall comply with the following requirements:

- a) positive feed and shut off of the rejuvenating agent, governed by the movement of the reprocessing machine
- b) control of the quantity of rejuvenating agent to $\pm 0.05 \text{ l/m}^2$ of surface reprocessed with an agent application range of 0.0 l/m^2 to 1.0 l/m^2
- c) measurement of the rejuvenating agent applied by means of a metering device, which is capable of recording accumulated litres to the accuracy of $\pm 2\%$, and which is fully visible to both the operator and the Ministry Representative
- d) mechanically or electronically controlled application of the rejuvenating agent relative to and variable with the processing rate of the equipment
- e) a mechanical or electronic metering device capable of supplying an accurate indication of the quantity of rejuvenating agent being applied per square metre
- f) a mechanical, electronic or manual method of measuring the quantity of rejuvenating agent in the tank
- g) heating of the agent to within $\pm 5^\circ\text{C}$ of the application temperature established by the manufacturer.

CONSTRUCTION

514.31 Preliminary The existing paved surface shall be cleaned to avoid contamination of the recycled pavement. It shall be swept back at least 20 cm wider than the area to be processed.

Prior to proceeding with the road work, the Contractor shall ensure that all catch basins and manholes, which are within the operating area of the heating units, are clear of any flammable liquids or otherwise hazardous fumes/gases. **514.32 Recycling** - The existing highway

HOT IN-PLACE RECYCLE

pavement shall be heated, planed, reprocessed, with or without the addition of a rejuvenating agent and with or without the addition of virgin mix as specified, remixed, replaced and compacted using a heater scarification or hot milling process and rollers.

The recycled material shall not be heated over an average of 150°C in order to avoid excessive oxidation and hardening of the recycled Asphalt Cement.

At the locations where the recycling operations begin and end, the Contractor shall ensure that the transition areas between the processed and unprocessed surface is smooth. If any bumps or irregularities occur resulting from the reprocessing operation, the Contractor shall repair these areas with fresh asphalt mix and/or additional reprocessing.

At all times the Contractor shall ensure that the appropriate cross slopes for safety and positive pavement drainage are maintained.

The Contractor shall ensure that the longitudinal edges of the recycled pavement are blended to conform in elevation with the adjacent pavement unless this surface is scheduled to be recycled.

Generally, the outer edge of each lane will be tapered to a 12:1 slope.

Excess materials shall be removed and deposited in a location such that they can be reincorporated into the recycled mixture. At no time shall excess material be cast across the newly processed surface or incorporated into the granular shoulders.

514.33 Compaction and Finishing - Immediately behind the reprocessing operation, the Contractor shall supply roller compaction to obtain a minimum of 97% laboratory density. The laboratory density will be the specimen density, (ASTM Test D 2726 or D 1188) that results from heating a representative sample of the existing pavement, or rejuvenated and blended mixture, as applicable, to a temperature of 130°C and producing a compacted laboratory specimen using the procedure for 75 blow Marshall method. (Sample preparation shall be in accordance with applicable portions of ASTM Test D 1559).

The mix for compaction testing shall be obtained behind the screed of the laydown machine, and the roadway shall be marked at that location for subsequent drilling of the core. The core shall be cut at the specified heater recycling thickness prior to obtaining its density.

The reprocessed mat shall have a uniform appearance. Any deficiencies shall be corrected to the satisfaction of the Quality Manager and the Ministry Representative.

The completed Hot In-Place Recycled surface shall conform to all requirements of DBSS 501.10.

SECTION 515

END PRODUCT SPECIFICATION FOR HOT-IN-PLACE RECYCLED ASPHALT PAVEMENT

PART A - GENERAL

515.01 General – This Section describes the materials, equipment, professional standards and end product requirements for the construction of Hot In Place Recycled Asphalt Pavement.

End Product Specifications contain the acceptance and payment criteria based on the results of specified sampling and testing. Payment is subject to adjustments upward and downward in accordance to the provisions provided in End Product Specifications (EPS).

515.02 General Description Of Work - The Contractor will be responsible for the following work associated with the construction of hot in place asphalt pavement by EPS:

- Preparing a Quality Control Plan for evaluation before commencing the Work and providing at the production site a testing facility to provide the data needed to implement that plan.
- Supplying, screening, crushing, processing and improving aggregate to produce virgin asphalt mix aggregate.
- Supplying and delivering asphalt cement meeting the requirements of DB SS 952.
- Supplying and delivering rejuvenating agents meeting the requirements of DB SS 514.11 and DB SS 514.23.
- Heating the virgin asphalt mix aggregate and mixing it with asphalt cement to produce asphalt admix that meets the Job Mix Formula.
- Hauling, and adding the asphalt admix into the recycling process.
- Recycling the existing highway pavement by heating, milling, reprocessing, with or without the addition of rejuvenating agents or admix (virgin mix) as specified, re-mixing, replacing and compacting using a multi-stage, hot milling process and rollers.

The Contractor shall provide an end product conforming in quality and accuracy of detail to the dimensional and tolerance requirements of the contract. Where no tolerances are specified, the standard of workmanship shall be in accordance with normally accepted good practice and those identified in DB SS 514. Payment is subject to adjustments based on quality audit tests performed by the Ministry Representative.

The Contract may provide information pertaining to the gradation of the admix, asphalt content, addition rates for rejuvenating agents and the percentage of admix to be incorporated.

515.03 Definitions Relevant To End Product Specification

515.03.01 End Product Specification (EPS) - A specification whereby the Contractor is entirely responsible for quality control of the construction processes, and whereby the Ministry performs the specified quality audit sampling and testing of the end product for the purpose of determining acceptance/rejection and payment adjustments.

515.03.02 Job Mix Formula - The Job Mix Formula, supplied by the Contractor, establishes the virgin aggregate proportions, gradation, the asphalt content and type of asphalt to be used for production of asphalt admix. The Job Mix Formula is based on an asphalt mix design, in accordance with DB SS 515.05.06, or on a variation in accordance with DB SS 515.05.07.

515.03.03 Asphalt Admix - The Asphalt Admix is virgin asphalt mix added to the recycled mix. The Asphalt Admix is project specific designed and is blended homogeneously within the recycling process. The Asphalt Admix becomes an integral component of the recycled pavement structure.

515.03.04 Asphalt Content - Asphalt Content means the quantity of asphalt cement in the virgin admix expressed as a percentage by weight of the total dry aggregate in the mix.

Design Asphalt Content - The asphalt content upon which the Job Mix Formula is initially established.

Approved Asphalt Content - The design asphalt content or subsequent adjustment to it, embodied in a Job Mix Formula or revised Job Mix Formula.

Actual Asphalt Content - Actual asphalt content is the amount of asphalt cement in the admix as determined by the Contractor's Quality Control Testing.

515.03.05 Smoothness - Smoothness is a measure of the longitudinal profile of the pavement surface. The unit for measurement is the International Roughness Index (IRI).

515.03.06 Sample Mean - The Sample Mean is the arithmetic mean of a set of test results constituting the sample.

515.03.07 Stratified Random Sample - A Stratified Random Sample is a set of test measurements taken one

each from a number of separate (stratified) areas or Sub-Lots within a Lot in an unbiased way.

515.03.08 Lot - A Lot is a portion of the work being considered for acceptance and for the determination of payment adjustments. A Lot is defined as follows.

For the application of the contract requirements for:

- Density,

A Lot shall be one day's scheduled production of at least 7 hours of pavement recycling where no changes have occurred to criteria such as but not limited to:

- approved Job Mix Formula,
- the specific thickness to be processed,
- the required materials addition rate,
- change in the ratio of the components making up the Hot In Place Recycled Pavement.

A change in any above criteria may require a new Lot designation.

One day's production of less than 7 hours will be dealt with as follows:

- the material will be added to the next Lot that has the same criteria, as described above, except that
- if a test indicates that this production is subject to a payment adjustment or to rejection, or if no further material will be produced with the same criteria, this production will be designated as a separate Lot,

A Lot shall be no more than two days total production even if the above criteria have not changed or been met.

For application of the contract requirements for:

- Smoothness,

A Lot shall be one kilometre length of recycled pavement for each driving lane.

515.03.09 Sub-Lots for Density and Smoothness - For the application of the contract requirements for:

- Density, each Lot shall be divided into three equal Sub-Lots.
- Smoothness, each Lot shall be divided into 100 metre Sub-Lots.

515.03.10 Driving Lane - A driving lane shall mean a single lane in any area of the pavement other than a shoulder or a barrier flare.

515.03.11 Not Used

515.03.12 Hot In Place Recycled Pavement - Hot In

Place Recycled Pavement shall be the result of the process where recycling, the addition of admix and/or rejuvenating agents, the spreading, compacting and finishing of the asphalt pavement have taken place to form a quality finished product. The Hot In Place Recycled Pavement may be comprised of the following components: existing asphalt pavement, admix, and/or rejuvenating agents.

515.04 Quality Control

515.04.01 General - Quality Control, by the Contractor, is the sum total of activities by the Contractor to ensure that a product meets contract specification requirements. Quality Control includes material handling and construction procedures, calibration and maintenance of equipment, production process control and any sampling, testing and inspection that is done for these purposes.

The Contractor is responsible for all Quality Control under this specification. The Ministry Representative will audit and monitor the Contractor's operations and the implementation of the Contractor's Quality Control Plan.

The Ministry will not take samples for quality control testing and will in no manner assist in any degree or in any aspect of the Contractor's operation in the production of asphalt pavement, beginning from the production of aggregate through the compaction of asphalt mix. The only exception shall be in accordance with the provisions of DB SS 515.05.07, where the Ministry shall have the ability to adjust the ratio of the components of the Hot In Place Recycled Pavement based upon the Contractor's Quality Control Results and visual inspections.

515.04.02 Quality Control Plan - The Contractor shall prepare a detailed, written Quality Control Plan, based on the guidelines as shown in Appendix 1 and functions integrally with any other Quality Management provisions of the Contract. The Contractor's Quality Control Plan shall be submitted to the Ministry Representative for information before starting the production of paving aggregate

The Contractor's Quality Control Plan shall include a description and schedule of the intended sampling, testing and reporting. The Quality Control Plan must also include a detailed description of the means by which the Contractor shall use the quality control test results to ensure that the asphalt materials, aggregate, mix production, recycling and pavement compaction processes will be controlled to keep the end product within the specified limits. The Quality Control Plan must clearly show the flow of information from the quality control laboratory to the individuals who shall make the actual adjustments to the processes and equipment to this control. The plan will show time allowance for each step, the

names and positions of all the people involved, and a clear description of the responsibilities of each.

515.04.03 Quality Control Testing and Inspection -

The Contractor shall provide and maintain equipment and qualified personnel to perform all laboratory testing, field testing and inspection necessary to determine and monitor the characteristics and properties of all the materials produced and incorporated into the work. They shall also monitor the workmanship of the final product in accordance with the Quality Control Plan as most recently submitted.

The Contractor shall use a qualified registered member of the Association of Professional Engineers and Geoscientists of British Columbia or a qualified, registered member of the Applied Science Technologists and Technicians of British Columbia. This person shall be designated as the Quality Control Manager for the purposes of these specifications. The Quality Control Manager shall be responsible for preparation and sign off of the Quality Control Plan, shall be responsible for all Quality Control testing and inspections and shall be responsible for the signing of all Quality Control testing and inspection records and submissions to the Ministry.

The Contractor shall provide a testing facility(s) that meets the requirements necessary to carry out all the test procedures listed within this Section. The facility(s) must have the equipment specified under the appropriate test designation to perform the tests.

All equipment and the laboratory shall be well maintained and in good working condition. All testing equipment shall be calibrated and evidence of the calibration shall be provided to the Quality Manager, and, upon request, to the Ministry Representative.

515.04.04 Quality Control Records - The results from quality control testing shall be reported on test logs and plotted on charts immediately after each test is completed. These test results, reports and charts shall be available, to the Ministry Representative upon request.

For the purposes of confirming delivery of asphalt mix to the road and the calculation of material application rates, the Contractor shall prepare and provide to the Ministry

Representative, a copy of the Road Checker's Summary.

515.04.05 Final Quality Control Testing Reports - The Contractor shall retain and provide the Ministry Representative on request :

- a summary of all virgin aggregate quality control test results;
- copies of all quality control test results for asphalt admix properties, Hot In Place Recycled Pavement and compaction; and
- copies of all quality control charts.

515.04.06 Minimum Acceptable Construction

Practices - Good construction practices shall be considered as standard construction procedures to be followed and shall include but not be limited to the procedures described below.

Stockpiles - Stockpiles of different types of material shall be located and constructed in such a manner as to prevent intermingling of the types and segregation of material.

Haul Vehicles - Lubrication of the truck boxes with diesel fuel will not be permitted. All vehicles shall have adequately insulated truck boxes and shall be equipped with an insulating tarpaulin of such size as to completely protect the asphalt mix.

Existing Paved Surfaces - Existing paved surfaces shall be clean to avoid contamination of the recycled pavement. The existing surfaces shall be swept back at least 20cm wider than the area to be processed.

Existing Utility Structures - The Contractor shall ensure all catch basins and manholes, which are within the operating area of the heating units are clear of any flammable liquids or otherwise hazardous fumes/gases.

Heating of Recycled Material - The recycled material shall not be heated over an average of 150°C in order to avoid excessive oxidation and hardening of the recycled Asphalt Cement.

Minimum Admix Temperature - Based on the most recent Temperature Viscosity Curve supplied by the Asphalt Cement Supplier. This information will be used to set minimum and maximum mixing temperatures.

TABLE 515-A-1 STANDARD SAMPLING AND TESTING PROCEDURES FOR VIRGIN AGGREGATES

All virgin aggregate tests shall use the following sieve sizes:

37.5mm, 25mm, 19mm, 16mm, 12.5mm, 9.5mm, 4.75mm, 2.36mm, 1.18mm, 0.600mm, 0.300mm, 0.150mm, and 0.075mm.

Item	Procedure	Test Reference
1	Sieve Analysis of Fine And Coarse Aggregates	ASTM C-136
2	Materials Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregate by Washing	ASTM C 117
3	Specific Gravity and Absorption of Coarse Aggregate	ASTM C-127
4	Specific Gravity and Absorption of Fine Aggregate	ASTM C-128
5	Determining the Percentage of Fractured Particles in Coarse Aggregate	ASTM D-5821
6	Total Moisture Content of Aggregate by Drying	ASTM C-566

TABLE 515-A-2 STANDARD SAMPLING AND TESTING PROCEDURES FOR ASPHALT CEMENT

Item	Procedure	Test Reference.
1	Penetration of Bituminous Materials	ASTM D-5
2	Viscosity of Asphalt by Vacuum Capillary Viscometer	ASTM D-2171

TABLE 515-A-3 STANDARD SAMPLING AND TESTING PROCEDURES FOR VIRGIN ASPHALT ADMIX AND HOT IN PLACE RECYCLED PAVEMENT

Item	Procedure	Test Reference
1	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures	ASTM D-2726
2	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures	ASTM D-2041
3	Sampling Compacted Bituminous Mixtures for Laboratory Testing	ASTM D-5361
4	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	ASTM D-1559
5	Determining Asphalt Content by Ignition Methods for Admix.	ASTM D-6307

Longitudinal Joints – Longitudinal joints in the top lift of asphalt pavement will generally only be permitted where lane dividing lines are to be painted.

Longitudinal Edges – Are to be blended to conform in elevation with the adjacent pavement unless this surface is scheduled to be recycled.

Minimum Temperature – Minimum Temperature behind the paver screed of the recycled material shall not be less than 110°C.

Metering of Rejuvenating Agents – To accurately

proportion the rejuvenating agent into the hot milled material, the equipment shall control the quantity of the rejuvenating agent to $\pm 0.05 \ell/m^2$ of surfaced reprocessed with an agent application range of $0.0 \ell/m^2$ to $1.0 \ell/m^2$. The measurement of the rejuvenating agent applied by means of a metering device shall be capable of recording accumulated litres to the accuracy of $\pm 2\%$, and be fully visible to both the operator and quality management personnel.

Outer Edges – The outer edge of each lane shall generally be tapered to a 12:1 slope.

Recycling Adjoining Mats – When recycling an adjoining parallel mat there shall be at least a 50-mm overlap onto the previously recycled surface. This overlap shall be properly “raked” to form a homogeneous bond between the two mats.

Raking – Any material that is raked from the joint shall not be placed on the new mat or placed on or in front of the paver. This material may be introduced at a point of the operation where the material shall be reheated and remixed with the Hot In Place Recycled Pavement.

Discontinued Paving - At locations where reprocessing operations begin and end, the Contractor shall ensure that the transition between the processed and unprocessed surface is smooth and without irregularities. If any irregularities occur resulting from the reprocessing operation, the Contractor shall repair these areas with fresh asphalt mix and/or additional reprocessing.

Pavement Drainage – The Contractor shall at all times ensure that the appropriate cross slopes for safety and positive pavement drainage are maintained.

Rollers – Rollers shall normally operate with the drive wheel nearest the paver and at a speed not in excess of 8 km/h. They shall not be allowed to park on the mat prior to complete cooling.

TABLE 515-A-4 TEST SAMPLE SOURCE LOCATIONS

Test	Sample Source:
Density	150mm diameter. road cores
Smoothness	Centre of Lane

515.05 Supply Of Virgin Aggregates, Asphalt Materials, Asphalt Admix Design And Job Mix Formula

515.05.01 Work in Ministry Pits or Quarries - When operating in a Ministry pit or quarry, the Contractor shall comply with all provisions of DB SS 145.26.

515.05.02 Supply of Virgin Aggregates, Aggregate Production and Characteristics - The Contractor shall not produce paving aggregate until the Contractor has received written notification that the Quality Control Plan is in accordance with DB SS 515.04.02, and has in place testing facilities for aggregate production that are in accordance with the Quality Control Plan.

Where the Ministry has available any test result

information on the properties shown in Table 515-B, for a Ministry pit or other source, the Ministry will upon request, provide that information to the Contractor. Otherwise, sampling and testing to determine and demonstrate the compliance of paving aggregate with the requirements of this Section shall be the responsibility of the Contractor.

Paving aggregates shall meet the following requirements:

- a) Virgin Coarse Aggregates;
 - i) shall be all mineral matter retained on the sieve designated in the test procedures for each individual test.
 - ii) shall consist of crushed stone, crushed gravel, or combination thereof, or materials naturally occurring in a fractured condition, or materials naturally occurring of highly angular nature or rough texture.
 - iii) shall be free from coating of clay, silt or other deleterious material, and shall meet the requirements listed in Table 515-B.
- b) Virgin Fine Aggregate
 - i) shall be clean, tough, durable, moderately sharp, and free from coatings of clay, silt, or other deleterious material, and shall contain no clay balls or other aggregations of fine material.
 - ii) shall have a sand equivalent of not less than 40 when tested in accordance with ASTM Test D-2419
 - iii) shall have a minimum value of 45 when tested according the AASHTO Test T 304, Method “A”, - Uncompacted Void Content of Fine Aggregate when determining Fine Aggregate Angularity.

c) Virgin Mineral Filler and Mineral Dust

- i) Mineral filler shall consist of all matter passing the 0.600-mm sieve and mineral dust shall consist of all mineral matter passing the 0.075-mm sieve.
- ii) Mineral filler and mineral dust shall be free from organic matter.
- iii) Mineral filler shall be non-plastic when tested in accordance with ASTM Test D-4318.

515.05.03 Supply of Asphalt Cement and Rejuvenating Agents - The Contractor shall supply the types and grades of asphalt cement and rejuvenating agents as specified in the Contract and the Design. The supply of these materials includes, but is not limited to, ordering,

scheduling delivery of, supply of Temperature Viscosity Curve information, receiving, handling, storing, heating, blending, sampling, and testing of the materials and other related work.

The Contractor shall retain and supply the Ministry Representative on request with copies of the supplier's weigh-bill and records of all asphalt and rejuvenating materials.

515.05.04 Responsibility for Asphalt Admix Design

Preparation of the asphalt admix design is the responsibility of the Contractor.

515.05.05 Evaluation of Asphalt Admix Materials -

The Contractor's Quality Manager will evaluate the Asphalt Admix materials.

515.05.06 Samples Required for Asphalt Admix

Evaluation - At the discretion of the Ministry Representative, the Ministry may request samples of the Admix materials and Quality Control results and documentation for evaluation. Shipping costs for samples delivered to the Ministry Representative are the responsibility of the Contractor.

515.05.07 Field Adjustment of the Job Mix Formula and/or Recycled Pavement

- During construction, the Contractor may require field adjustments to the job mix formula and/or recycled pavement. A field adjustment to the Job Mix Formula is defined as a change in the asphalt cement content of the admix, aggregate gradation, rejuvenating agent and/or proportioning of various aggregate sizes.

shall be randomly selected and provided to the Contractor by the Ministry Representative and the cores shall be taken within a 300 radius of that location, unless otherwise agreed by the Ministry Representative. The Contractor shall provide 150 mm diameter cores for these purposes. The minimum core thickness shall be 37 mm. The Contractor shall prepare the cores prior to submission by removing all material not representative of the pavement lift to be tested. The Contractor shall deliver these cores to the Ministry Representative on site, within 24 hours of being provided the locations for the coring.

In the case of a core sample location falling in an obvious non representative area, such as a previously patched area, at the sole discretion of the Ministry Representative, a new random core location will be chosen for that sample.

All costs associated with obtaining the cores, including the filling and compaction of the core holes are considered incidental to the contract and are the responsibility of the Contractor.

515.11.02 Percent Density - One random core sample will be obtained from each Sub-Lot and tested. The test results for the three Sub-Lots will be averaged to determine the percent density for the Lot.

$$\text{Hot-In-Place \% Density} = \frac{\text{In Place Density of Sample}}{\text{Maximum Theoretical Density (ASTM D-2041)}} \times 100$$

The Maximum Theoretical Density for the lot will be determined by combining the Sub-Lot cores. Prior to testing to determine the maximum theoretical density, the cores should be prepared in accordance with the procedure outlined in Appendix 3.

515.11.03 Payment Adjustments - The payment adjustment for percent density will be the amount shown in Table 515 C for the Sample Mean of the test results for the Lot.

PART B - PAYMENT ADJUSTMENTS

515.11 Density

515.11.01 Coring - The Contractor shall be responsible for providing all core samples for quality assurance and payment adjustment purposes. The location of the cores

TABLE 515-B – REQUIREMENTS FOR VIRGIN COARSE AGGREGATES

Test Reference	Requirements	
ASTM C-127	Maximum Water Absorption: % by Mass	2
ASTM C-88	Soundness of Aggregate Maximum Loss After 5 Cycles	20
ASTM C-142	Maximum % by Mass of Clay Lumps and Friable Particles	1.5
ASTM D 6928–	Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	17 minimum
ASTM D-5821	2 Fractured Faces: Minimum % by Mass Retained on the 4.75 mm sieve	85

END PRODUCT SPECIFICATION FOR HOT-IN-PLACE RECYCLED ASPHALT PAVEMENT CONSTRUCTION

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515.11.04 Rejection Limit - The rejection limit for percent density is the limiting value of the Sample Mean as shown in Table 515 C.

If the test result for density of a Sub-lot is outside the acceptance limits, the Sub-lot is rejected automatically regardless of the values of other acceptance parameters. To minimize the cost of rejection to the Contractor, the Contractor shall isolate the area of low density within the Sub-lot and perform the necessary corrective measures to ensure specifications are met. The limits of the low density area must be verified and approved by the Quality Manager before remedial work proceeds.

TABLE 515 C PAYMENT ADJUSTMENTS FOR DENSITY

% MAXIMUM THEORETICAL DENSITY LOT AVERAGE	PAYMENT ADJUSTMENT (\$ PER m ²) FOR DESIGN LOT
95.6 Plus	+ \$0.25
95.0 – 95.5	+ \$0.15
94.0 – 94.9	+ \$0.10
93.0 – 93.9	0.00
92.6 – 92.9	- \$0.10
92.0 – 92.5	- \$0.25
91.9 or less	Reject

TABLE 515-D – LOT ASSESSMENT AND PAYMENT ADJUSTMENTS FOR SMOOTHNESS

For the final surface course only, the following payment adjustments shall apply to each Lot.

Lot IRI (m/km)	Payment Adjustment
≤ 0.80	+\$2,000
0.81 to 1.0	+\$1000
1.01 to 1.10	+\$500
1.11 to 1.40	0
1.41 to 1.6	-\$250
1.61 to 1.7	-\$500
1.71 to 1.99	-\$1,000
≥ 2.00	Reject and corrective work required

515.11.05 Payment for Rejected Work Made

Acceptable - The payment adjustment for density will be based on testing of the reprocessed, replaced, or overlaid material where applicable. Where replacement or overlay material does not cover the entire Lot or Sub-Lot, prior tests of the uncovered area will be averaged with new tests on the corrective work.

515.12 Smoothness

515.12.01 Determination of Pavement Smoothness -

The finished pavement surface shall be tested by the Ministry using a Class I precision rolling profile measuring instrument, to determine the longitudinal profile and compute the International Roughness Index (IRI) in each driving lane. Profiles shall be measured and the IRI calculated in the centre of the lane for each Sub-Lot. IRI values will be recorded to a precision of 0.01 m/km for each Sub-Lot. The Lot IRI value is the average of the IRI values calculated for the Sub-Lots within the Lot.

For any Sub-Lot between 50 m and 100 m in length, the IRI value shall be considered representative of a complete Sub-Lot. For any Sub-Lot less than 50 m in length, the IRI value will be combined with the proceeding Sub-Lot IRI value.

The profile shall be measured over the entire length of the pavement exclusive of structures and shoulder areas. Acceleration, deceleration and turning lanes are considered part of the driving lanes and shall be tested in accordance with this provision. For the measuring process, the Contractor shall provide a chalk guide line in the centre of the lane immediately prior to measurement.

515.12.02 Auxiliary Lanes - For smoothness testing, sections of the driving lanes that do not fall within the continuous through lanes, such as acceleration lanes, deceleration lanes and turning lanes, and lanes which are less than 1 km in length, shall be treated as follows. The ratio of the section length to the standard Lot length of 1 km shall be determined and the payment adjustment shall be pro-rated on this basis as in the following example:

$$\text{Length of segment, } = \frac{0.565 \text{ times the Standard Lot}}{\text{i.e. 565 metres}} \quad \text{Length of 1000m.}$$

Hence the applicable payment adjustment is 0.565 times the payment adjustment for a 1-km Lot as determined from Table 515-D.

515.12.03 Acceptance Limits - The acceptance limit for smoothness is the limiting value as shown in Table 515-D, beyond which corrective work is required. Payment adjustments are shown in Table 515-D. The International Roughness Index (IRI) value, calculated for each Sub-Lot, will be used to determine if the Lot will be accepted, and if

so whether it will be subject to any payment adjustment.

515.12.04 Payment Adjustments for Full or Increased Payment - Acceptance of any Lot at full or increased payment will occur if it contains no obvious defects as per DB SS 515.22 and in the case of top lift pavement only, the pavement smoothness, as reported by the International Roughness Index (IRI) meets the following requirements:

- All Sub-Lots shall have an IRI value ≤ 2.0

515.12.05 Rejection Limit - If a Sub-Lot has an IRI ≥ 2.0 , the Sub-Lot is rejected.

515.12.06 Remedial Work - If the test results on a Sub-Lot of pavement indicate a payment reduction or rejection because of smoothness, the Contractor may propose remedial work to improve the smoothness. Such proposals are subject to the approval of the Quality Manager and the Ministry Representative, but such approval does not imply that the proposed remedy will be successful, and does not reduce the Contractor's responsibility for meeting the acceptance requirements. Reprocessing may be acceptable, but cold milling and repaving may be required. Only one attempt may be made to improve smoothness, and this must be completed within ten (10) calendar days from the time the Contractor receives notification from the Ministry Representative of the original smoothness test results for that Sub-Lot.

Following any attempt to improve the smoothness of a Sub-Lot or Sub-Lots, the Ministry Representative will retest the Sub-Lot or Sub-Lots, and the new results will replace the previous data for the purposes of determining acceptance and payment.

515.12.07 Smoothness Deficiency Repairs - Smoothness deficiencies (bumps and dips) less than 8 mm over 3 m will not have a fix or remedial work requirement. Individual Smoothness deficiencies between 8 mm and 12 mm over 3 m will result in a \$200.00 penalty per deficiency and Smoothness deficiencies over 12 mm over 3 m will require remedial work. (see DB SS 515.22).

PART C - ACCEPTANCE AND REJECTION

515.21 Acceptance At Reduced Or Adjusted Payment - Acceptance of any Lot at reduced payment will occur if it contains no obvious defects as per DB SS 515.22, and if:

- the test results for acceptance parameters are such that the Lot or Sub-Lot meets the requirements for acceptance at a reduced payment; and
- the Lot or Sub-Lot is approved in respect of all other requirements; and if
- the Contractor has not notified the Ministry Representative in writing that it will exercise its

option to either repair or remove and replace the work, at its own cost, with work meeting the requirements for acceptance at full or increased payment.

515.22 Rejection For Workmanship Defects - The finished surface of any lift shall have a uniform "closed" texture and be free of visible signs of poor workmanship. Any obvious defects as determined by the Quality Manager or Ministry Representative such as, but not limited to the following, will be cause for automatic rejection of asphalt pavement regardless of the values of any other acceptance parameter:

- individual bumps and dips that exceed 12 mm over 3 m.;
- areas of excess or insufficient asphalt;
- improper matching of longitudinal and transverse joints;
- roller marks;
- tire marks; or
- cracking or tearing.

When asphalt pavement is rejected by reason of obvious defects, the minimum area of rejection will be the actual length of the defect for the full width of the driving lane in which the defect exists.

Rejected work shall be promptly repaired, remedied, or removed and replaced in a manner acceptable to the Quality Manager and Ministry Representative. The Contractor shall be responsible for all costs including materials.

No payment will be made for work in any Lot or Sub-Lot, which has been rejected, until the defects have been remedied.

515.23 Appeal Testing

515.23.01 Density - The Contractor may appeal the results of acceptance testing for density for any lot only once. Appeals will only be considered if quality control results can be presented to support the appeal.

Quality control test results for density which are provided to the Ministry Representative subsequent to the Contractors receipt of the quality assurance test results for that Lot will not be considered (when evaluating evidence) for an appeal. The appeal shall be for all tests within the Lots, and there will be no appeal allowed for single tests within the Lot.

The following procedures will apply for the appeal:

- The Ministry Representative will arrange for an independent testing laboratory to perform the

appeal testing. The personnel employed or testing laboratory retained by the Contractor for quality control testing on the project will not be used for appeal testing.

- The original quality audit results will not be considered in the appeal. The Contractor will sample the pavement at locations randomly re-selected by the Ministry within three site occupancy days following receipt of the appeal such that total of (5) new core specimens are extracted throughout the Lot. The Ministry Representative will observe the sampling process. The procedures used to determine the test results shall be consistent with the original acceptance testing methods.

515.23.02 Smoothness - The Contractor may appeal smoothness acceptance test results of any rejected or penalised Lot, once. The appeal shall be in writing and submitted within the next three site occupancy days following receipt of the test results.

Any attempt to improve smoothness on the appealed Sub-Lot after the Ministry Representative has tested the Lot shall void the appeal and the original test results will apply.

The Ministry Representative will perform, and the Contractor will be given the opportunity to witness, the appeal testing and the new results will be binding on the Contractor and the Ministry.

515.23.03 Application of Appeal Testing Results - For density appeals, the original test will be discarded. A new Sample Mean for the five new test results will be determined and used for acceptance and payment adjustment.

The new values, thus determined, in all cases, will be binding on the Contractor and the Ministry.

515.23.04 Payment for Appeal Testing - If the new results indicate a change in the payment adjustment in the Contractor's favour, then sampling and testing costs incurred during the appeal procedures for that Lot will be borne by the Ministry.

If the new results verify that any payment reduction or rejection remains valid for that Lot, then the costs of sampling and testing (plus 10% mark-up) incurred during the appeal procedure will be charged to the Contractor.

515.23.05 Time Limits for Appeals of Test Results - All appeals shall be in writing and submitted within the next three days of receipt of the test results.

515.24 Cold Milling And Re-Paving As A Corrective Measure - If cold milling and re-paving is used as a corrective measure on a defective Lot or Sub-Lot, the thickness will be subject to the approval of the Ministry Representative, but shall not be less than 40mm. In all other respects, the re-paving will be subject to the same specifications as the pavement being replaced.

Whether the cold milling and re-paving is applied as a corrective measure, acceptability and payment adjustment will be determined as follows:

- acceptability, and eligibility for either positive or negative payment adjustment, will be determined entirely on the results of testing and observations conducted on the re-paving, regardless of test results that have been obtained on the hot-in-place recycled pavement;
- the quantity, to which any payment adjustment is to be applied, will be derived from the square meters of recycled pavement affected by the re-paving.

PART D - PAYMENT

515.31 General - Applicable payment adjustments (Additions or subtractions as applicable) shall be applied in accordance with Part B of this Section

The first 4,000 m² of hot in place asphalt pavement recycling production will not be subject to bonus/penalty payment adjustments but will be required to meet minimum Specification requirements for quality and workmanship.

515.31.01 Not Used

515.31.02 Not Used

515.31.03 Not Used

515.31.04 Not Used

515.31.05 Payment for Acceptable Work - The following end product properties of recycled asphalt pavement will be measured for acceptance:

- Density
- Smoothness

515.31.06 Payment for Rejected Work Made Acceptable - When defects have been remedied in Lots or Sub-Lots which had been rejected, payment for the original quantity of material in those Lots or Sub-Lots will be made subject to payment adjustments and penalty assessments and subject to DB SS 515.24.

515.31.07 Payment Adjustment - Payment adjustments resulting from the application of this Section will be effected on each progress payment as follows.

1. For each Lot paid for by the square metre (m²), the applicable payment adjustment derived from Table 515-C (Density), in dollars per square metre will be expressed as positive in the case of increases and negative in the case of decreases. The algebraic sum of these unit adjustments will then be applied to the payment quantity for the Lot. The resulting amount, in dollars, will be the net payment adjustment, positive or negative, for that Lot.

The algebraic sum of the net payment adjustments for all such Lots for which payment is authorized on the current progress payment, computed in dollars, shall be the total payment adjustment for density for the current progress payment.

2. For each Lot, the applicable payment adjustment derived from Table 515-D (Smoothness), in dollars per Lot, will be expressed as positive in the case of increases and negative in the case of decreases, and will be the payment adjustment, positive or negative, for that Lot.

The algebraic sum of the payment adjustments for all such Lots for which payment is authorized on the current progress payment, computed in dollars, shall be the total payment adjustment for smoothness for the current progress payment.

3. The algebraic sum of the total payment adjustments for density and smoothness, derived in accordance with 1 and 2 above, shall be the total payment adjustment, positive or negative, in dollars, for all attributes for the current progress payment. This amount shall be added, if positive, or subtracted, if negative, by a single entry in computing the current progress payment.
4. The process set out in 1 to 3 above will be used in computing each progress payment to which it is applicable.

515.32 Surplus Aggregate In Stockpile – Surplus aggregate in stockpile in Ministry pits shall be the property of the Ministry.

515.32.01 Ministry Purchase of Surplus Aggregate – – No additional compensation will be paid for surplus aggregates.

APPENDIX 1

QUALITY CONTROL REQUIREMENTS AND GUIDELINES

1.01 GENERAL

The Contractor's responsibilities for preparing, submitting and adhering to a Quality Control Plan are specified in DB SS 515.04. This Appendix provides requirements and guidelines for the Contractor's Quality Control Plan, in addition to those set out in DB SS 515.04.

1.02 QUALITY CONTROL PLAN

As a requirement, the Contractor shall prepare and submit a Quality Control Plan for evaluation. The Plan may be operated wholly, or in part by a qualified Subcontractor or an independent organization/agency. However, the Quality Control Plan, including compliance with the Plan and its modifications, is the responsibility of the Contractor.

The Plan shall address all elements that affect the quality of the hot in place recycled asphalt pavement, including but not limited to the following:

- Supply of Asphalt Materials
- Supply of rejuvenating agents
- Identification of source and proof of quality of virgin aggregates to be supplied;
- Virgin aggregate production and its gradation control;
- Quality of virgin aggregate components;
- Stockpile management;
- Asphalt plant calibration and proportioning of aggregate components;
- Mixing including asphalt cement content control;
- Process temperature controls;
- Admix Material and Rejuvenating Agent application rates and processed dimensions, placing and finishing;
- Joints;
- Density;
- Smoothness;
- Segregation;

The plan shall also include the following:

- The name of the Quality Control testing agency and its proven capability to provide the specific services required for the project.
- The list of dedicated technical staff, if available, (including names, qualifications and relevant experience) and their proposed roles.

The list of testing equipment available for project work.

The Quality Control Plan shall include the designation of specific personnel responsible for specific quality control duties.

- There shall be a designated Quality Control Manager, as per DB SS 515.04.03. The Quality Control Manager shall be qualified as per DB SS 515.04.03. The Quality Control Manager shall be responsible for the preparation and sign off of the Quality Control Plan, responsible for all Quality Control testing, and inspections, responsible for the sign off of all quality control testing and inspection records and responsible for all quality control submissions to the Ministry. The individual shall be identified and named in the Quality Control Plan submission. If the Contractor requests a change in the Quality Control Manager, then a formal request to the Ministry Representative shall be made and the Ministry will review the request for approval.
- There may be a designated Process Control Technician (PCT) who would be responsible to ensure that laboratory test results and other quality control practices are used to control the quality of aggregates and other mix components and to adjust and control mix proportions to meet the mix design(s). The PCT is responsible for ensuring that testing equipment, utilized for proportioning and mixing are calibrated and in good working order. The Plan may describe how the PCT's duties, including sampling methods and responsibilities are to be accomplished and documented. The Plan should also describe the criteria to be used by the PCT to correct or reject unsatisfactory materials.
- There may also be a Pavement Quality Control Technician (PQT) who would be responsible to ensure that delivered materials meet the requirements of the specifications. In addition, the PQT shall be responsible for periodically inspecting all equipment used in recycling, placing, finishing, and compacting to assure its proper operating condition and to assure that recycling, placing, application rate, finishing, joint construction, and compaction is in conformance with this specification and the contract requirements.

**1.03 CONTRACTOR'S RECORD OF QUALITY
CONTROL TESTING**

Test results shall be made on specified forms or charts immediately after completion of each test. These test results are to be made available to the Ministry Representative upon request.

Records of gradation control, both during aggregate production and also during the asphalt mixing operation, should be kept on the form H-295 - Mechanical Analysis of Aggregates.

1.04 MATERIALS APPLICATION RATE

The Contractor shall control the Material Application Rate by monitoring the amount of asphalt admix delivered to the road against the area covered by checking the application rate every five loads.

The Contractor shall monitor the addition of rejuvenating agents by calculating the application rate, through comparing the metered amount with the total area processed every one-half hour.

The Contractor is to advise the Ministry Representative on

an ongoing basis of the application rates.

1.05 DENSITY

The Contractor shall take core samples to determine actual pavement density. At the start of paving, the Contractor may take a minimum of two pavement cores from each Sub-Lot. The Contractor may employ a nuclear densometer to ensure intermediate density control.

**1.06 OTHER QUALITY CONTROL
PROCEDURES**

The Contractor may initiate other Quality Control procedures as necessary for ensuring production of a quality product and include them in the Quality Control Plan. Procedures may also be introduced after the start of work as necessary as amendments to the Quality Control Plan.

**1.07 QUALITY CONTROL TESTING
FREQUENCY GUIDELINES**

Test frequency guidelines for Quality Control are described in TABLE 1:

TABLE 1 –TEST FREQUENCY GUIDELINES

	Test	Minimum Frequency
Tests During Crushing (Virgin Aggregate)	ASTM C-136, Dry Sieve Analysis of Aggregate	Split Stockpiles: One for each stockpile for every 2 hours of production. One main stockpile: for every 300 tonnes. Blend Sand: One for every 100 tonnes during stockpiling. Natural filler: One for every 50 tonnes during stockpiling.
	ASTM D-5821 Determining the Percentage of Fractured Particles in Coarse Aggregate	Every second coarse aggregate sieve test.
	ASTM C-117 Sieve Analysis of Aggregates by Washing (Field Lab)	One per day on reduced sample obtained from combined samples from the crusher
Tests During Asphalt Plant Mixing (Admix)	ASTM C-136, Dry Sieve Analysis of Aggregate	One of combined aggregate every 100 tonnes.
	ASTM C-566 & D-2216, Moisture Content	Aggregate: 2 tests/Lot Asphalt mix: 1 on first Sub-Lot and every second day.
	ASTM C-117 Sieve Analysis of Aggregates by Washing (Field Lab)	One per shift on reduced sample obtained from combined samples from the plant cold feed
	Asphalt Extraction Test ASTM D-6307 Ignition Method	One per Lot.
	Penetration of Bituminous Materials ASTM D-5	One per Manufacturer's Batch
	Viscosity ASTM D-2171	Contractor's Option
Rejuvenating Agents Tests	Rejuvenating Agent	Contractor's option.
Test During Asphalt Paving for Density Testing (Hot In Place Recycled Pavement)	ASTM D-1559, Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	Contractor's Option
	ASTM D-2726 Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures (Briquette or Cores)	One per Sub-lot
	ASTM D-2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures	One (see Appendix 3 for Combining Cores)
	Core Samples	One core for each Sub-Lot. All cores to be 150mm diameter.

APPENDIX 2**REQUIREMENT FOR PRODUCTION OF ADMIX AGGREGATES****2.01 GRADATION MAXIMUM PERMISSIBLE VARIATION LIMITS:**

Sieve Size	
19.0 mm or 16.0 mm	0%
12.5 mm	+/-3.5%
9.5 mm	+/-3.5%
4.75 mm	+/-3.0%
2.36 mm	+/-3.0%
1.18 mm	+/-2.0%
0.600 mm	+/-2.0%
0.300 mm	+/-1.5%
0.150 mm	+/-1.0%
0.075 mm	+/-0.75%

The variation limits, when applied to the Ministry specified design Admix gradation, shall not result in a gradation that is outside of the limits as specified by the Ministry.

APPENDIX 3

METHOD TO COMBINE ROAD CORES INTO A SINGLE COMBINED SAMPLE FOR THE DETERMINATION OF MAXIMUM THEORETICAL DENSITY.

3.01 INTRODUCTION

After the individual Density for each core has been determined, the Sub-lot road cores shall be combined into one single sample for the determination of maximum theoretical density.

3.02 SAMPLE PREPARATION

The upper re-cycled portion of the cores shall be separated from other pavement layers by sawing or other effective methods.

The minimum combined sample size required shall be 2000 grams and 2500 grams for 19.0 mm and 25.0 mm maximum aggregate size respectively.

Select a core trimmer to ensure that the minimum sample size is obtained depending on the thickness of the samples. 100 mm, 114 mm, or 127 mm core trimmers may be used.

Place the core samples in a pan and heat to $130^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for about 20 minutes to allow the specimens to be easily trimmed. Do not overheat. The cores can be stacked on top of each other and trimmed together or individually.

Select a core trimmer to attain the minimum combined sample size. Heat the base of the trimmer by placing on a burner for a few minutes.

Centre the heated trimmer on the heated cores (allow equal clearance on all sides of the core).

Hold the trimmer vertically by its handle, then press it down through the core until it reaches the bottom of the pan. Apply a slight twist if the heated cores(s) are difficult to penetrate.

Remove the outside cut rock mix by means of a spatula spoon and discard.

Thoroughly mix the resultant combined sample prior to testing to ensure uniform aggregate coating.

The complete combined sample must be tested. If the resultant sample size exceeds the available capacity of the container used for vacuum saturation, it may be tested a portion at a time.

SECTION 521

ASPHALT STABILIZED BASE COURSE MIXED IN PLACE

DESCRIPTION

521.01 Scope - This Section describes the materials, plant, equipment and work practice required for the in place stabilization of granular base course material mixed with selected bituminous binder.

This product may only be used if explicitly authorized in the Contract or in the sole discretion of the Ministry Manager

EQUIPMENT

521.21 General Condition of Plant and Equipment

DBSS 521.22 to DBSS 521.25 inclusive are guidelines only, and as such, are not mandatory.

521.21.01 Not Used

521.21.02 Not Used

521.21.03 All equipment and plant shall be in good mechanical condition and adjustment and be capable of efficiently performing the work as required by the Contract.

521.21.04 Not Used

521.21.05 The Ministry Representative shall have access at all times to any plant, equipment or machinery to be used on this contract in order to check calibration, control or operating adjustments

521.21.06 Not Used

521.21.07 Not Used

521.22 Pressure Distributor - The pressure distributor used for applying bituminous materials may consist of a fully insulated tank with a minimum capacity of 5000 ℓ permanently and rigidly mounted on a truck or trailer provided with pneumatic tires and propelled by a power unit capable of maintaining a constant and uniform speed. The distributor may be provided with the following minimum equipment:

- a) quick opening gate in the dome.
- b) a measuring dipstick calibrated in 100 ℓ increments or in 20 mm gradations and provided with a calibration chart indicating the number of litres for each 20 mm in depth of contained bituminous material for accurate checking of the distributor contents. In addition an external and readily visible depth gauge or levelometer

indicating the asphalt content of the tank to the nearest 100 ℓ and having an accuracy of $\pm 50\%$.

c) an efficient and positive means of heating the bituminous contents uniformly to any temperature up to 175°C and maintaining the contents constantly at any selected temperature without any local overheating.

d) an approved industrial type thermometer so situated that its face shall always be readily visible to the spray bar operator. The sensing element of the thermometer shall be placed either directly in contact with the hot bituminous material or enclosed in a thin walled well of approved manufacture, so placed as to accurately measure the temperature of the material in the tank. The thermometer shall have a minimum range of 10° to 175°C subdivided into 1°C graduations and be accurate to $\pm 0.5^\circ\text{C}$

e) rear mounted spray bars and nozzles set parallel to the surface to be sprayed and capable of vertical and lateral adjustment. The spray bars shall be capable of adjustment to provide a minimum spraying width of 1.8 m and a maximum spraying width of 7.5 m.

The feed to the spray bars may be so arranged that there is a constant circulation of hot bituminous material to the bars such as will ensure a uniform viscosity and constant pressure of the bituminous material at each nozzle, both before and during spraying operations. Feed manifolds to spray bars may be provided with strainers to prevent clogging of bars and nozzles.

f) rotary adjustable, spray bar nozzles which may be so designed and set as to ensure a uniformly fan shaped spray without atomization, overlapping on the surface to be sprayed, such that there is a uniformly sprayed surface to clearly defined edges of the sprayed lane without any reduction of the rate of application adjacent to the edges of the lane. Spray nozzles may be provided with valves capable of instant full opening or positive cut-off.

g) a connection to a circulating pressure manifold to which a hose may be attached for a single nozzle, hand operated outlet.

h) a pressure gauge accurate to 15 kPa and calibrated pressure pump, equipped with a tachometer registering litres per minute and driven by an independent mechanically governed power unit, so designed as to be capable of applying through the spray nozzles fitted, accurately measured quantities of bituminous material at a minimum rate of 900 ℓ per minute.

SECTION 521

ASPHALT STABILIZED BASE COURSE MIXED IN PLACE

Both pressure gauge and tachometer should be mounted so as to be readily visible to the operator.

- i) a fifth wheel tachometer, registering metres per minute and so calibrated and mounted as to be readily visible to the driver of the distributor, to enable the operator to maintain the constant speed required for application of bituminous material to the road at the specified rate.

521.23 Blade Graders - Self-propelled blade graders mounted on pneumatic tires may be of approved modern type, either four wheel drive or tandem type having sufficient capacity to efficiently perform all work that may be required on the contract

521.24 Pulverizing and Rotary Mixing Machines - TABLE 521-A CRITERIA FOR BLADE GRADERS

Minimum Weight	7.25 t
Minimum Blade Length	3.6 m
Minimum Wheel Base	5.5 m
Minimum Cubic Displacement of Pistons: 4 Cycle Motors	7.0 ℓ
Minimum Cubic Displacement of Pistons: 2 Cycle Motors	4.0 ℓ

Pulverizing and rotary mixing machines to be used on the work may be standard machines, factory produced by a reputable manufacturer, so designed and constructed as to satisfactorily break up all base aggregations into constituent particles and capable of thoroughly and uniformly mixing the granular base material and applied asphaltic binder so as to produce a uniformly coated mix free from lumps, balls or segregation

521.25 Compaction Equipment - Compaction equipment may consist of steel wheel rollers, pneumatic tired rollers, vibrating rollers or tampers.

521.25.01 Self Propelled Steel Rollers - These rollers may be equipped with power units of not less than four cylinders, and under working conditions be capable of developing a compression in the rear wheels of not less than 4.0 kg/mm² over a minimum roller width of 500 mm, with one roller capable of developing a roll pressure of 4.5 kg/mm² of width. Rollers should be in good working condition and free from backlash, faulty steering mechanism or worn parts. Rollers may be equipped with adjustable scrapers to keep the rolls clean and with an efficient means of keeping the wheels wet to prevent mixes from sticking to the rolls. Rolls should be free of flat areas, dents, openings or projections which will mar the surface of the pavement.

521.25.02 Pneumatic Tire Rollers - Pneumatic tire rollers

may be either self-propelled or towed type, single or double axle, having a minimum effective rolling width of 1.2 m. The rollers may be equipped with smooth tread pneumatic tires of equal size and diameter. The wheels of the roller should be so spaced that two passes of a single axle roller or one pass of a two axle roller will accomplish one complete coverage equal to the rolling width of the machine. There should be a minimum 6 mm overlap of the tracking wheels of a double axle roller. The wheels of towed rollers to be used on granular base preparation may wobble. The roller should be so constructed that the contact pressure is uniform for all wheels and the tire pressure of the several tires should not vary more than 35 kPa. Pneumatic tire rollers should be constructed with ample ballast space to provide an operating weight of 4.5 to 8 kg/mm² of tire track width. The towing vehicle for towed type roller should be equipped with smooth tread pneumatic tires.

521.25.03 Vibrating Tampers - Vibrating tampers to be used for the compaction of bituminous base in places inaccessible to rollers, should be of a type suitable for the work to be performed.

521.25.04 Vibrating Compaction Equipment - The Contractor may use vibrating compaction equipment to compact the stabilized base, provided that such equipment produces compaction and surface finish equal to that obtainable by using a steel wheel finish roller having a minimum compression roll pressure of 4.5 kg/mm².

CONSTRUCTION

521.31 Method I - When the roadway has been completed in its entirety by others, the following method shall apply:

- a) The granular base shall be regraded to true line, grade and cross-section; the top 65 mm of the base shall be loosened by means of scarifying. The lumps of bonded material are to be broken to constituent gravel by harrowing, blading or rotary tilling. The loose material is to be bladed into a windrow, approximately 10 cm in height on both sides of the road. This windrow will act as a dam in case of spillage or the occurrence of rain after the spraying has taken place.

- b) The prepared gravel surface shall be primed on the side not obstructed by the windrow, to the outside width required at a rate of 1 to 1.5 ℓ/m², employing the bituminous binder as required by the Contract and the Design within a spraying temperature range which corresponds to a kinematic viscosity of 150 to 200 mm²/s in the binder.

Priming shall be applied only when the surface is dry or slightly damp, when the air temperature in the shade is not less than 10°C and rising. When the prime has been completely absorbed by the prepared surface, blade

the windrow of loose surface course onto the primed half of the road and prime the untreated half of the surface in a like manner.

Generally, this work shall be governed by the applicable provisions of DB SS 501.31.

c) Immediately prior to application of the bituminous binder, the windrow of loose gravel shall be bladed across the road to a full width uniform cross section. If wet or damp, it shall be first bladed back and forth until dry unless an emulsion is to be used. Cutback bituminous binder shall not be applied until the moisture content has been reduced to 1.5%. In the case of emulsions, mixing may commence when the moisture content of the gravel has been reduced to 4%. No asphaltic binder shall be sprayed on the granular aggregate unless the average temperature of the aggregate on the road is 13°C or higher and such temperature can be maintained in the aggregate until the full mixing cycle has been completed.

Upon the layer of graded aggregate, the bituminous binder shall be applied uniformly at a rate of 1.35 ℓ/m², at application temperature required to produce a kinematic viscosity of 150 to 200 mm²/s in the binder.

A disc harrow or rotary type mixer shall immediately follow the distributor after the application of the bituminous binder and shall continue to operate on the treated strip until all free bituminous material has been mixed into the mineral aggregate. The treated mixture shall then be further mixed with a blade grader until a thoroughly uniform mixture results.

The mixture shall then be spread uniformly across the road once more, a second uniform application of bituminous binder at a rate of 0.9 to 1.8 ℓ/m², shall be sprayed at application temperature so as to give a final asphalt content of 4 to 6% of the mix. The second application of bituminous binder shall be mixed with the mineral aggregate in a similar manner to the first application, taking care that during the blade mixing none of the untreated base below the prime or shoulder material is brought into the mix. Blade mixing shall be continued until the bituminous binder and mineral aggregates are thoroughly mixed to uniform colour, free from fat spots, balls and uncoated particles. If the mixture should become wet before the mixing process is complete, the mixing operations shall be continued until it has dried out. After final mixing, the mixture shall be brought to a single windrow.

d) Before the finished mixture is finally spread for compaction, a triangular cut shall be made with a blade at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be

approximately 50 mm deep at the outer edge and slope to zero, 0.6 m in toward the centre. In making the cut, the excavated material shall be thrown to the shoulder in a small windrow against which the mixture shall be spread. The bituminous mixture shall be spread for compaction from the large windrow. It shall be bladed from this windrow in a succession of thin layers to correct thickness and a uniform cross section with a camber of 1 in 45 (except at curves, where the correct superelevation originally set for base shall be followed).

After the mixture has been spread as specified, it shall be compacted by means of rollers, which operation shall begin at the edges of the course and progress toward the centre parallel to the centreline of the roadway, overlapping in successive passes by at least one-half the width of the roller. Initial breakdown compaction may be obtained by use of steel or rubber tired rollers until no appreciable surface movement or roller marks are visible and the surface has been satisfactorily sealed. Final rolling to eliminate rubber tire or other marks and irregularities shall be carried out using an approved steel wheel finish roller or steel wheel vibrating rollers or other satisfactory equipment.

Compaction shall be carried out to the satisfaction of the Quality Manager and the Ministry Representative.

Should unsatisfactory areas develop during compaction, they shall be corrected.

521.32 Method II - When the granular base and base stabilization are included in the contract, Method II shall apply as described hereunder:

a) The first lift of granular base, 90 mm, shall be hauled to the roadway, spread, graded to line, grade and cross-section, compacted to 100% of the density as obtained in the laboratory following ASTM Designation D698 Method D.

On completion of the above roadways, as described in the foregoing, priming may be commenced.

On completion of priming and curing the second lift, 60 mm of granular base may be hauled to the primed roadway and spread in a uniform windrow and mixing commenced as described in DBSS 521.31(c).

On completion of base stabilization, the remaining granular base may be applied, i.e., from the edge of the stabilized base to the shoulder.

SECTION 536

PAVEMENT CRACK SEALING

DESCRIPTION

536.01 Scope - This work consists of restoring the asphalt concrete pavement surface to a less permeable condition. The work includes routing when necessary, cleaning and filling the crack with sealant, and dusting or sanding.

536.02 Purpose - The purpose of crack sealing shall be to prevent moisture from penetrating into the road base through surface cracks and to extend pavement life. This shall be carried out by effectively sealing the cracked surface with a crack sealant product.

MATERIALS

536.11 Asphaltic - The rubberized, asphaltic and or elasticized asphalt sealant products shall meet the requirements listed in Table 536-A.

It shall be noted that ASTM D 3405 requirements are not mandatory in the Lower Mainland, Vancouver Island or the Sunshine Coast.

As specified in the Contract the Contractor shall use a Rubberized or High Float Emulsified Asphalt HF150S or equivalent.

TABLE 536-A REQUIREMENTS

	ASTM Test	DESCRIPTION
	D 3405	Specification for joint sealants, hot poured for concrete and asphalt pavements
	D 1190	Specification for concrete joint sealer, hot poured elastic type

536.12 Sand - On pavements that require the use of High Float Emulsified Asphalt, the Contractor shall supply a "blinding sand." The sand, when tested according to ASTM C 117, shall meet the gradation requirements shown in Table 536-B and shall be approved by the Designer.

536.13 Dust Cover - Pavements that are sealed with rubberized or elasticized sealant shall receive a dust coating with a material such as Portland Cement, lime or the equivalent material approved by the Designer.

EQUIPMENT

536.21 Router - The Contractor shall provide a vertical router capable of routing asphaltic pavements to a depth of 25 mm and a width of 16 mm.

TABLE 536-B GRADATION REQUIREMENTS

Sieve (mm)	% Passing
12.5	100
9.5	80 - 100
4.75	50 - 95
2.36	30 - 80
0.600	10 - 50
0.300	0 - 25
0.075	0 - 6

536.22 Cleaner - The cleaner unit shall be a hot compressed air capable of cleaning, heating and drying routed cracks with not less than 1.7 m³/min. of compressed air at 690 kPa. The hot air exhaust shall not exceed 315°C.

536.23 Melter - The melting kettle shall be of the double boiler type supplying indirect heating so as to slowly heat the asphaltic material with heat transfer oil. It shall have built in calibrated thermometers for both transfer oil and the sealing compound. The heating of the sealant shall be efficient and thermostatically controlled so as not to exceed the manufacturer's maximum safe heating temperature and shall be such as to maintain a constant temperature once the sealant is heated. The melter shall be capable of constantly agitating the asphaltic material as it is being heated and shall have a pump circulating the sealant from the bottom to the top of the kettle.

The melter must comply with the Gas Safety Act Regulations and Codes and any other applicable acts and regulations.

536.24 Filler Tools - Crack filler devices and strike off tools must be such that successful forming of the bead of sealant over the prepared crack is as specified in this Specification.

CONSTRUCTION

536.31 General - Crack sealing shall only be performed when the pavement surfaces are dry, and the crack and road base are dry or nearly dry (no visible moisture), and the temperature is 10°C and rising.

A random sample of virgin sealant shall be selected from each lot for testing purposes by the Quality Manager.

Cracks up to 16 mm in width shall be widened by using a router to form a sealant reservoir 16 mm in width and from 19 to 25 mm in depth. All routing shall be performed keeping the crack centreline within ± 8 mm of the centre of

SECTION 536

the rout and shall be cleaned with a hot compressed air lance. Material removed from the cracks shall be disposed of in an environmentally sound manner.

The routing speed shall be such that the pavement is carefully cut, not broken or torn out, and the sides of the rout are smooth and uniform. The surface of the pavement and routed crack shall be cleaned of all dust and routing debris.

Routing should not be carried out on pavements that are of such an age that the pavement fractures or spalls occur along the edge of the freshly routed crack

The crack shall be filled with sealant from the bottom to the surface level in such a manner that the sealant does not bridge entrapped air pockets. Material shall be placed to overfill the crack. It will then be struck off to leave a uniform amount of sealant directly over the crack, with the edges of the spread evenly feathered to overlap on the pavement surface from a minimum of 25 mm to a maximum of 40 mm on each side of the crack. The sealant overband shall not be so thick that it can be removed during snow plowing or produce a noticeable bump when traversed by traffic.

Any damage done to the sealant by stones or any other deleterious material being embedded in the sealing compound shall be repaired.

The Contractor shall ensure that traffic is kept off the sealed cracks until such time as the sealant has properly set up and will not be damaged or pulled out by the passage of traffic.

536.32 Rubberized and Elasticized Asphalt Sealants -

These shall be used on pavements that are less than 10 years old and where the majority of cracks are less than 25 mm in width.

PAVEMENT CRACK SEALING

The sealant shall be applied to cracks that have been routed to a uniform depth and width.

Cracks having a width greater than 16 mm need not be routed but shall be cleaned to a minimum depth of 25 mm.

Within two minutes of the completion of the cleaning operation the crack shall be filled with sealant from a melter using a connecting wand or manual applicator (pouring cone) which ensures minimum pour application temperatures for the product are maintained.

Upon completion of the pouring the sealant shall be dusted to prevent the asphalt from tracking. Excess dusting material shall be removed.

536.33 High Float Emulsified Asphalt - High Float

Emulsified Asphalt shall be used on pavement where there are depressions or lipping at the cracks, or the majority of cracks are over 25 mm in width.

The cracks shall be cleaned as close to the actual depth as possible and the removed material shall be disposed of in an environmentally sound manner. Immediately after cleaning, they shall be filled with sealant from a distributor truck or melter. The distributor truck or melter shall have an efficient means of heating the sealant to any temperature up to 100°C and maintaining it constantly at the manufacturer's prescribed temperature without overheating.

Upon completion of the sealing of the crack, the sealant shall be sanded to prevent the asphalt from tracking. Excess sand shall be removed and disposed of in an environmentally sound manner.

SECTION 541

RUBBLE MASONRY

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

DESCRIPTION

541.01 Scope - This Section covers the construction of stone paving for grouted traffic island and median capping, dry-laid and grouted slope protection, culvert and spillway aprons, ditches and other like uses.

Paving rock, thickness of 100 to 200 mm, will be specified depending upon location, use and setting requirements. Requirements for rock exceeding 200 mm minimum thickness are specified by DB SS 205 for hand-laid and grouted riprap.

MATERIALS

541.11 Materials

541.11.01 Rock - Rock for stone paving shall generally be obtained from the roadway excavation, stockpiled where designated and selected as necessary for use at the locations indicated on the Design, unless the supply of off-site rock is specified.

Rock will be required either as: angular rock as found or blasted, or rounded rock.

All rock shall be sound, durable and clean, relatively flat on the face to be exposed, reasonably consistent in colour tone, of acceptable size (200 to 450 mm across) and of the required thickness range.

541.11.02 Gravel Base - Gravel base shall be 25 mm minus well-graded crushed granular aggregate.

541.11.03 Bedding Mortar - Bedding mortar shall consist of one part Portland cement to three parts clean, well-graded fine aggregate or coarse sand mixed with water to give a 150 mm slump.

541.11.04 Setting and Jointing Mortar - Setting and jointing mortar shall consist of one part Portland cement to three parts clean, well-graded fine aggregate mixed with water to give a 75 mm slump.

CONSTRUCTION

541.31 Preparation - Graded surfaces to receive paving shall be trimmed and well tamped to the lines and grades indicated on the Design and to the approval of the Quality Manager.

Edges of paving shall be constructed of thicker stones to form a stable foundation and protection against any undercutting in waterways.

All paved areas shall receive a minimum 150 mm layer of gravel base, well consolidated.

Gravel level inside curbs shall permit the surface of the jointing mortar to be flush with the top of the curb.

541.32 Construction - Construction shall be carried out with all material, labour, tools, equipment and incidentals supplied by the Contractor as necessary to complete all stone paving work in accordance with good work practice.

Gravel base of grouted stone paving shall be well saturated with bedding mortar slurry.

All rock shall be firmly embedded into the base material so that the voids between stones are of minimal width with the rock surfaces relatively even as indicated on SS Drawing SP541-01.

Voids of grouted paving rock shall be filled with setting and jointing mortar, 75 mm thick and, after consolidation and any necessary chinking of the larger voids, the mortar surface shall be smooth finished and sloped to drain freely.

Finished stone paving shall show a clean even appearance, free of disfiguring spalls and, where grouted, cleaned of mortar staining.

SECTION 582

CONCRETE CURB AND GUTTER AND STORM DRAINAGE

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

DESCRIPTION

582.01 Scope - This Section describes the requirements for construction of roadside curb and gutter and associated underground drainage systems. Such work shall consist of constructing and/or installing appurtenances shown or indicated on the Design.

MATERIALS

582.11 Drain Pipe - All drain pipe shall be of first quality, sound, true in form and free from defects of all kinds.

582.12 Salt Glazed Clay Sewer Pipe - Salt glazed clay sewer pipe shall be in accordance with the current ASTM Specifications.

582.13 Concrete Pipe

582.13.01 Reinforced Concrete Pipe - Reinforced concrete pipe shall have joints of the tongue and groove type and shall meet the requirements of the current specification ASTM C 76 Series.

582.13.02 Plain Concrete Pipe - Plain concrete pipe shall meet the requirements of the current specification ASTM C 14 Series.

582.13.03 Requirements - Pipe shall be legibly marked with the date of manufacture, the name or trademark of the manufacturer and by marks denoting plain concrete pipe, reinforced concrete pipe or extra strength reinforced concrete pipe as the case may be. Pipe containing elliptically placed reinforcement shall be marked on the inside of the pipe with the words "Top" or "Bottom" at the correct place to indicate the proper position when laid.

582.14 Corrugated Steel Pipe - Corrugated metal pipe shall conform to the requirements of DBSS 320.

CONSTRUCTION

582.31 Portland Cement Concrete Curb and Gutter - Combined Portland cement concrete curb and gutter shall be constructed to the line and grade shown on the Design or as otherwise directed by the Designer and will include returns at the intersections if so directed.

The combined curb and gutter shall be constructed to the standard cross-section shown on SS Drawing SP582-01.01 and to such layout plans as are attached, except where the face of the curb varies and at lanes and driveways where drop curbs are ordered.

Expansion joints 13 mm in thickness cut to the cross-section of the combined curb and gutter, composed of premoulded joint filler shall be installed at approximately 15 m intervals or such closer interval as the Designer may direct.

582.32 Catch Basins - Catch basins shall be constructed, where shown and as required in the Design or as the Designer may direct, in accordance with the intent of SS Drawings SP582-02.01 through SP582-02.05.

582.33 Manholes - Manholes shall be constructed at the locations and to invert levels shown in the Design or as the Designer may direct in accordance with the intent of SS Drawings SP582-03.01 through SP582-03.08.

582.34 Storm Drains - Storm drains shall be constructed where shown on the Design, or as directed by Designer, and in accordance with the Drawings and specifications covering the various types and attached herewith. The trench and other preparatory work shall be approved by the Designer before actual placing starts.

582.35 Placing

582.35.01 Spigot and Bell Pipe - Spigot and bell pipe shall be laid beginning at the lower end with the bell end pointing up-grade. Suitable excavation or bedding must be provided to accommodate the bell so that the pipe is supported along its full length and not at the ends alone.

582.35.02 Concrete Pipe - Concrete pipe shall be laid beginning at the lower end with the groove end pointing up-grade. Pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement as marked by the manufacturer in a vertical position.

When jointing salt glazed clay and concrete pipes, the trench shall be in a dry condition and the joints shall be cleaned and wetted before sealing with mortar. The mortar shall consist of one part of Portland cement to two parts of fine sand, mixed to the proper consistency. Sealing shall be neatly and thoroughly done and the interior of the pipe cleaned of all surplus mortar. Joints shall be kept damp with burlap or earth for at least three days after sealing.

582.35.03 Corrugated Steel Pipe - Corrugated steel pipe shall be laid beginning at the lower end with the outside laps pointing up-grade and the longitudinal joint on the side. The

separate sections shall be firmly jointed together and any metal in joints which is not thoroughly protected by galvanizing shall be coated with a suitable asphaltum paint.

582.35.04 General - The Contractor shall provide and fix at such points, as may be directed, properly painted substantial sight rails set to correct levels. At least three sight rails shall be in position for each length of sewer. Pipes shall be accurately set and laid to even gradients, concentric and in straight lines between manholes.

582.36 Special Jointing Material - Where pipe trenches are necessarily restricted in width or where unavoidable wet conditions exist, which would prevent proper normal jointing of pipes with Portland cement mortar, special

prefabricated joints may be authorized by the Designer to be used

582.37 Bedding and Backfilling - The bedding of all concrete pipes shall consist of 19 mm or 25 mm crushed gravel to a minimum depth of 150 mm below the pipe. The backfill shall consist of 19 mm or 25 mm crushed gravel with a minimum cover of 150 mm and in the remainder of the trench shall consist of the natural excavated material unless such material is considered unsuitable by the Designer. Such natural material shall have a maximum size of 75 mm. All materials shall be compacted in horizontal layers not more than 200 mm.

582.38 Concrete End Walls - See DBSS 303.31.04.

SECTION 586

PLANT MIXED PORTLAND CEMENT TREATED BASE COURSE

DESCRIPTION

586.01 Preliminary and General - This Specification describes the materials, plant equipment and quality of work required for the stabilization of base course material with Portland cement.

586.02 General Description of Work - The cement treated base shall consist of prepared aggregate, Portland cement and water uniformly mixed in the proportions directed, in a central mixing plant of satisfactory type, hauled out and laid on the prepared subgrade and compacted to established line and grade.

MATERIALS

586.11 Cement - Portland cement to be supplied for the work will comply with the requirements and tests of the Canadian Standards Association CAN 3-A5-M86 "Standard Portland Cements" and subsequent revisions thereof.

586.12 Water - The water shall be clean and free from substances deleterious to the hardening of the cement stabilized base course and shall be subject to the approval of the Ministry Representative.

586.13 Aggregate - The aggregate supplied shall be composed of inert durable material uniform in quality and free from organic impurities and soft or disintegrated particles. When tested according to ASTM C 136, the aggregate shall meet the gradation requirements listed in Table 586-A.

TABLE 586-A GRADATION REQUIREMENTS FOR AGGREGATE

SIEVE SIZE (mm)	PERCENT PASSING BY MASS
25	100
19	80 - 1000
9.5	50 - 100
4.75	35 - 70
2.36	25 - 50
1.18	15 - 35
0.300	5 - 20
0.075	0 - 5

The material shall have a liquid limit not greater than twenty-five and plasticity index not greater than six.

All aggregate shall be stockpiled in horizontal layers not more than 1.0 m in thickness. The stockpile area shall be cleared of all vegetation, trees, brush, rock and other debris and a uniform ground surface prepared before the aggregate is deposited on the site. The material shall be loaded from the stockpile into the plant in such a manner as to ensure that a uniform cut of the pile is obtained. Subsequent addition of prepared aggregate to the pile shall be so organized to ensure continued uniformity of the aggregate supply to the mixing plant.

EQUIPMENT

586.21 Mixing Plant - The Portland cement treated base course shall be mixed in a stationary plant employing either continuous or batch type equipment. The plant shall be equipped with interlocked feeding and metering devices which will add the cement, water and aggregates in proportions established by the mix design to a tolerance of $\pm 3\%$ by weight. The plant shall be capable of mixing the ingredients uniformly. Suitable storage shall be provided for bulk cement, and if required, bulk mineral filler. The capacity of the mixing plant shall be such that a minimum of 0.4 km of full width cement treated base can be laid per daily shift, i.e., sustained mixing capacity shall normally be not less than 250 tonnes per hour. Details of the plant and its operation shall be submitted to the Ministry Representative upon request.

586.22 Cement Treated Base Spreader - The spreading device may be self-propelled, pushed or towed; and shall be so constructed and operated as to produce without segregation or surface tearing, a layer of material which is uniform in thickness and surface contour, either longitudinal or transverse, and free from irregularities in density. Whichever type of spreader may be used, it is mandatory that it be provided with a positive mechanical means for distributing the cement treated base transversely across the front of the cutoff mechanism or screed.

Spreading equipment which rides on the freshly spread material and produces tracks or partially compacted areas behind the cutoff blade will be acceptable provided no displacement of material or filling of the tracks occurs, and provided further that the tracks are not of such depth as to be visible after compaction is completed. The use of a motor grader or any other spreading device, which requires repeated trips over the same area, will not be permitted for spreading.

586.23 Water Distributors - Water distributors shall be the pressure type equipped with a spray bar mounting nozzles similar to those used on asphalt distributors and capable of applying the water in accurate quantities and as a uniform spray. Splash plate type distributors or those equipped with spray bars that eject fine streams of water will not be permitted. The distributor must be provided with a satisfactory accurate means of measuring the quantity of water sprayed.

CONSTRUCTION

586.31 Mixing - The mix proportions shall be determined by the Designer from samples taken at the commencement of aggregate production.

The aggregate, mineral filler and cement shall be fed into the pugmill accurately, according to the proportions required, and shall be thoroughly dry mixed. Water shall then be added in the required amount and mixing continued until uniformity is achieved.

586.32 Spreading and Compaction

586.32.01 Surface - The surface of the subgrade shall be thoroughly moistened just prior to placing the cement treated base mixture thereon and shall be kept moist but not excessively wet until covered by the mixture.

586.32.02 Cement Treated Base Mixture - The cement treated base mixture shall be hauled to the roadbed in trucks equipped with protective covers and shall then be laid in a manner to produce a layer of uniform density and cross-section and in sufficient quantity to provide a compacted base conforming to the grade and cross-section set by the Design. End dumping on the roadway followed by spreading will not be permitted. Depositing and spreading the material on the roadway shall progress continuously. At any break, including the end of each day's full width construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face and by installing a temporary wooden header, if required by the Quality Manager.

586.32.03 Compaction - Immediately following spreading, the material shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698.

586.32.04 Compaction Equipment - The use of compacting equipment which marks, ruts, cracks or otherwise loosens or damages the surface of the cement treated base will not be permitted. The compacting equipment shall have sufficient capacity to produce the specified degree of compaction within the time limits specified.

Wherever compaction planes are formed in the cement treated base during spreading, shaping or compaction, they shall be removed by scarifying or tilling the surface to such depth and in such a manner as to thoroughly break up the compaction planes. Scarifying and pulverization may be performed by any suitable equipment - nail drag, weeder, disk harrow or rotary tiller that will satisfactorily perform the work required. The scarified material will be regraded and recompacted, to conform to design Specifications.

586.32.05 Water - Water shall be applied at the rates and in the quantities directed by the Designer. The surface of the uncompacted, partially compacted and completely compacted material shall be kept moist at all times. An adequate water supply shall be maintained at the point of compacting.

586.32.06 Speed - The speed of operations shall be such that not more than forty-five minutes shall elapse between the time of starting mixing and the time of starting compaction. Shaping and final compaction shall be completed within two hours of commencement of mixing at the plant.

586.32.07 Finished Surface - The finished surface of the compacted base shall at all points be accurate to ± 15 mm of the grade and shall not, at any point, deviate by more than 10 mm from the bottom of a 3 m straight edge laid in any direction on the surface on either side of the crown of the roadway.

586.32.08 Temperature - No construction shall be undertaken when the temperature is below 4.0°C or when the conditions indicate that the temperature will fall below 4.0°C in the next 24 hours or if the subgrade is frozen.

586.33 Protection and Cover

586.33.01 General - Protection and cover shall be provided by one of the methods, A or B, given below and as directed by the Designer in accordance with the Contract.

a) **Method A - Crushed Gravel Course** - 25 mm crushed gravel shall be laid not more than 24 hours after the treated base is laid. The surface of the treated base and the overlying gravel shall be kept moist by the application of water as directed by the Designer.

b) **Method B - Bituminous Seal** - As soon as possible after the cement treated base course has been finished, in accordance with preceding subsections, a bituminous seal shall be applied to the surface and sanded to protect the cement treated base course from drying out during the seven day curing period. The finished base course shall be kept continuously moist until the seal has been applied.

The bituminous sealing material shall be applied at a rate between 0.7 to 1.0 /m² or as directed by the Designer in order to give complete surface coverage without excessive runoff.

Generally, this work shall be governed by the applicable provisions of DB SS 501.31 "Spray Primer and Tack Coat". At the time of sealing, the surface of the cement treated base must be dense, free from all loose and extraneous material and shall contain sufficient moisture to prevent penetration of the bituminous material. If needed, water shall be applied in sufficient quantity to fill the surface voids of the soil cement immediately before the bituminous material is applied. The seal cover shall be effectively maintained by the Contractor during the seven day curing period.

586.33.02 Protection - Any finished portion of the base course adjacent to construction, which is travelled by

equipment used in constructing an adjoining section, shall be protected in such a manner as to prevent equipment from marring or damaging the completed work.

586.33.03 Temperature - At any time when the air temperature may be expected to fall to the freezing point, during the day or the night, sufficient above protection shall be given to the cement treated base to prevent its freezing for seven days after placement and until the soil cement has hardened.

586.34 Maintenance - The Contractor shall maintain the entire base course in good condition satisfactory to the Ministry Representative from commencement of construction until it has been paved with asphalt concrete. Maintenance shall include immediate repairs to any defects that may occur and shall be repeated at the Contractor's expense as often as may be necessary to keep the section continuously intact.

SECTION 604

STEEL TRAFFIC BARRIER CONSTRUCTION

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

604.01 Scope - This Section covers the construction of roadside and median steel traffic barriers in accordance with the general layout and details indicated on Drawings of the SP312 series.

Steel beam guardrail, wood posts and accessory materials are specified by DBSS 312. Steel posts are not covered in this section. Use of steel posts with steel beam guardrail will meet the provisions in NCHRP Report 350 for Test Level (TL) 3 or higher. Installation of steel posts with steel beam will be to the manufacturer's specifications, and/or to Ministry's contract requirements. Manufacturer's steel post and steel beam product must be on, or have tentative approval to be on the Ministry's recognized products list.

Design and part number references are taken from the ARTBA Technical Bulletin #268-B, as noted in DBSS 312, unless indicated otherwise on SS Drawings 1-SP312 and 2-SP312.

604.02 Provision of Steel Barriers - Barriers of the type(s) called for shall be constructed at the locations and as shown on the Design with the materials, accessories and necessary ancillary work all in accordance with the details indicated in the Contract, Specifications, Special Provisions and/or typical standard SP Drawings.

All material will be supplied by the Contractor.

Construction shall be carried out with all labour, tools, equipment and incidentals necessary to complete all barrier work in accordance with good work practice, for a substantially supported and anchored steel barrier developing a continuous beam strength together with necessary crashworthy end treatment.

604.03 Materials - Detailed material requirements are set out in DBSS 312 and indicated on SS Drawings 1-SP312, 2-SP312 and the manufacturer's drawings. Materials not listed in this section will have to be listed in the Ministry's recognized products list, or approved by the Ministry's highway engineering branch.

Concrete for post footings shall be constructed of minimum 15 MPa Portland cement concrete in accordance with Section 218, and reinforcement,

152 x 152 MW18.2 welded steel wire fabric to CSA G30.5 and 10M deformed bar or minimum 7 mm stirrups in accordance with DBSS 412, and in accordance with the Contract requirements.

Preservative treatment for protecting field cuts and borings and for making good any superficial damage to treated wood post material, as approved by the Quality Manager, shall be creosote, pentachlorophenol or preservative salts in proper solution corresponding to the original pressure treatment for application in three separate heavy coatings.

Touch-up treatment for damaged galvanized metal surfaces shall be a heavy application of zinc rich paint to CGSB Standard 1-GP-181M Specification for Ready Mixed Zinc Rich Coating.

604.04 Wood Post Installation - Posts shall be set true to the lines, spacing, depth(s) and height(s) indicated or required. The layout, type of support and fixing treatment at ends of barriers or where adjacent to abutments and the like shall be as indicated on the Design and relevant SS Drawings 1-SP312 and 2-SP312, and/or to the direction of the Designer.

Wood posts shall be driven in place or set in augered or dug holes with necessary dampened and well tamped layers of approved backfill material. Driving will be permitted only if no damage results to shoulders and adjacent slopes. In broken rock embankments the prepunching of holes will be permitted only prior to final compaction, surfacing and paving. Construction details appertaining on exposed rock, rock with minimum overburden or on concrete shall be to the indicated requirements and/or the direction of the Designer.

All work preparatory to and for the installation of posts shall be to the direction and prior approval of the Designer and Quality Manager for each type of sub-surface condition to produce a thoroughly sound guardrail support system.

Surplus excavated material remaining after guardrail support installation shall be disposed of.

Tops of all wood posts shall be set a uniform 25 mm \pm 5 mm above the line of the beam's top edge and where necessary cut to line up.

Wood posts damaged by the driving operation or other damage from their handling and installation shall be replaced at the Contractor's expense.

The tops of all wood posts and offset blocks, all post bolt holes and bored holes in posts shall receive a heavy soaking coat of the specified preservative treatment on three succeeding days.

Steel posts and beam shall be installed to the manufacturer's specifications and as specified in the Contract. Steel product damaged during installation shall be replaced by the Contractor.

604.05 Steel Beam Erection - Beam sections will normally be supplied or required for joining at 3.81 m intervals.

All punching, cutting or welding shall be shop executed except for special details in unforeseen and exceptional cases and to the prior approval of the Designer.

Sections shall have full bearing one to another at laps with splicing bolts drawn tight to 100 N·m for a continuous beam effect. Where guardrail is on a curve, the beam sections shall make close contact over the whole splice area. Shop bent beams will normally be supplied or required for curvature radii under 45 m.

Beam sections shall be bolted to posts so that the edges and centre portion(s) of beams make full bearing with each offset block or where applicable with back-up plate, post or other support. Where posts are treated with waterborne preservative salts, the bolt holes shall be filled with heavy grease before bolt insertion for corrosion protection.

Bolts shall not extend more than 15 mm beyond the fixing nut when tightened, with any excess removed and the threads burred.

Washers shall be used only where indicated on the SS Drawings of the SP312 series.

604.06 End Assemblies - End assemblies shall be carried out strictly according to the manufacturer's specifications unless specifically directed otherwise by the Designer in writing as to approved alternative methods and the like.

Note the safety preference for:

- a) Continuing guardrail to shield the entire length of any hazard (as indicated on SS Drawing 1-SP312), bridge abutment and the like in place of a bolted connector (RE-8).
- b) Approach transitions stiffened by means of reduced post spacing and, where necessary, the use of Thrie-beam or nested twin W-beams.
- c) End assemblies to be NCHRP 350 TL-3 or higher certified.

Note: the discontinuance of the flared (spade shaped) terminal section, especially at the approach ends of guardrails.

Footings for posts shall be constructed of specified concrete and reinforcement to the minimum sizes indicated on SS Drawing 2-SP312, neatly trowelled on top to weathering slope with bullnosed edge circular on plan.

SECTION 635

ELECTRICAL AND SIGNING

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

PART A - GENERAL

635.01 Scope - This Section covers the requirements for electrical and signing works. Temporary construction signing is covered in DBSS 194 - Traffic Control.

The maintenance of the electrical infrastructure contained within the limits of the Design Build project will be undertaken by the Contractor. The Contractor will be required to coordinate with the Ministry's Manager, Electrical Services, the commissioning and turnover of electrical equipment to the Ministry's electrical maintenance contractor or Electrical Trades Supervisor, as applicable.

The Contractor shall arrange the supply, installation and removal of temporary C-63 (Traffic Pattern Changed), C-64 (Signal Operation Changed Signs) and W-329 (New) tabs with Ministry Electrical Maintenance. The Ministry's electrical maintenance contractor, or Ministry Electrical Trades Supervisor, will remove these signs at no expense to the Contractor, if removal is not required prior to the Completion Date.

635.02 Work Regulations - All electrical work shall comply with the latest edition of the Canadian Electrical Code. In addition, any applicable bulletins published by the Province of British Columbia shall apply.

The Contractor shall also conform to all applicable regulations of the Workers' Compensation Board and if required, submit a Notice of Project Form 52E49 before commencing a Ministry project. The Contractor shall ensure compliance with the following sections:

- a) A Workers' Compensation Board Form 30M33 must be completed prior to working in the vicinity of overhead power lines.
- b) Notice of Construction Projects, Workers' Compensation Board Occupational Health and Safety Regulation, Section 20.2.

635.03 Electrical Permits & Inspections - All electrical work shall be performed by a Registered Electrical Contractor under the provisions of the Electrical Safety Act. The Registered Electrical Contractor shall appoint at least one Registered Representative whose qualifications shall comply with the provisions of the Electrical Safety Act. The Contractor shall provide the Ministry Electrical

Representative with the name and phone number of the Registered Representative prior to starting construction.

Prior to construction the Contractor shall obtain and pay for all permits required under the provisions of the Electrical Safety Act. The Contractor shall submit a copy of all permits to the Ministry Representative prior to starting construction.

Upon completion of an installation and prior to energization, the Contractor shall advise the Designer, the Quality Manager, the Ministry Representative, and the Ministry's Manager, Electrical Services that the work is complete and ready for final inspection. The Designer and Quality Manager shall undertake a review of the installation for conformance to the design and all applicable codes and regulations. The Quality Manager will report comments to the Ministry Representative.

Once the items identified have been completed and corrected the Contractor will advise the Ministry's Manager, Electrical Services who will undertake a final check and will advise if acceptable. If acceptable "notification of completion" will be issued by the Ministry's Manager, Electrical Services. If not, corrections will be required by the Contractor.

The Ministry will not accept the installation until all work has been approved by the British Columbia Safety Authority, and the Ministry's Manager, Electrical Services.

635.04 Electrical Energy Supply - The electrical energy will be supplied from overhead lines of the utility company's secondary distribution system unless otherwise noted on the Design.

The Contractor shall be responsible for making the necessary arrangements with the utility company for the connection of new service(s) and, if required, the disconnection of existing service(s). The Contractor will pay all utility connection costs.

635.05 Materials - The Contractor shall supply all materials necessary for the satisfactory completion of the project other than those materials listed in the Contract as supplied by the Ministry. All materials shall be new and conform to the requirements of the Design, the DB Specifications, and the *Electrical and Signing Material Standards Manual*.

The *Electrical and Signing Material Standards Manual* may be purchased from:

Government of British Columbia

Ministry of Labour and Citizens' Services
Publication Index Website:

<http://www.publications.gov.bc.ca/>

(Go Shopping)

(Keywords: *Electrical and Signing Material Standards Manual*)

email: QPPublications@gov.bc.ca

Phone: (250)387-6409 or 1-800-663-6105

Fax: (250)387-1120

Address: PO BOX 9452 STN PROV GOVT
VICTORIA BC V8W 9V7

The Electrical and Signing Material Standards is available electronically on the Ministry of Transportation web at

http://www.th.gov.bc.ca/publications/eng/publications/electrical/electrical_and_traffic_eng/2003_material_standards/2003_material_standards.htm

All products contained in the Electrical and Signing Material Standards shall be supplied from the Ministry's *Recognized Products Book*. This list identifies the manufacturer, the approved product, the product model number and the product approval date. This list can be viewed via the Ministry web page at:

<http://www.th.gov.bc.ca/publications/eng/publications/geotech/rpb.htm>

This list will be updated periodically as products become pre-approved.

All electrical materials shall conform to all applicable CSA Standards and shall meet the approval of the British Columbia Safety Authority Inspector.

Unless noted otherwise, all permanent signs shall meet current Ministry specifications. The Ministry *Specifications for Standard Highway Sign Materials, Fabrication and Supply* are located on our Ministry web page at:

http://www.th.gov.bc.ca/publications/eng/publications/signs/Sign_Fabrication_Specs.pdf

Where alternative materials are permitted, approval must be received from the Ministry Representative prior to their use.

635.06 Utilities - Existing utilities are generally not shown on the electrical and signing Drawings. Where utilities are shown on the Drawings, their locations are approximate.

The Contractor shall locate and protect all existing utilities such as power lines, fibre optic cables, telephone lines, gas and oil pipelines, sewers, water works, etc. The Contractor

shall at all times conduct its operations in accordance with the requirements of the utility authorities having jurisdiction. In the event of any damage to utilities, the Contractor shall be held responsible for the cost of all necessary repairs and restoration to the satisfaction of the Ministry Representative and Utility Authority.

PART B - UNDERGROUND

635.07 Concrete Bases - Concrete bases shall be constructed in accordance with Drawings SS SP635-1.1.1 through SS SP635-1.1.43 and SS SP635-1.4.1 through SS SP635-1.4.5. The use of the term "concrete bases" in DBSS 635 shall also mean "concrete spread footings" where applicable.

The Design makes reference to concrete bases that are poured in place or precast. Poured-in-place bases shall be constructed in the excavation whereas precast bases shall be constructed outside the excavation (e.g., at a precast plant or precast on site by the Contractor). The Contractor has the option to use either precast or poured-in-place bases.

Supply and installation of concrete bases shall include the following:

- excavation and backfill;
- supply and installation of concrete and formwork;
- supply and installation of reinforcing steel;
- supply and installation of conduit;
- supply and installation of steel tubing sleeves in sign post bases, and
- installation of anchor bolts.

For poured-in-place bases, the Contractor shall notify the Ministry Representative prior to pouring concrete.

The Contractor shall check for conflicts with overhead lines prior to excavating for concrete bases. If it appears there may be an overhead conflict, the Contractor shall contact the Designer for further instructions. If the Contractor installs a concrete base in a location where the pole conflicts with overhead power lines, the Contractor shall remove the pole and relocate the concrete base to a location approved by the Designer.

635.07.01 Excavation and Backfill - Excavations shall meet the requirements of DBSS 407 - Foundation Excavation.

All excavation work shall be carried out as required to suit concrete bases. Where directed by the Designer, excavations shall be shored to avoid the cutting of pavement, sidewalks, and curb and gutter.

Base excavations shall be backfilled using the excavated material provided it consists of clean well graded granular soil having a maximum fines content of 8% (silt and clay size particles) and a maximum aggregate size of 100 mm. Where backfill material does not conform as noted above, base excavation shall be backfilled with 25 mm Well Graded Base Course Aggregate material as specified in DBSS 635.14. Unacceptable materials shall be disposed of as specified in DBSS 635.15.

Backfill shall be placed in layers not exceeding 150 mm compacted thickness and shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698. Layer thickness shall be reduced and moisture content of the material adjusted as required to achieve compaction. Care shall be taken not to damage conduits.

All excavated and backfilled areas shall be restored to their original condition.

Asphalt restoration shall be performed in accordance with DBSS 635.12.

Concrete curb and gutter restoration shall be performed in accordance with DBSS 635.13.

635.07.02 Concrete and Formwork - Concrete construction, including formwork, shall meet the requirements of DBSS 211 - Portland Cement Concrete.

Proportioning of the concrete mixes shall be the responsibility of the Contractor. The Contractor shall notify the Ministry Representative 48 hours prior to pouring concrete for poured-in-place bases.

The concrete mix shall meet the specifications listed in Table 635-A.

Concrete shall be vibrated in accordance with DBSS 211 - Portland Cement Concrete.

All exposed concrete surfaces shall be given a Class 3 finish and all buried surfaces a Class 1 finish in accordance with DBSS 211.17.

When supplying poured-in-place concrete bases, the Contractor shall have the concrete strength verified, using concrete test cylinders, prior to installing the structure onto the base. Contrary to DBSS 211 the minimum number of concrete strength tests shall be one each week per mix design or concrete supplier. The Contractor shall take concrete test cylinders at the location of the pour and perform tests in accordance with DBSS 211.09.01. The Contractor must provide written confirmation of concrete

TABLE 635-A CONCRETE MIX

Minimum compressive strength at 28 days	30 MPa
Maximum nominal aggregate size	28 mm
Maximum W/C ratio by mass	0.45
Air content	5 ± 1%
Slump	50 ± 20 mm

test cylinder results prior to installing any structure on the bases.

Where installations are of a fast-track nature, the Contractor shall use a stronger concrete mix that will give the equivalent 28 day strength.

All concrete bases shall have their concrete strength verified with the exception of controller bases, sign post bases and post mounted flasher bases. Pre-cast concrete bases constructed off-site shall have their strength verified by the supplier.

The top finished surface of a concrete base shall not vary by more than 3 mm in depth as measured across the widest surface. If this variation exceeds 3 mm then the top 50 mm of the base shall be broken off by hand and reformed or the base shall be replaced.

635.07.03 Reinforcing Steel - Reinforcing steel shall meet the requirements of DBSS 412 - Reinforcing Steel.

All reinforcing steel shall conform to CAN/CSA-G30.18-M 400R.

The Contractor shall adjust the spacing of reinforcing steel to suit anchor bolts and conduit.

635.07.04 Anchor Bolts and Conduit - Anchor bolts and conduits shall be cast into the concrete bases.

Where an anchor bolt is damaged it shall be repaired in accordance with Drawings SS SP635-1.1.42 and 1.1.43.

Welding of anchor bolts shall not be permitted.

635.07.05 Steel Pipe Sleeves - Steel pipe sleeves shall be cast into the concrete bases. The type of sleeve shall be as noted on the Design and shall be in accordance with DBSS 635.28 or 635.29

635.07.06 Not Used

635.08 Junction Boxes and Vaults - Plastic junction boxes shall be installed in accordance with Drawings SS SP635-1.2.1 through SS SP635-1.2.16 and SS SP635-1.4.1 through SS SP635-1.4.3.

Concrete junction boxes shall be supplied and installed in accordance with Drawings SS SP635-1.3.1, 1.3.2, and 1.3.4. Concrete vaults shall be supplied and installed in accordance with Drawings SS SP635-1.3.3 and 1.3.4.

Concrete Junction Boxes shall be designed to withstand 5000 kg static loading.

Concrete vaults shall be designed to withstand CS600 (H-20) Static Loading.

The Ministry-approved concrete junction box and vault suppliers are listed on Drawings SS SP635-1.3.1 and 1.3.3. Concrete junction box or vault suppliers wishing to seek Ministry approval must submit shop drawings sealed by a Structural Engineer (registered with the APEGBC) to the Ministry of Transportation - Engineering Branch, Victoria, verifying that their junction box or vault meets the loading requirements. The junction box or vault shall also meet the size and functional characteristics shown on the Drawings and the Design.

Excavations for junction boxes and vaults shall meet the requirements of DBSS 407 - Foundation Excavation.

All excavation work shall be carried out as required to suit junction boxes and vaults. Where possible, excavations shall be shored to avoid the cutting of pavement, sidewalks and curb and gutter.

Junction boxes and vaults shall be installed on a bedding of 25 mm Well Graded Base Course Aggregate material in accordance with DBSS 202 - Granular Surfacing, Base and Sub-bases.

Junction box or vault excavations shall be backfilled using the excavated material except where excavated material is ruled unacceptable by the Designer or Quality Manager. Where new material is required, 25 mm Well Graded Base Course Aggregate material shall be used as specified in DBSS 635.14. Unacceptable materials shall be disposed of as specified in DBSS 635.15.

Bedding and backfill material shall be placed in layers not exceeding 150 mm compacted thickness and shall be compacted to a minimum 95% of the laboratory density obtained by the current ASTM test method D 698. Layer thickness shall be reduced and moisture content of the material adjusted as required to achieve compaction. Care shall be taken not to damage conduits.

The top of junction boxes and vaults shall be installed so that they are flush with the finished grade.

Concrete for junction box collars shall conform to DBSS 635.07.02.

All areas where excavation and backfilling have been performed shall be restored to their original condition.

Asphalt restoration shall be performed in accordance with DBSS 635.12.

Concrete curb and gutter restoration shall be performed in accordance with DBSS 635.13.

Lid hold down bolts shall be coated with anti-seize lubricant.

635.09 Conduits - All electrical conduits shall be installed in accordance with the Design.

Rigid PVC (RPVC) conduit shall be unplasticized polyvinyl chloride and conform to CSA C22.2 No. 211.2. Couplings, adapters, bends and fittings shall be unplasticized polyvinyl chloride and conform to CSA C22.2 No. 85. RPVC conduit shall be installed using CSA certified cement. Each standard length of RPVC conduit and fitting shall bear a certification mark to the applicable CSA standard.

Rigid metal conduit (RMC) shall be hot-dipped galvanized rigid steel and conform to CSA C22.2 No. 45. Any exposed metal on conduit shall be coated with cold galvanizing compound in accordance with DBSS 635.23.

Flexible liquid-tight non-metallic conduit (FC) shall conform to CSA 22.2 No. 227.2. All joints shall be made with FC threaded couplers, adapters or conduit fittings.

Liquid-tight flexible metal conduit (FMC) shall conform to CSA 22.2 No. 56. All joints shall be made with FMC threaded couplers, adapters or conduit fittings.

Conduit straps shall be galvanized steel single hole or double hole type (sized to suit conduit).

All empty conduits shall have a pull string and shall be capped in accordance with Drawings SS SP635-1.2.16 and 1.3.4. Pull string shall be polypropylene with a minimum tensile strength of 1.1 kN.

The Contractor shall lay out conduit so that 90° bends are avoided. Where 90° bend cannot be avoided, only one will be allowed for each conduit run.

Conduit couplings or bell ends damaged when pulling

conductors shall be rejected and replaced at the Contractor's expense. An appropriate pulling jig or method shall be used to avoid damaging conduit or fittings when pulling conductors.

635.10 Trenching and Backfilling for Conduit -

Trenching and backfilling shall be performed in accordance with Drawings SS SP635-1.5.1, 1.5.2, 1.6.1, 1.6.2 and 1.7.1.

RPVC conduits shall be installed in an open trench in accordance with Drawings Ss SP635-1.5.1, 1.5.2, 1.6.1, 1.6.2 and 1.7.1 except where conduits are to be drilled or pushed under the surface as specified in DBSS 635.11.

Trenches shall be excavated with neat, uniform sides to the minimum width necessary, but not less than the minimum dimensions indicated on Drawings SS SP635-1.5.1 and 1.5.2 (care shall be taken to prevent sloughing). Material in the floor of the trench shall be undisturbed, or if disturbed shall be re-compacted to the requirement herein for backfill.

Trenches shall be backfilled using the excavated material except where excavated material is ruled unacceptable for backfill. Where new material is required, 25 mm Well Graded Base Course Aggregate material shall be used as specified in DBSS 635.14. Unacceptable materials shall be disposed of as specified in DBSS 635.15.

A 150 mm wide yellow plastic marker tape indicating "WARNING ELECTRICAL" shall be installed in each trench for the complete length of the trench. The location of the marker tape shall be as shown on Drawings SS SP635-1.5.1 and 1.5.2.

Bedding and backfill material shall be placed in layers not exceeding 150 mm compacted thickness and shall be compacted to a minimum 100% (for road crossings) and 95% (for shoulder trenches) of the laboratory density obtained by the current ASTM test method D 698. Layer thickness shall be reduced and moisture content of the material adjusted as required to achieve compaction. Care shall be taken not to damage conduits.

All areas where trenching and backfilling have been performed shall be restored to their original condition.

Asphalt restoration shall be performed in accordance with DBSS 635.12.

Concrete curb and gutter and sidewalk restoration shall be performed in accordance with DBSS 635.13.

635.11 Trenchless Conduit Installation - Where noted on the Design the Contractor shall install the conduit using a suitable trenchless technology to avoid cutting the existing

pavement or sidewalk.

The trenchless technology selected shall suit the site conditions.

The Contractor shall give the Ministry Representative a minimum of 48 hours notice prior to installing conduits.

The Contractor shall locate all underground utilities prior to installing conduits.

635.12 Asphalt Pavement - Asphalt paving shall be performed in accordance with DBSS 501 - Hot Mixed Asphalt Pavement.

Asphalt patching of conduit trenches shall be performed in accordance with Drawing SS SP635-1.5.1. Asphalt patching of excavations for junction boxes, vaults and bases shall be performed similar to the details shown on Drawing SS SP635-1.5.1.

Contrary to the requirements of DBSS 501, Asphalt placing by a paving machine will not be required. Asphalt pavement restoration shall be Class 1 medium mix installed to the depth shown in the Design or to match pre-existing conditions, installed in lifts of a maximum of 50 mm.

The Contractor shall use a pavement saw to cut pavement and shall exercise care to obtain a neat, uniform excavation line along the edge of the pavement. The Contractor shall also prevent the existing base gravel from sloughing and undermining the pavement.

Where three lifts of asphalt pavement are being placed to reinstate a trench, the first two lifts shall be compacted with vibratory equipment capable of operating within the excavated area and of compacting over the whole of it. The third lift shall be compacted with rolling equipment to produce a uniform surface matching the adjacent existing pavement.

635.13 Concrete Curbs and Sidewalks - All concrete curbs and sidewalks shall be installed in accordance with DBSS 582 - Concrete Curb and Gutter and Storm Drainage.

Concrete shall meet the requirements of Note 1 on Drawing SS SP582-01.01.

The Contractor shall use a pavement saw to cut existing concrete and shall obtain a neat, uniform cut along the edge of concrete. The Contractor shall also prevent base gravel from sloughing and undermining the concrete.

635.14 25 mm Well Graded Base Course Aggregate - 25 mm Well Graded Base Course Aggregate shall meet the

requirements of DBSS 202 - Granular Surfacing, Base and Sub-bases.

When acceptable excavated material is not available, 25 mm Well Graded Base Course Aggregate shall be used as backfill. It shall also be used for additional backfill around bases, junction boxes, vaults, median island fill and other work.

635.15 Removal of Rejected Excavated Material - Where excavated material is designated unacceptable for backfill it shall be removed from the work site and disposed of by the Contractor at an approved site.

635.16 Restoration - Areas where work has been performed shall be returned to their original condition and must be left in a neat state to the satisfaction of the Quality Manager and Ministry Representative.

PART C - ELECTRICAL

635.17 Luminaire, Signal and Sign Poles - Luminaire and signal poles shall be installed in accordance with Drawings SSSP635-2.1.1 through SS SP635-2.1.14, and SS SP635-2.2.1 through SS SP635-2.2.10.

Where specified, luminaire poles shall be mounted on frangible or breakaway bases in accordance with Drawings SS SP635-2.1.15 and 2.1.16.

Sign poles shall be installed in accordance with Drawings SS SP635-3.1.1 through SS SP635-3.1.22.

Poles shall not be erected until concrete bases have attained a strength of 30 MPa.

Push button and signal head locations shall be verified before poles are drilled and assembled.

Field drilling of holes larger than 33 mm (1 5/16") diameter will not be permitted in Type 1, 3, 6, 7, L, M and H shafts, and all arms and extensions. Where larger holes are required, the holes shall be reinforced with a welded bushing in accordance with Drawing SS SP635-2.4.13.

All components of the luminaire, signal and sign poles shall be handled with care to prevent stress to the components through bending or twisting. A nylon sling shall be used to transport and erect the components. The use of steel chains as slings will not be permitted. Any damage to the components through overstress, scratching or denting shall be repaired or replaced at the Contractor's expense to the satisfaction of the Quality Manager and Ministry Representative.

All pole shafts shall be installed plumb. Where possible, all luminaire poles shall be positioned with the handhole oriented opposite the road and if not possible, on the downstream traffic side.

All wiring inside the poles shall be in accordance with DBSS 635.19.

Pole shafts shall mount directly on concrete bases and, where necessary, shall be trued to plumb using levelling shims.

The Contractor shall tighten all bolts and nuts to 1/3 past snug tight. "Snug-tight" is the tightness attained by a few impacts of an impact wrench or the full effort of a person using a spud wrench.

All scratches in poles and all field drilled holes shall be coated with cold galvanizing compound as per DBSS 635.23.

Hand hole bolts shall be coated with anti-seize lubricant.

635.17.01 Traffic and Pedestrian Signal Heads - Traffic and pedestrian signal heads shall be installed in accordance with Drawings SS SP635-2.3.1 through SS SP635-2.3.6 and -2.3.10.

All traffic and pedestrian signal heads and mounting hardware shall be securely attached to the pole.

Traffic and pedestrian signal heads shall be correctly aimed in the field to the satisfaction of the Designer and the Ministry Representative.

All traffic and pedestrian signal heads shall have LED (light emitting diode) traffic signal heads unless noted otherwise on the Contract.

The Contractor shall completely cover all traffic and pedestrian signal heads with dark coloured pre manufactured signal cover bags from the time they are installed until the system is activated.

The Contractor shall aim all traffic signal heads in accordance with Drawing SS SP635-2.3.11. Pedestrian signal heads shall be aimed to line up with the opposing wheelchair ramp or centre of the crosswalk.

635.17.02 Pedestrian Pushbuttons and Signs - Pedestrian pushbuttons and signs shall be installed in accordance with Drawing SS SP635-2.3.7.

Pedestrian push buttons and signs shall be securely attached to the pole. Pedestrian pushbutton signs shall be temporarily covered until the signal is in operation.

635.17.03 Luminaires and Photocells - Luminaires and photocells shall be installed as per manufacturer's instructions or as noted on the Design. Luminaires shall be installed level. Where the luminaire has a multi-tap ballast, the Contractor shall verify the service voltage and adjust the luminaire voltage tap to suit.

When installing flat glass cobra head roadway luminaires the flat glass lens shall be oriented parallel to the roadway surface to reduce glare.

Sign luminaires will require different aiming depending on the manufacturer. Aiming angles shall be noted on the Design.

Photocell eyes shall be aimed north.

635.17.04 Streetname Signs - Streetname signs shall be bolted directly to the pole arms in accordance with Drawing SS SP635-3.2.1.

635.17.05 Audible Signals - Audible Signals shall be installed on pedestrian signal heads in accordance with Drawing SS SP635-2.3.8. The Contractor shall aim and adjust the audible signal heads to the satisfaction of the Designer and the Ministry Representative.

635.17.06 Emergency Vehicle Pre-emption Equipment - Emergency vehicle pre-emption equipment shall be installed in accordance with the Contract, Design and manufacturer's instructions. The Contractor shall undertake all commissioning and set-up of the equipment under the direction of the supplier technical representative.

635.17.07 Small Overhead Signs - Small overhead signs are classed as signs 1200 mm x 900 mm or smaller. Small overhead signs shall be installed in accordance with Drawings SS SP635-3.2.2 through SS SP635-3.2.6.

Sign installations shall meet the requirements of DBSS 635.32.

635.17.08 Video Detection Equipment - Video Detection equipment shall be installed in accordance with the Contract, Design and manufacturer's instructions. The cameras shall be installed on signal arms or on special combination type 2A luminaire / camera arms in accordance with Drawings SS SP635-2.3.12 and .13 The Contractor shall undertake all commissioning and set-up of the equipment under the direction of the supplier technical representative.

635.18 Service Equipment - Service equipment shall be installed in accordance with Drawings SS SP635-2.4.1 through SS SP635-2.4.16.

Service Equipment shall include electrical panels and telephone demarcation panels.

Specialized service equipment (e.g., service kiosks) shall be installed in accordance with the Design and the Contract.

Service equipment shall be securely attached to the poles.

635.19 Wiring - All wiring shall be installed in accordance with the Design or as directed by the Designer.

All conductors shall be stranded copper, RW90 XLPE insulated unless otherwise noted.

Conductor gauges (AWG) shall be as specified on the Drawings and the Design.

Shielded detector loop and telephone demarcation cables shall be 2 conductor No. 18 Ministry pre-approved product. Shielded detector loop cables shall run continuous with no splices, from the traffic controller (or other type of control equipment) to the respective detector loop conductor.

Single conductor colour coding and labelling is required and shall be as noted on Drawings SS SP635-2.5.7 and 2.5.8. Conductor colour coding shall also meet the requirements of the Canadian Electrical Code.

Where specifically noted on the Design, signal cable shall be used. Signal cable colour coding and conductor designations shall be as noted on Drawing SS SP635-2.5.9. Where signal cable is used all conductor splices shall be made in pole hand holes in accordance with Drawing SS SP635-2.5.10.

Each traffic and pedestrian signal head section and luminaire shall be wired separately to the base of the pole. A separate neutral and bond conductor shall run to each signal head and luminaire from the base of the pole. The neutral and bond conductors shall be bundled with the feeder circuits.

Luminaire conductor wiring and fusing in pole handholes shall conform to Drawing SS SP635-2.5.6.

Wiring inside junction boxes and vaults shall conform to Drawings SS SP635-2.5.1 through SS SP635-2.5.5.

Conductor splices shall be secured with solderless "Marrette" type connectors. Where the number and/or size of conductors exceed the capacity of the Marrette split bolt connectors shall be used.

All wiring shall be neatly bundled and labelled in all junction boxes, vaults, traffic controllers, handholes at pole bases, and service panels.

Sealing of connections shall be performed using one of the following methods:

- a) Double dipping using 3M "Scotchcote" or approved alternate. Dipping shall be performed strictly adhering to the manufacturer's specifications.
- b) Each conductor shall have a wrap of the self-holding tape (3M Linerless Rubber Splicing Tape, Steadfast 8 Ounce Splicing tape or approved alternate), then the complete splice shall be wrapped. PVC tape shall then be applied to cover the complete splice.

If conductor connections require the use of split bolts or similar style devices due to wire size, then the splice shall be completely covered with Duct Seal to form a ball over the connection. This Duct Seal shall be thick enough to prevent sharp ends of the conductors and/or points of the connector from protruding through the taped connection. Once the duct seal has been applied, the splice shall be taped with self-holding and PVC tape as described in DBSS 635.19 b).

All luminaires and signal heads shall be bonded with a No. 12 RW90 conductor. Steel junction box lids and steel vault lids shall be bonded in accordance with Drawings SS SP635-2.5.1 through SS SP635-2.5.5.

635.20 Traffic Counter Stations - Traffic counter stations shall be short-duration type or permanent type.

Short duration traffic counter stations shall be installed in accordance with Drawing SS SP635-2.6.1.

Perforated square steel tubing shall conform to DBSS 635.28.

Permanent traffic counter stations shall be installed in accordance with Drawing SS SP635-2.6.2 and 2.6.3.

The Contractor will install all pole mount cabinets. The Ministry's electrical maintenance contractor will connect all field wiring in cabinets, trouble-shoot problems in the cabinet and undertake all equipment set-up

635.21 Controllers - Type B, C, M and S traffic controller cabinets shall be installed in accordance with Drawings SS SP635-2.7.1 through SS SP635-2.7.3.

The Ministry's electrical maintenance contractor or Ministry Electrical Trades Supervisor will install all base mount traffic controller and cabinets. The Contractor will install all

pole mount cabinets. The Ministry's electrical maintenance contractor or Ministry Electrical Trades Supervisor will connect all field wiring in controller cabinets, trouble-shoot problems in the cabinet, enter all signal timings, undertake modifications to existing signal phasing and timings, start-up controller and complete Ministry signal turn-on sheets.

The Contractor shall be on hand to assist with controller start-up and make any repairs to field wiring or hardware as required. The Contractor shall provide traffic control and assistance during the controller start-up.

The Contractor shall coil and label 2 m of each conductor inside the traffic controller for connections by the Ministry's electrical maintenance contractor or Ministry Electrical Trades Supervisor. The Contractor shall verify that all traffic and pedestrian signal phases are wired as shown on the Design and that all circuits are tested prior to activation. The Contractor shall verify that all signal and pedestrian phases are properly colour coded and labelled with identification tags.

635.22 Detector Loops - Detector loops shall be constructed as noted on the Design and shall be installed in accordance with Drawings SS SP635-2.8.1 through SS SP635-2.8.16. Loop check sheets shall be completed and submitted to the Ministry Representative prior to signal start-up.

635.23 Repairing Galvanized Surfaces - Any spots where the galvanized finish is damaged due to drilling, tapping, reaming or welding and any surface damage incurred during transportation and erection shall be refinished with cold galvanizing compound. Cold galvanizing compound shall be Crown No. 67007 spray type (or approved alternative). The application of cold galvanizing compound shall conform to the Manufacturer's instructions and the following:

- a) The surface shall be mechanically cleaned with a wire brush or grinder and chemically cleaned to remove all welding flux, paint, grease, oil, rust, scale or other detrimental foreign matter.
- b) The surface shall be absolutely dry and the ambient temperature shall be over 10°C.
- c) Uniform coats shall be applied. Each coat shall be as thick as possible without causing runs on the finished surface.

635.24 Flasher Luminaires - Flasher luminaires shall be mounted on perforated square steel tubing in accordance with Drawings SS SP635-2.9.1 through SS SP635-2.9.3.

Flasher luminaires shall be mounted on poles in accordance with Drawings SS SP635-2.9.4 through SS SP635-2.9.6.

All perforated square steel tubing shall be in accordance with DBSS 635.28.

PART D - SIGNING

635.25 Overhead Signs - Overhead signs are categorized in two classes:

- a) small overhead signs are 1200 mm x 900 mm or smaller;
- b) large overhead sheet aluminum, plywood or extruded aluminum guide signs are larger than 1200 mm x 900 mm.

Small overhead signs are generally plywood or sheet aluminum, and are mounted on signal poles. Small overhead signs shall be installed in accordance with Drawings SS SP635-3.2.2 through SS SP635-3.2.6.

Large overhead guide signs are installed on sign poles in accordance with Drawings SS SP635-3.3.1 through SS SP635-3.3.6, unless otherwise noted. Large overhead extruded aluminum signs are installed on sign poles in accordance with Drawings SS SP635-3.3.11 through SS SP635-3.3.17, unless otherwise noted. Sign poles shall be installed in accordance with Drawings SS SP635-3.1.1 through SS SP635-3.1.19. Large overhead plywood signs are not typically used for new installations.

Sign lighting, where specified by the Ministry, shall be installed in accordance with Drawing SS SP635-3.3.18 and DBSS 635.17.03.

Overhead signs shall be securely installed on sign pole structures.

All horizontal supports and signs shall be level and vertical supports plumb.

Sign Poles shall be installed in accordance with DBSS 635.17.

Advance warning signs shall be extruded aluminum, and shall be installed in accordance with Drawings SS SP635-3.3.7 through SS SP635-3.3.10.

All signs shall be installed in accordance with DBSS 635.32.

635.26 Breakaway Sign Structures - Breakaway sign structures shall be installed in accordance with Drawings SS SP635-3.4.1 through SS SP635-3.4.12.

After concrete bases are installed, the Contractor shall survey the finished base elevations to determine the correct leg lengths. The fabricator shall cut legs to the correct lengths.

All legs and columns are to be transported in an unstressed manner.

All breakaway structures shall be installed with the legs and columns plumb, and the battens and signs level.

The Contractor shall tighten all bolts and nuts with a torque wrench to the torque specified on the Design.

Signs shall be sheet aluminum plywood or extruded aluminum, as specified.

Plywood signs shall generally be installed in accordance with Drawings SS SP635-3.4.7 and, 3.4.8 and DBSS 635.32.

Plywood signs shall be installed with wood battens on the breakaway sign columns to support the signs. Wood battens shall be 4" x 6" Douglas Fir/Larch, No. 1 Grade or pressure treated, surfaced four sides, in complete lengths without splices. Battens shall be straight and free of cracks. All wood battens shall be painted green with one coat of oil base exterior paint (General Paint No. 63-324 - Highway Green, or approved alternative) over a compatible primer (General Paint No. 32002 - Primer or approved alternative). All painting shall conform to DBSS 308 – Paint It is not required to paint pressure treated sign battens.

All pressure treated wood battens shall be pressure treated in accordance with CSA Standard 080.5 “Preservative Treatment of Posts by Pressure Processes”

Signs shall not be installed until the paint on the battens has completely dried.

Extruded aluminum signs shall be installed in accordance with Drawings SS SP635-3.4.9 through SS SP635-3.4.12 and DBSS 635.32.

Extruded aluminum signs on breakaway sign structures will not be illuminated.

All sign installations shall be in accordance with DBSS 635.32.

635.27 Wood Post Sign Structures - Wood post sign structures shall be installed in accordance with Drawings SS SP635-3.5.1 through SS SP635-3.5.9.

Excavations for wood posts shall be wide enough to allow for proper compaction of backfill around the wood posts. Wood posts shall be embedded in the ground to the depths indicated on Drawings SS SP635-3.5.1 through SS SP635-3.5.3.

Wood post excavations shall be backfilled using the excavated material except where excavated material is ruled unacceptable. Where new material is required, 25 mm Well Graded Base Course Aggregate material shall be used as specified in DBSS 635.14. Unacceptable materials shall be disposed of as specified in DBSS 635.15.

Wood posts shall be Douglas Fir/Larch, No. 1 Grade or pressure treated, surfaced four sides, and shall be supplied in complete lengths without splices. Posts shall be straight and free of cracks.

All pressure treated wood posts and battens shall be pressure treated in accordance with CSA Standard 080.5 "Preservative Treatment of Posts by Pressure Processes"

All portions of wood posts that are not pressure treated installed below finished grade shall be treated with wood preservative.

Wood posts shall be installed plumb and at the proper offset and elevation.

Backfill material shall be placed in layers not exceeding 150 mm compacted thickness and shall be compacted to a minimum 100% of the laboratory density obtained by the current ASTM test method D 698. Layer thickness and moisture content of the material shall be adjusted as necessary to achieve compaction.

All areas excavated and backfilled shall be restored to their original condition.

Wooden sign posts shall be completely painted, prior to installing the sign or signs, with one coat of white oil base exterior paint (General Paint No. 10010 or approved alternative) over a compatible primer (General Paint No. 32002 primer or approved alternative) for the length of the post from the ground line to the bottom of the sign. Where plywood signs are installed, the portion of the post behind the sign from the bottom of the sign to the top of the post shall be completely painted with one coat of green oil base exterior paint (General Paint No. 63-324 - Highway Green or approved alternative) over a compatible primer (General Paint No. 32002 primer or approved alternative). All painting shall meet the requirements of DBSS 308 - Paint. It is not required to paint pressure treated sign posts

Signs on single wood post structures shall be plywood or

sheet aluminum. Sheet aluminum signs shall be installed in accordance with Drawing SS SP635-3.5.1 and DBSS 635.32.

Signs on multiple wood post structures shall be sheet aluminum, plywood or extruded aluminum.

Plywood signs shall be installed in accordance with Drawings SS SP635-3.5.4 and 3.5.5, and DBSS 635.32. Plywood signs shall be installed on wood battens mounted on the sign posts to support the signs. Wood battens shall be Douglas Fir/Larch, No. 1 Grade or pressure treated, surfaced four sides, and shall be supplied in complete lengths without splices. Wood battens shall be straight and free of cracks.

Wood battens shall be painted green with one coat of exterior paint (General Paint No. 63-324 - Highway Green, or approved alternative) over a compatible primer (General Paint No. 32002 primer or approved alternative). It is not required to paint pressure treated wood battens.

Extruded aluminum signs shall be installed in accordance with Drawings SS SP635-3.5.6 through SS SP635-3.5.9 and DBSS 635.32.

Signs or battens or extruded aluminum signs and angle mounting brackets shall not be installed on wood posts until the paint has completely dried.

All areas around the post shall be fully restored to their original condition.

635.28 Perforated Square Steel Sign Post Structures - Perforated Square Steel Sign Post shall be supplied in accordance with Drawings SS SP635-3.6.1 through SS SP635-6.4.

Sign posts shall be perforated square steel tubing. The perforated square steel tubing will be required in different outside dimensions as noted on the Design. The perforated square steel tubing shall be formed from 12 gauge cold rolled steel, conforming to ASTM Specification A 446, Grade A. The tubing shall be hot dipped galvanized conforming to ASTM Specification A 525, Designation G-90. Steel tubing shall have 7/16" holes on all four sides at 1" centres.

Galvanized perforated square steel tubing shall be supplied in continuous lengths, with no splices, and shall be field cut to suit the particular installation. All field cuts shall be painted with cold galvanizing compound in accordance with DBSS 635.23.

Perforated square steel tubing sign posts shall be installed on concrete bases or direct buried in accordance with Drawing SS SP635-1.1.35.

Perforated square steel tubing posts shall be installed plumb.

Signs on single perforated square steel sign posts shall be sheet aluminum or steel. Sheet aluminum and steel signs shall be installed in accordance with Drawings SS SP635-3.6.1 and 3.6.3 and DBSS 635.32.

Signs on double perforated square steel sign posts shall be plywood or sheet aluminum.

Double post plywood and sheet aluminum signs shall be installed in accordance with Drawings SS SP635-3.6.2 through SS SP635-3.6.4 and DBSS 635.32.

635.29 Round Steel Sign Post Structures - Round Steel sign posts shall be installed in accordance with Drawings SS SP635-3.8.1 through SS SP635-3.8.3.

Barrier sign posts shall be mounted on barrier stands, which shall be securely bolted to concrete roadside or concrete median barriers.

Posts and pipe sleeves shall be round Schedule 40 steel pipe conforming to ASTM Specification A 53, Grade B. The pipe shall be hot dip galvanized in accordance with CSA Specification G164 Table A. Pipe shall be field cut to lengths to suit sign mounting heights as noted on the Design or as directed by the Designer. All field cuts in galvanized steel pipes shall be coated with cold galvanizing compound in accordance with DBSS 635.23.

Signs shall be installed in accordance with DBSS 635.32.

635.30 Sign Mounting on the Side of Poles - Signs mounted on the side of steel poles shall be installed in accordance with Drawing SS SP635-3.9.1.

Signs shall be securely attached to poles.

Signs shall be installed in accordance with DBSS 635.32.

Holes drilled in galvanized steel poles shall be coated with cold galvanizing compound in accordance with DBSS 635.23.

635.31 Delineators - Delineators shall be wood, perforated steel tubing or plastic as noted on the Design.

Wood delineator posts shall be installed in accordance with Drawing SS SP635-3.10.1.

Perforated square steel tubing delineator posts shall be installed in accordance with Drawing SS SP635-3.10.2.

Where plastic delineators are specified, they shall be a Ministry preapproved type and shall be installed in accordance with the manufacturer's instructions.

Where delineators are mounted on a pole, sign post or structure, they shall be installed in accordance with Drawing SS SP635-3.10.3.

Wood delineator post excavation, backfill, type of wood, painting and installation methods shall be in accordance with DBSS 635.27.

Perforated square steel tubing shall be in accordance with DBSS 635.28.

All holes drilled in galvanized surfaces shall be coated with cold galvanizing compound in accordance with DBSS 635.23.

635.32 Signs - Small signs which are generally 1200 mm x 900 mm or smaller shall be sheet aluminum or plywood. Large signs which are generally larger than 1200 mm x 900 mm shall be plywood or extruded aluminum as specified.

All sign installations shall meet the requirements of the most current edition of the Ministry *Manual of Standard Traffic Signs and Pavement Markings* available at;

http://www.th.gov.bc.ca/publications/eng_publications/electrical/MoST_PM.pdf

The Contractor shall have a current copy of this document on site when installing signs.

All signs shall be completely covered with a suitable grade of polyethylene sheeting from the time they are installed until the roadway is in full operation, unless otherwise directed by the Designer. The polyethylene sheeting material shall prevent sign messages from being visible.

All signs shall be handled so as not to damage them in any way. Slip sheets between signs shall be removed carefully to avoid damage due to adhesion of the slip sheet to the sign. Signs shall be stored on end on dunnage or racks in a dry, covered area, safe from damage. Damaged signs shall be replaced by the Contractor at the Contractor's expense. Taping, screwing, nailing, gluing, bolting or stapling to sign faces or back is prohibited unless otherwise noted.

The Contractor shall confirm that all signs have the correct messaging. The Contractor shall verify that all signs are free of cracks, dents or warpage prior to installation.

Signs shall be bolted to the mounting hardware or structure as indicated on the applicable Design. Nylon washers shall be installed between the mounting bolt heads and the plywood sign face. The sign panels shall be tightened so as to eliminate sign movement but not over tightened so as to recess the bolt heads into the sign face.

Plywood signs larger than 1200 mm x 3000 mm will consist of multiple plywood panels. Each panel shall be correctly aligned so that no gaps exist between sign panels. The bottom of the sign panels shall be installed level.

Plywood exit number tabs shall be attached to plywood signs in accordance with Drawing SS SP635-3.7.1.

Extruded aluminum signs will be supplied unassembled. Aluminum sign sections shall be assembled and correctly aligned to the satisfaction of the Ministry Representative

Extruded aluminum signs are supplied in typical widths shown on Drawing SS SP635-3.3.13.

Extruded aluminum exit number tabs shall attach to extruded aluminum signs in accordance with Drawings SS SP635-3.7.2 and 3.7.3.

Any unused holes in wooden sign boards shall be sealed. Holes on the sign face shall be covered with a trimmed piece of patching material to match the colour of the sign face.

Patching material shall meet current Ministry Specifications.

All plywood, sheet aluminum and extruded aluminum signs will be identified with their sign numbers labelled on the back. Sign numbers shall be determined as directed by the Ministry Representative

The Contractor shall maintain all signs installed as part of the work within the project area for the duration of the Work. Maintenance shall be performed for the duration of the work in accordance with the following:

- a) Sign maintenance shall include the straightening, replacing, repairing and cleaning of all signs installed.
- b) The Contractor shall regularly inspect the signs to ensure consistent maintenance for maximum visibility.
- c) Where necessary the Contractor shall clean the signs by power washing or steam cleaning using pressures not exceeding 7 MPa and temperatures not exceeding 65°C. Chemical washing of sign faces will not be accepted.

SECTION 741

FENCE CONSTRUCTION

DESCRIPTION

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

741.01 Scope - This Section covers the construction of wire fencing with wood and/or metal posts, gates, wood privacy and noise barrier fencing and, with reference to the SS SP741 drawing series, is intended to specify acceptable standards and some optional features as may be required by the Contract.

Alternative construction and methods may be called for by the Drawings, the Special Provisions or instructions of the Designer.

For SP Drawing referenced herein, such as SS SP741-01.01, see the corresponding SP Drawing in the Ministry’s *Standard Specifications for Highway Construction, 2006 edition*.

MATERIALS

741.11 General - Material for fencing including wire fabric, barbed and high-tensile wire, chain link mesh and metal posts are specified in DBSS 316. Wood fence posts are specified in DBSS 909.

Chain link fabric as protection on rock slopes is covered by DBSS 207 and DBSS 316.

The types of standard wire and chain link fencing are designated in Table 741-A. Tentative requirements for High-tensile Smooth-wire Fences are included.

TABLE 741-A TYPES OF STANDARD WIRE AND CHAIN LINK FENCING

TYPE A	Special Wire Fabric Fence for use only on railway right-of-way
TYPE B	Standard Wire Fabric Fence
TYPE C	Standard Barbed Wire Fence
TYPE D	Chain Link Fence

Note: Drawing SS SP741-01.01 indicates the general requirements of Types A and B Fences, Drawing SS SP741-02.01 indicates those of Type C Fences, and Drawing SS SP741-05.01 indicates those for Type D. The requirements for Type C are acceptable to the Provincial

Wildlife Branch and the B.C. Cattlemen's Association.

741.12 Standard Wire Type A, B & C Fences and Gates

- Materials generally shall be in accordance with the requirements set out on Drawings SS SP741-01.01 and SS SP741-02.01, the relevant subsections of DBSS 316 and DBSS 909 and/or the Special Provisions.

Preservative treatment for protecting field cuts and notches and for making good any superficial damage to treated wood posts, braces and anchors, where permitted by the Quality Manager, shall be compatible with the original pressure treatment for application in two separate heavy coatings.

Touch-up treatment for damaged galvanizing of steel posts and braces shall be a heavy application of a zinc rich colour matched paint to CGSB Standard 1-GP-181M Specification for Ready Mixed Zinc Rich Coating.

741.12.01 Gates - Gates shall be of the prefabricated type indicated on Drawings SS SP741-04.04, SS SP741-04.05 and as specified in DBSS 316.11 and/or as specified in the Special Provisions.

741.13 High-tensile Smooth-wire Fences - Materials to be supplied in accordance with the Purchase Order will include:

- high-tensile smooth galvanized wire 2.5 mm nominal diameter
- mechanical wire splices and fasteners for high-tensile wire
- in-line high-tensile wire tensioning devices
- metal or wood droppers for high-tensile fencing.

Wood posts and braces shall be supplied by the Contractor in accordance with the requirements of DBSS 909 together with steel posts, gates and hardware, brace wire, dowels, staples and the like in accordance with the relevant subsections of DBSS 316.

741.14 Chain Link Type D Fences and Gates- Chain link mesh, steel pipe and accessory materials generally shall be in accordance with the requirements set out on Drawings SS SP741-05.01 and SS SP741-05.02, the relevant portions of DBSS 316, and/or the Special Provisions.

741.14.01 Gates - Gates shall be of the type indicated on Drawings SS SP741-05.03 and SS SP741-05.04 and/or specified by the Special Provisions, and shall be equipped with hinges (or sliding) and locking hardware.

741.15 Wood Fences - Materials used for the fabrication and installation of wood fences shall be as follows:

- i) Concrete footings:** Minimum 18 MPa compressive strength concrete, comprised of aggregate, sand and Portland cement (4:2:1).
- ii) Lumber:** Rough sawn or dressed, as specified, shall be of Western Red Cedar with:
 - Wood posts and stringers of "No. 1 Structural" grade posts and framing or plank
 - Boards and planks of "Quality Fencing" grade except where noise barrier fencing is specified for "Select Fencing" or plank equivalent.

Other species may be specified or approved and shall be of equivalent grades with pressure preservative treatment in accordance with CSA Standard 080 and compatible with staining requirements.

All lumber shall be in conformity with the NLGA "Standard Grading Rules for Canadian Lumber."

iii) Galvanized steel pipe: 48 mm OD for privacy fence posts shall conform to the requirements of DBSS 316.10 with weatherproof caps where open ends are not covered by wood members.

iv) Steel: Steel used as posts for noise barrier fences or as wood post supports shall be of the structural shape(s) indicated in accordance with CAS Standard G40.21M, grade 300W and where galvanized, hot dipped to the requirements of CSA G164.

v) Fastenings: Bolts generally shall conform to ASTM A 307, nuts to ASTM A 563 Grade A, plain washers to ANSI B27.2 Type A, plate washers, where required, to ASTM A 36; all galvanized according to CSA G164. Nails shall be casing headed heavy gauge of appropriate length, hot dip galvanized with deformed shank (annular, barbed or helical) for noise barrier fence plank fixing.

vi) Finish: Penetrating stain with preservative shall be of type and colour specified at least conforming to CGSB Standards 1-GP145M and 204M, to all surfaces prior to prefabrication or installation and on any cuts before final fitment.

CONSTRUCTION

741.31 Provision of Fencing - Fencing of the type(s) called for shall be carried out at the locations and as shown on the Design with the materials to the height, spacing and with accessories all in accordance with the details indicated on the Design, Standard Specifications, Special Provisions and

SP Drawings.

All material shall be supplied by the Contractor.

Construction shall be carried out with all labour, tools, equipment and incidentals supplied by the Contractor, as necessary, to complete all fencing work in accordance with good work practice.

741.32 Clearing & Grading - All trees (other than any required by the Design or Contract to remain), all brush and other obstacles which interfere with the construction and maintenance of fencing and not removed by the normal clearing operations, shall be removed prior to commencing fencing work so that both sides of the fence line are free of all clearing and grubbing debris.

Minor ground undulations shall be corrected to obtain a smooth uniform grade, but appreciable grade depressions may be backfilled only with the permission of the Designer and Quality Manager.

The site shall be left in a smooth and tidy condition.

741.33 Setting Out and Connections to Existing - Fence line, as shown on the Design, generally will be along the right-of-way boundary. Where undergrowth clearing is carried out to the right-of-way boundary, the fence line will be offset 0.5 m in from the boundary.

Post installation in fill material or minimum overburden shall be carried out to the Designer's or Quality Manager's directions. Where it is not possible to drive or set wood posts to proper depth or to relocate same along the fence line, steel fence posts as specified or, where permitted, multiple wood post and brace assemblies shall be substituted.

Existing cross fences shall be connected to new with posts and braces for tensioning fencing wire in every direction in accordance with Drawings SS SP741-01.03 and SS SP741-02.02.

741.34 Standard Wire Type A, B & C Fences and Gates

741.34.01 Post Installation - Fence posts shall be driven in place with equipment acceptable to the Quality Manager, set in augered pilot holes or, where permitted by the Quality Manager, set in dug holes with necessary well tamped backfill for a firm installation and post penetration to at least the depth indicated on Drawings SS SP741-01.01 and SS SP741-02.01.

On straight alignments all posts shall be plumb. On appreciable grades, posts shall be installed perpendicular to

the slope.

On curved alignments, the posts shall be set 50 mm off plumb away from the curve centre, with a post spacing in accordance with Drawing SS SP741-04.02 and increased post lengths and bury depth for post stability where necessary.

Gate post sizes and stabilizing shall be as required by the Special Provisions and/or Drawing SS SP741-04.04.

Steel fence posts, as specified by DBSS 316.09, are required on exposed rock or rock with "minimum overburden" (as defined on Drawing SS SP741-04.01) and shall be driven and/or wedged to the full depth in a vertical drilled hole of minimum diameter or set plumb and rigid in cement and sand or fine aggregate mortar all as indicated by Drawing SS SP741-04.01.

Note: Assemblies of securely wire tied multiple wood posts/braces may be specified by the Design or permitted by the Designer especially for minor rock outcropping and unforeseen minimum overburden occurrences.

When full bury depth of wood posts is not attainable, the specified steel fence posts shall be used to the full penetration into rock, all as indicated on Drawing SS SP741-04.01.

Tops of all posts shall be set to a uniform 50 mm above the level of the top wire of fencing and, where necessary, cut to line-up in vertical uniformity. Wood post tops where cut, shall be bevelled and preservative treated in two heavy applications.

Wood posts which are burred, split or otherwise damaged from the installation shall be replaced.

741.34.02 Bracing for Fence Tensioning - Braces of treated wood and twisted galvanized diagonal wire shall be installed between end posts and adjoining panel posts to stabilize the tensioning of the fencing fabric and/or barbed wire, all as indicated by Drawings SS SP741-01.03 and SS SP741-02.03. Corner and intersection assemblies shall be similarly tensioned in each fence direction.

Intermediate tensioning assemblies shall be provided within the maximum spacings indicated on Drawings SS SP741-01.02 and SS SP741-02.02 to make use of rolls of fabric etc. of standard length with a minimum of cutting and waste.

Steel corner, intersection and intermediate tensioning assemblies with steel angle posts and diagonal bracing are indicated on Drawing SS SP741-04.01.

Horizontal alignment changes over 30° with wood posts and over 15° with steel posts shall be stabilized as for corners above. Where a change is less than 30° with wood posts, a pair of line posts, set 2.4 m or 3.0 m apart, shall be stabilized with a horizontal wood brace and diagonal wire bracing both ways. For a change of less than 15° with steel posts, a steel line post at the change shall be stabilized in both directions with diagonal steel braces to adjoining line posts as indicated on Drawing SS SP741-04.01.

Similar requirements shall be maintained at each change to or within any curved fence alignment where the closer post spacing indicated by Drawing SS SP741-04.02 is not considered adequate.

Vertical alignment changes shall be stabilized, and fence requirements at ditch and gully conditions shall be as called for by Drawing SS SP741-04.03 or as the Designer may direct.

741.34.03 Fabric and Wire - Fence fabric shall normally be installed on the side of the posts away from the highway, stretched between end type assemblies and intermediate tensioning assemblies with proper equipment (tensioning directly by truck or tractor will not normally be permitted) and securely stapled in accordance with good practice to wood posts, as indicated by Drawing SS SP741-01.01, or securely wired or clipped to steel posts to permit free wire movement on line posts. Similarly, barbed wire shall be installed so as to allow it to "prestretch" before final tensioning, and shall be securely stapled to tensioning assemblies.

For fencing on a curve requiring the fabric and/or barbed wire on the highway side of the posts, all line wires shall be double stapled and the top wire shall be securely wire tied to posts in addition where the adjoining property has livestock.

Barbed wire Type C fences shall normally have wood droppers "interwoven" and securely figure-of-eight wire tied to every line wire, as indicated by Drawing SS SP741-02.01. Alternatively, proprietary galvanized sheet metal prefabricated droppers of pre-approved design for secure clip-on application may be approved.

Note: High livestock pressures may warrant Type C1 fencing and nursery livestock enclosures Type C1 or B fencing. Where such fences, 1200 mm and higher, are in wildlife sensitive areas, the top strand may be specified smooth (barbless) as Type C2 or B1 fences.

741.34.04 Gates - Hardware, of design to permit the gate to operate correctly, shall be securely attached to prevent the easy removal of the gate and hardware. Hinges shall be installed to permit the gate to swing back one-way against

the fence. Locking hardware shall be of the type specified.

741.35 High-tensile Smooth-wire Fences - For rangeland and other locations with favourable terrain, soil conditions and fence alignment at the locations indicated on Design, construct high-tensile smooth-wire fencing between rigid end, gates, corner and any necessary intermediate tensioning assemblies in general accordance with Drawings SS SP741-03.01 through SS SP741-03.03.

741.35.01 Fence Style - Fence style for wildlife crossing areas shall comprise 5 wires, the bottom wire for installation at 250 mm \pm 50 mm above grade at and between posts, the next two wires at 200 mm spacing and the top two 225 mm for a total height of 1100 mm, as indicated by Drawing SS SP741-03.01 for HT Fences. Elsewhere, and for nursery livestock enclosures and other areas of high livestock pressure, a 6-wire fence may be specified, having the bottom wire 200 mm \pm 50 mm above grade at and between posts with the remaining wires at 200 mm spacing for a total height of 1200 mm indicated as HT-1 Fences.

741.35.02 Post and Brace Installation - Fence posts shall be driven in place with equipment acceptable to the Quality Manager and set out in general accordance with the recommendations of the B.C. Ministry of Agriculture and Food (BCMAF) Publication #ISBN 0-7719-9824-4, good local trade practice and to the Quality Manager's direction.

Terminal (end and gate) tensioning assemblies and any intermediate assemblies shall be "single" assemblies and at the spacings and post bury depths indicated by Drawing SS SP741-03.02 (or such greater depths and/or decreased spacings as may be directed by Designer) with "double" assemblies used with scant bury depths all to form rigid, stable and accurately aligned assemblies for tensioning line wires.

Line posts 100 mm minimum diameter driven to a depth of not less than 650 mm in firm soil, or as otherwise required by Drawing SS SP741-03.01, or directed, shall be spaced up to a maximum of 15 m where permitted, but normally at 10 m spacing and such closer spacing at changes in horizontal and vertical alignments to keep the bottom wire at the regular specified ground clearance.

741.35.03 Wire and Dropper Installation - Wires shall be installed on the side of the fence posts away from the highway except on such curves requiring the wires on the highway side so as to bear on the posts.

Stapling doubled at curves, etc. and mechanical fasteners at tied-off ends and splices (where permitted) shall be to BCMAF recommended practice.

With supplied tensioning devices installed in each line, all wires shall be individually tensioned in stages and after "wire-set" to 1.33 kN (300#) at completion.

Droppers, as supplied, shall be installed and securely clipped to all line wires at 3 to 4 m spacing.

741.36 Chain Link Type D Fences and Gates

741.36.01 Post and Rail Installation

i) All terminal posts (posts at ends, gates, corners and intersections), all line posts and any intermediate tensioning posts shall be set plumb into concrete footings in augered or dug holes to the depths and regular spacing all as shown on Drawing SS SP741-05.01, or as otherwise specified.

ii) Gate post sizes and stabilizing shall be as required by the Special Provisions and/or Drawing SS SP741-05.03.

iii) On exposed rock, posts shall be set without concrete footings to full depth and fully grouted in holes, 25 mm greater than the pipe diameter, drilled to a depth into solid rock of half the depth of pipe bury to that indicated for concrete footings on Drawing SS SP741-05.01 (i.e. c/2 and f/2).

Grout shall be non-shrink cement and sand mortar. Standard length posts may be used where the overburden depth is such that the depth of bury into solid rock is less than that specified above, provided normal diameter concrete footings of the diameter indicated on Drawing SS SP741-05.01 are formed from solid rock to grade level. Similarly, form concrete footings for posts set in loose or friable rock. Sleeves shall be provided to form holes similar in diameter and depth to above for casting into concrete where shown or specified.

iv) Tops of all posts shall be set or cut for an even height of top rail, which shall form a continuous brace and mesh support between terminal posts and any intermediate tensioning posts. Top rails shall pass through line post caps and be joined in the length with internal sleeves to allow expansion and contraction. All posts shall be fitted with appropriate weathertight caps securely fixed.

741.36.02 Bracing for Fence Tensioning - Bottom tension wire shall be securely fixed taut and sag free to terminal posts and any intermediate tensioning posts. Similarly, provide top tension wire, when specified, in place of top rail to pass through line post tops except on uneven terrain where the height of the top tension wire shall be such that it is secured to all line posts and the mesh within the top

300 mm of the mesh.

Terminal posts, where more than 10 m apart in any fence run, shall have horizontal pipe braces to adjoining line posts. Diagonal pipe braces may be called for where soil conditions warrant, especially where fencing without top rails is specified, but no pipe bracing is normally required for residential height fences.

Intermediate tensioning assemblies shall be provided where terminal posts are more than 150 m apart, and at any subsequent 150 m maximum spacing, to consist of a straining post (to full height of fence where barbed wire on extension arms is specified) with horizontal pipe braces at the mid to two-thirds height above grade to adjoining line posts each way for the discontinuity of top rail, tension and/or barbed wire and mesh; provide similar tensioning assembly at abrupt vertical alignment changes.

Horizontal alignment changes where abrupt shall be considered as corners.

At changes in horizontal alignment and to curved fence alignments, where the top rail can be continuous by accurately bending to proper curvature without damage to the galvanized coating, a pair of line posts shall be stabilized and tensioned as follows:

- A horizontal pipe brace shall be securely fixed to adjoining line posts at the two-thirds height above grade.
- Crossed diagonal wire braces shall each be two strands of 3.5 mm nominal diameter galvanized wire securely fixed to the brace band fixing of the horizontal brace and to a brace band 100 mm above grade.
- Each pair of wires shall be twisted taut to mutually stabilize the assembly with the tensioning battens left in place.

Similar requirements shall be maintained within any curved fence alignment over 30 m in length.

Fencing where continuous over a creek or ditch shall be stabilized with a horizontal pipe brace and diagonal brace wires as specified above, and the bottom tension wire shall be wire tied to a similar pipe brace. In addition, in-fill under where specified or required, shall be a hanging or rigidly fixed bent pipe of brace diameter hung or in-filled with closely spaced barbed wire or suitable fence fabric (similar to that indicated on Drawing SP741-04.03), all to the Designer's direction.

741.36.03 Fabric and Wire - Chain link fencing mesh shall be stretched between terminal posts and any intermediate tensioning posts with proper equipment (tensioning directly by truck or tractor will not normally be permitted), and secured with tension bars and bands, tie wire and clips all in

accordance with the requirements shown on Drawing SS SP741.05.02. The mesh shall be installed on the highway side of the fence posts, or as otherwise specified or directed, and joints in the length shall be made by weaving the meshes together with a single wire picket to form a neat continuous fabric mesh.

Security barbed wire, where specified, shall be installed in the slots of all extension arms and secured to extended height terminal and any intermediate tensioning posts taut and free of sag.

741.36.04 Gates - Hardware, of design to permit the gate to operate correctly, shall be securely attached to prevent the easy removal of the gate and hardware. Hinged gates shall be installed to permit the gate to swing back one-way against the fence.

741.37 Wood Fences

741.37.01 Privacy Fences - Galvanized pipe posts shall be set plumb in concrete footings in augered or dug holes to the depth and regular spacing all as shown on Drawing SS SP741-06.02.

Wood fixing members for fence panels shall be securely nailed, "II-shaped" frames fixed and supported with 9.5 mm (3/8") galvanized bolts and nuts to pipe posts all as indicated on Drawing SS SP741-06.01.

Metal fixing members for fence panels, when specified, shall be of named or otherwise pre-approved proprietary brand or detailed formed metal channel and strap, bolted on around pipe posts and securely machine screwed and tapped at the correct levels all as indicated on Drawing SS SP741-06.03.

Fence panels of boards and stringers prestained, as specified, shall be prefabricated to the required design, as indicated by the Design, Special Provisions and/or Drawings SS SP741-06.01 through SS SP741-06.03, and shall be accurately fitted and securely nailed to fixing members on steel posts to form uniformly level and/or stepped fencing.

741.37.02 Noise Barrier Fences - Posts of indicated type, size and length shall be set plumb in concrete footings in augered or dug holes to the depth and regular spacing all as shown on the Design.

Stringers, to bear full width of post at each end of "alternating" or "zig zag" (on plan) panels, shall be securely bolted with large washers behind head and nut.

Planking shall be firmly secured to stringers with deformed shank nails to form close butted and battened or tightly overlapped vertical planked panels. All gaps, especially at bottom, shall not exceed 1% of the total area of the fencing. Ends of panels shall be closed over the gap between stringer and post with return plank material.

SECTION 751

TOPSOIL AND LANDSCAPE GRADING

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

DESCRIPTION

751.01 Scope - This Section refers to those portions of work that are unique to the supply and placement of topsoil and subsequent finish grading. In this Section, the term "topsoil" is used to identify either:

- a) On-Site topsoil: material stockpiled for use, or
- b) Imported topsoil, or
- c) Manufactured topsoil (Growing Medium).

751.02 Related Work - DBSS 754, Planting of Trees, Shrubs and Ground Covers; DBSS 757, Revegetation Seeding.

751.03 References - Canadian System of Soil Classification, Canada Fertilizer Act, Canadian National Master Specification.

751.04 Topsoil Supplied by the Contractor - The Contractor shall advise the Ministry Representative of the sources of topsoil not less than seven days before any is used in the work.

The Contractor shall acquire a soil analysis from an accredited soil testing laboratory, to verify that supplied material is within the requirements indicated.

MATERIALS

751.11 General - In this Section, a range of measurable physical and chemical properties are set out as being acceptable in a topsoil. Compliance with this Section shall be determined by testing for those properties. When imported or on-Site topsoil is used, it shall be tested and modified as necessary by a mixture of other components to bring its properties to within the range set in DBSS 751.16, or as stated in the Contract. Topsoil shall not be prepared or handled in an excessively wet or frozen condition, or in any manner in which structure is adversely affected.

751.12 Topsoil Types - Three topsoil types are described in DBSS 751.13 through DBSS 751.15. Regardless of origin, all types shall conform to DBSS 751.16.

751.13 On-Site Topsoil - On-Site topsoil may be used provided that it meets the standard set for imported topsoil and can be modified to meet the requirements set out for the specified topsoil. On-Site topsoil shall be defined as the existing "A" horizon containing accumulated organic matter. On-Site topsoil shall be tested prior to stockpiling.

751.14 Imported Topsoil - Imported topsoil shall be of a sandy loam or loamy sand texture (no less than 50% sand by weight) containing between 4% and 15% organic matter (dry weight basis).

Imported topsoil shall be free of propagules of plant species designated as noxious weeds under the BC Weed Control Act and Regulation and other perennial, weedy plants such as couch-grass, horsetail, broom, Japanese Knotweed and blackberry species.

At least 80% of imported topsoil shall pass a Tyler #10 sieve after appropriate crushing of structural units using accepted laboratory test methods.

751.15 Manufactured Topsoil - Manufactured topsoil is any soil or growing medium mixture whose chemical and physical properties fall within ranges required by this Section for a particular application.

Manufactured topsoil shall conform to DBSS 751.16 or as specified in the Contract.

751.16 Requirements For Topsoil - Commercial processing and mixing of topsoil components shall be done thoroughly by a mechanized screening process. No hand mixing shall occur. The resulting product shall be a homogenous mixture having the required properties throughout.

The general amendment of both natural topsoils and manufactured topsoils by mixing in situ with rototill cultivation equipment after placement is an acceptable method. Fertilizers typically used at time of seeding or planting will be surface applied and incorporated as described in DBSS 751.33, Applying Fertilizers.

The Contractor shall also require the laboratory to include recommendations for incorporating fertilizers and other amendments into the topsoil as needed for plant establishment and maintenance, and as they specifically relate to:

- grassed areas
- ground covers, shrubs and trees
- container or planter box installations, and to site conditions and season of planting.

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Refer to Table 751-A for required properties of growing medium for different applications.

Other specific requirements are as follows:

Fertility :

- Nitrogen - total nitrogen shall be 0.2% to 0.6% by weight.
- Phosphorus - available phosphorus shall be 20 to 100 ppm.
- Potassium - available potassium shall be 50 to 250 ppm.
- Boron - concentration in saturation extract shall not exceed 1 ppm

General:

- Acidity - in accordance with Table 751-A. Maximum of 0.5 kg/m² of dolomite lime to achieve the required pH level.
- Salinity - saturation extract conductivity shall not exceed 3.0 mmho/cm at 25 degrees C. Sodium absorption ration (SAR) as calculated from analysis of saturated extract shall not exceed 8.0.
- C/N ratio - carbon to nitrogen ration shall not exceed 40:1.
- Texture - in accordance with Table 751-A.
- Organic content - in accordance with Table 751-A
- Cedar or redwood sawdust shall not be present in the topsoil.
- Soil shall be virtually free from subsoil, wood including woody plant parts, weeds, toxic materials, stones over 30 mm, and foreign objects.
- Drainage - in accordance with Table 751-A. Drainage of growing medium can be measured only after growing medium is in place. Mixing and handling of growing medium shall be done in such a manner that the minimum saturated hydraulic conductivity indicated is achieved.

751.17 Soil Amendments - The following amendments shall be added to the topsoil as required.

751.17.01 Peat Moss - Peat moss shall be Horticultural grade, partially decomposed fibrous or cellular stems and leaves of sphagnum mosses with a texture varying from porous to spongy fibrous, fairly elastic and substantially homogeneous with pH value not less than 3.5 and not greater than 6.5, medium to coarse shredded, suitable for horticultural purposes.

751.17.02 Sand - Sand shall be clean river pump sand or alternative suitable source, free of impurities, chemical or organic matter.

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Particle size in sand shall be as follows:

- 95 - 100% passing a 4.75 mm sieve;
- 0 - 40% passing a 0.600 mm sieve;
- 0 - 5% passing a 0.075 mm sieve.

751.17.03 Manure and Compost - Manure shall be well-rotted farm animal manure or mushroom manure, rotted to the extent that the material is crumbly. Manure shall be free from weed seeds, rocks, sticks, rubble and shall contain not more than 40% composted sawdust, straw or shavings. Manure shall be free of propagules of plant species designated as noxious weeds under the BC Weed Control Act & Regulation and other perennial, weedy plants such as couch-grass and horsetail.

Commercial compost shall be free from all weed seeds, coliform, pathogens and chemical or toxic contaminants. Physical contaminants such as rocks, plastic, metal or glass shall be less than 0.5%. Compost shall not be derived from or contain processed municipal sewage sludge, unless such product is authorized for use by the Ministry of Environment, and meets all local regulations and approvals.

751.17.04 Wood Residuals - Raw sawdust and woodwaste are not acceptable components of topsoil. Wood residuals used as a component of topsoil, compost, farm animal manure or mushroom manure are acceptable provided they are rotted and the total Carbon to total Nitrogen ratio for the topsoil is a maximum of 40:1.

751.18 Fertilizers - Fertilizers shall be standard commercial brands, meeting the requirements of the Canada Fertilizer Act.

All fertilizers shall be in granular, pelleted or prill form, and shall be dry, free-flowing and free from lumps.

Fertilizers shall be packed in standard waterproof containers, clearly marked with the name of the manufacturer, weight and guaranteed analysis.

All fertilizer shall be stored in a weatherproof storage place and in such a manner that it will stay dry and its effectiveness will not be impaired.

The types, formulations, and rates of application for fertilizers and liming agents to topsoil supplied by the Contractor shall be as recommended by a laboratory soil specialist on the basis of tests of the topsoil.

751.19 Fill Material - Fill Material shall not be toxic to plant and animal life in part or in concentration.

TABLE 751-A PROPERTIES OF TOPSOIL FOR DIFFERENT APPLICATIONS

PROPERTIES	Low Traffic Lawn Areas and Trees and Large Shrubs	Planting Areas, Planters, Shrub and Groundcover Areas
TEXTURE: Particle size classes by the Canadian system of soil Classification	Percent of Dry Weight Mineral Fraction (%)	
Gravel greater than 2 mm, less than 30 mm	0 - 10	0
Sand greater than 0.05 mm, less than 2 mm	50 - 70	50 - 70
Silt & Clay combined	Maximum 25%	Maximum 25%
ACIDITY (pH)	6.0 - 7.0	4.5 - 6.5
DRAINAGE: Minimum saturated hydraulic conductivity (cm/hr) in place	2.0	2.0
ORGANIC CONTENT: Percent of Dry Weight (%)	5 - 10	14 - 20

CONSTRUCTION**751.31 Area Preparation**

751.31.01 Stripping of Topsoil - Existing top soil material shall be stripped and removed to stockpile(s) within the project area, kept properly drained, and maintained in a neat and presentable condition free of spoil and subsoil material for subsequent spreading on prepared rough graded areas.

The storage of topsoil shall not interfere with the effective utilization of a granular source or borrow pits.

751.31.02 Preparation of Landscape Area Subgrade - This Section applies only to grading of landscaped areas outside the roadway prism.

Rough grading shall be carried out by necessary cutting and filling work to produce the lines and grades shown on the Design and allowing for the stipulated new topsoil

thickness.

Surplus excavated material shall utilized on-Site in accordance with the Design or shall be removed from the Site and disposed of at the Contractor's expense

The landscape area subgrade shall be prepared to a consistent 80 - 85% Proctor density.

Soft and unstable areas below the landscape area subgrade that cannot be compacted to this standard shall be excavated and filled with suitable fill material, except in locations where special environmental conditions have been identified. In such cases, appropriate alternative solutions shall be approved by the Ministry Representative and environmental agencies as required and carried out.

Debris, roots, branches, stones, building material, contaminated subsoil, visible weeds and anything else that may interfere with the proper growth and development of the planned finished landscaping shall be removed.

Fill materials shall be placed so as to achieve stability. This may necessitate placing in lifts of 225 mm and compacting each layer to 80 - 85% standard proctor density.

Grade transitions of landscape area subgrade should be smooth and even and shall be such that ponding cannot occur on the landscape area subgrade surface.

Existing land forms shall be warped and blended into the landscaped areas with a minimum of visual disharmony.

751.31.03 Fine Grading - Areas requiring topsoil shall be fine graded by raking out spoil material and debris such as rocks, asphalt and concrete over 50 mm in diameter.

Naturalized areas not requiring topsoil shall be similarly cleaned, raked and manicured.

751.31.04 Scarifying - All landscape area subgrade shall be scarified to a minimum depth of 150 mm immediately before placing topsoil.

751.31.05 Cleanup - All unsuitable material and inorganic debris shall be removed from the project area by the Contractor.

All surplus or unsuitable organic waste and debris shall be removed from the Site unless its complete burning is approved by the Ministry Representative in compliance with the B.C. open burning regulation.

751.32 Placing Topsoil - The landscape area subgrade shall be appropriately prepared prior to placing of topsoil

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The topsoil shall be:

- placed over the prepared landscape area subgrade and shall be allowed to settle or be compacted by light rolling such that it is firm against deep footprints and shall not be compacted more than necessary to meet this requirement;
- moist (25% to 75% of field capacity) but not wet when placed, and shall not be handled if frozen or wet such that its structure will be altered;
- manually spread around trees, shrubs and obstacles;
- evenly spread to a depth which after settlement or light compaction will be that shown in the Design .
- During hauling and spreading, the paved roadway and other finished surfaces including subgrade under future base courses shall be kept clean and free of all topsoil.

751.33 Applying Fertilizers - Fertilizers shall be added to bring topsoil fertility within the ranges set out in this Section or as specified in the Design.

Manufactured topsoils and processed imported topsoils will typically have fertilizers and amendments incorporated at the time of mixing and screening, while other topsoils will receive in situ amendment.

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Fertilizers normally applied at the time of seeding and planting are specified under the appropriate sections. These fertilizers are generally supplemental to the base fertility requirements outlined for topsoil and are applied after topsoil is in place.

Surface applied fertilizers shall be evenly spread over the topsoil with a suitable mechanical spreader and fully incorporated to a minimum depth of 50 mm.

Lime used for top dressing shall be thoroughly cultivated into the top 100 mm of topsoil.

751.34 Finish Grading - After placing the topsoil to the finish elevations and contours required, the grade shall be finished to a high standard, to the grades shown on the Design with a smooth and even surface. Rough spots and low areas shall be eliminated to ensure positive surface drainage, and the surface shall be left smooth, uniform, free of debris and firm enough to resist deep footprinting.

Topsoil placed in traffic islands and medians shall be crowned for drainage, as shown on SS Drawing SP751-01.

SECTION 754

PLANTING OF TREES, SHRUBS, AND GROUND COVERS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

DESCRIPTION

754.01 Scope - This Section refers to those portions of the work that are unique to the supply and planting of trees, shrubs and ground covers, including seeded and sodded areas that are not designated for treatment under DBSS 757 "Revegetation Seeding". This Section must be referenced and interpreted simultaneously with all other Sections pertinent to the works described herein.

754.02 Related Work – DBSS 751, Topsoil and Landscape Grading; DBSS 757, Revegetation Seeding; .

754.03 References - Canadian Standards For Nursery Stock (Canadian Nursery Trades Association), BC Weed Control Act & Regulations, Canada Seed Act, British Columbia Standard for Turfgrass Sod.

754.04 Warranty

754.04.01 The Contractor shall warranty all materials and quality of work for a period of one full year from the Actual Completion Date.

754.04.02 The warranty includes replacing all plants as determined by the Ministry Representative which are found dead or failing during the entire warranty period. Replacements shall be made immediately unless otherwise directed by the Ministry Representative, and conditions of the warranty shall apply to all replacement seeding for one full growing season.

Approval of plant material at the source does not preclude rejection of non-conforming stock on the Site prior to, or after planting.

The warranty shall not apply to plants and planted areas damaged after Acceptance by causes beyond the Contractor's control, such as vandalism, "acts of God", "excessive wear and tear", or abuse.

MATERIALS

754.11 Source Quality Control - The Contractor shall notify the Ministry Representative of the sources of plant materials to be supplied at least two weeks prior to commencing the landscape work. All non-seed plant materials shall be made available for inspection at the nursery by the Quality Manager or Ministry Representative upon at least three days notice. Field grown material is not

to be dug prior to inspection.

Approval of plant material at the source does not preclude rejection of non-conforming stock on the Site prior to, or after planting.

Imported plant material shall be accompanied by all necessary permits and import licences, and shall conform to federal and provincial regulations.

It shall be the Contractor's responsibility to ensure that all regulations pertaining to the import of plant materials or their movement to or from a particular region of the province are adhered to, and all inspection certificates required by the Ministry of Agriculture and Lands are completed to the satisfaction of that Ministry.

754.12 Transporting Plants to Site

754.12.01 Dormant Period

Deciduous: Bare Root Stock (only in dormant period): Adequate protection shall be given in order to preserve moisture around the root system. For short transit period, four hours or less, maximum temperature in the truck shall not be above 20°C. In all cases, at all times, roots should be protected from frost, wind and sun (e.g., a closed van with wet straw or other suitable packing material protecting the roots). The temperature shall be maintained as uniformly as possible by mechanical means, or in any event to prevent frost damage to roots. The appropriate temperature range shall be between 1°C and 10°C.

Evergreens: It is recommended that root balls not be subjected to freezing temperatures below -5°C for a period longer than four hours. Plants shall be protected to prevent desiccation by wind and sun.

754.12.02 Non-Dormant period - Deciduous and Evergreen plant material shall be transported in a closed van or well-covered truck with a tarp or similar material in order to protect the leaves or needles from windburn. When in transit, with protection of a tarp cover only, it is recommended that foliage be sprayed with an antidesiccant. For the above material in transit for more than three days, it shall be unloaded and then stored away from direct sun for 24 hours to avoid leaf burning.

Sod shall be protected during transportation to prevent drying out and shall arrive at the Site in a fresh and healthy condition.

754.13 Unloading and Handling Procedures - Plants shall be carefully handled to minimize disturbance to root systems

and damage to stems and branches. Plants shall not be dropped to the ground when unloading. Plant material that is mishandled and showing evidence of damage to root balls, or undue damage and breakage to top growth will be rejected.

Plants are to be kept in a moist condition at all times. All plants shall be well protected against physical damage and desiccation until they are planted on the Site.

B.R. (Bare Roots) Stock: Roots shall be covered and protected immediately from frost, sun and wind.

Stock in Pots/Containers: Shall be handled as much as possible by pots only in order to reduce breakage of branches/leaves.

Balled & Burlapped (B & B) Material: Plants shall be handled by holding the root ball and supporting the stem to minimize disturbance to the root ball and damage to stems and branches.

Material in Wire Basket: Specimen trees shall be lifted and supported by the wire basket and not by the trunk.

All plants shall be promptly unloaded and their condition checked immediately upon arrival. Watering shall be provided as required and necessary pruning of minor breakage on branches performed.

Protection Against Stem and Branch Damage - During loading, transportation, off-loading and planting, all trees shall be protected against damage to stems and branches. This applies particularly to larger wire-basketed trees.

Bark shall be protected against chafing and cuts by providing a wrapping of cardboard, sackcloth or other material as appropriate and when required.

754.14 Storage

754.14.01 Storage During Growing Season - All plants in containers, balled and burlapped, or in wire basket, if not planted within three days, shall be stored in an upright position in an area providing even light and offering protection from wind and sun scald. Enough space shall be provided between plants so that light reaches all around to the bottom of the plant in order to avoid leaf burning when planted out.

Sod: Sod shall be installed as soon as possible after delivery. If there is a delay of more than 24 hours, the sod shall be properly stored and kept moist and cool until it is placed. Sod shall not be stacked more than three levels high while being stored.

Balled and Burlapped Material: Special attention shall

be given to the root ball, and unless weather is rainy or cool, root balls shall be protected by covering with material suitable to protect them from drying out (e.g. sawdust, peat moss, topsoil). Plants intended to be planted in the open shall not be kept stored in a building or any area of low light intensity for a period exceeding seven days. All plants shall be kept well watered and protected from heat and frost.

Containerized Plants: In extreme weather, freezing or high dry heat, the containers shall be buried in a protective medium. Plants intended to be planted in the open shall not be kept stored in a building, truck or any area of low light intensity for a period exceeding seven days during the growing season.

754.14.02 Storage During Dormant Period - Plants shall be cared for according to each plant's requirement for winter protection, and according to geographical location.

754.15 Plant Material

754.15.01 Species - Selection of species shall be as specified Contract and the Design. Every effort shall be made by the Contractor to obtain the plant material specified. Where evidence is submitted that a Contract-specified plant cannot be obtained, substitutions in kind, size and grade shall be made upon written approval by the Ministry Manager.

754.15.02 Origin and Requirements - All plant material shall be nursery grown stock or approved collected native plants unless specified otherwise. All nursery grown plants shall, as a minimum, comply with the Canadian Nursery Trades Association Specification "Canadian Standards for Nursery Stock" with respect to sizing, grading and quality.

Plants shall be true to name, type and form and shall be representative of their species and variety.

All plants shall be sturdy stock, with tree and shrub heights proportional to trunk caliper, overall plant width and size of root ball. Plants that are weak and thin, and those showing effects of being grown too closely together or poorly maintained, will not be accepted.

Plants shall be vigorous and healthy with normal, well developed branches and good fibrous root systems and be free from decay, physical injury, disease and insect damage and infestation.

In particular, conifers shall have a healthy, single leader with well shaped whorls of vigorous, newly growing branches and shall exhibit natural growth habit characteristic of the species and variety. Trees sheared as Christmas trees are not acceptable.

The root balls of dug material and the soil of containerized plants shall be free from pernicious perennial weeds. All balled and burlapped plant stock shall be supplied in biodegradable root ball sacking.

The search area for plants shall include, but not necessarily be limited to, the provinces of British Columbia, Alberta and the states of Washington, Oregon, California (northern portion), Idaho and Montana. All plant material being sourced from milder areas shall be properly "hardened off" prior to shipping and planting.

754.15.03 Nursery Grown Stock - All plants specified "Container" shall be grown for the length of time necessary to permit the roots to fill and hold the soil within the container, as required by the Canadian Standards for Nursery Stock.

Similarly, all field dug material will show evidence of having been root pruned to encourage fibrous root system development and resulting in root balls that retain their integrity during handling.

Forestry seedlings shall be supplied and handled in accordance with the requirements of the Silvicultural Manual, Ministry of Forests, Province of B.C., 1993. This manual can be found on the Internet at: <http://www.for.gov.bc.ca/hfp/pubs/silvman/index.htm>

All plant material shall be appropriately identified and individually labelled with weatherproof tags. In the case of small containerized plants such as ground covers and bundled bare root seedlings, which are supplied in large numbers, labelling shall be limited to identification of group lots.

754.15.04 Collected Plant Stock - The Contractor shall provide either permits or verification that permission was obtained for collecting native and/or introduced plant materials. Information shall be supplied on where, when and how collection was made.

All collected plant material shall have been grown and maintained in a nursery environment for a minimum of one growing season, unless, at the sole discretion of the Ministry Representative, certain species are approved for a lesser period of time. As for nursery grown stock, collected plants shall be held long enough prior to planting to allow roots to fill the container or the dug root ball and to retain the soil within.

Collected plant stock shall be appropriately labeled with weather proof tags for easy identification at the job site.

754.15.05 Seed - Seed quality and type shall conform to that specified in the Contract and Design

All other requirements are referenced in DBSS 757 Revegetation Seeding.

754.15.06 Sod - Sod shall be nursery grown, true to type and conform to the British Columbia Standard for Turfgrass Sod, and the general requirements of the Canadian Standards For Nursery Stock.

Sod grade shall be as specified in the Contract and Design.

754.16 Water - Water shall be clean and potable and shall be supplied by the Contractor.

754.17 Fertilizer - Fertilizer shall comply with the provisions of the Canada Fertilizers Act and Fertilizer Regulations. Fertilizer shall be supplied to the specifications in the Special Provisions.

754.18 Bark Mulch - Bark mulch shall be sized 25 mm and minus, Douglas Fir or Hemlock bark chips and fines, or a combination of both types and of the quality used for decorative landscape mulching purposes. It should be free of chunks and sticks, dark brown in colour and free of all soil, stones, roots or other extraneous matter.

754.19 Backfill Topsoil - Backfill topsoil for planting operations shall conform to the requirements of DBSS 751 - Topsoil and Landscape Grading.

754.20 Other Materials - When required, various other materials such as soil amendments, erosion control products, hydraulic mulches, etc. shall be supplied to the specifications in the Contract and Design.

CONSTRUCTION

754.31 Scheduling - Work shall be scheduled to meet the milestone dates provided in the Contract, and to ensure its execution meets the requirements of living plant material.

The work shall be co-ordinated with the schedule of other trades, and be well integrated with other specific requirements such as Sediment and Drainage Management Drawings, which may be provided for any given project.

754.32 Preplanting Operations - The Contractor shall ensure that all requirements of DBSS 754.11 through DBSS 754.15 have been met and that any minor damage to plant stock is taken care of through appropriate pruning or other measure. When conditions require it, the Contractor shall apply anti-desiccant to large conifers and deciduous trees that are in leaf. Application will be in accordance with the manufacturer's instructions for the particular product.

754.33 Location of Planting - Locations, quantities and spacing of trees, shrubs, vines and groundcovers as shown on the Design shall be considered approximate and may

SECTION 754

PLANTING OF TREES, SHRUBS, AND GROUND COVERS

require adjustment by the Contractor to meet field conditions. If underground obstructions are uncovered they shall be reported to Designer for resolution.

754.34 Area Preparation

754.34.01 Finish Grade Preparation - The Contractor shall verify that grades are correct.

754.34.02 Planting Beds and Grass Areas - Prepare planting beds and grass areas in accordance with DBSS 751 - Topsoil and Landscape Grading.

754.34.03 Planting Holes - Planting holes shall be dug in accordance with the specific requirements described below. The bottom of planting holes shall be scarified and loosened to a depth of 100 mm prior to placement of plants and backfill soil.

Subsoil, rocks, roots and extraneous material shall be removed from excavated material that will be used as planting backfill soil. Unsuitable or excess material shall be disposed of.

Holes dug by a mechanical tree spade shall have their sides scarified to loosen any compaction glazing caused by the blades. Planting holes shall be tested by filling with water. Inadequate drainage conditions permitting the retention of water in planting pits for more than 12 hours shall be rectified by the Contractor before proceeding with the work.

i) Free Draining Sub-Grade: Where the subgrade and existing native surface soils are of good drainage and of a non-compacted nature, planting holes shall be excavated and prepared to allow the following depth of topsoil backfill underneath and around the root ball:

- For plants up to and including 27 cm (#5) pot size - not less than 150 mm .
- For plants larger than 27 cm (#5) pot- size not less than 300 mm

ii) Poor Draining Sub Grade: Where the subgrade and existing native surface soils are of poor texture and conditions are generally compacted, planting holes shall be excavated and prepared to allow the following depth of topsoil backfill underneath and around the root ball:

- For plants up to and including 27 cm (#5) pot size not less than 300 mm
- For plants up to 45 cm pot size - not less than 450 mm
- For tree root balls larger than 45 cm - not less than 600mm

If severely compacted conditions are encountered, and surface or ground water entering the excavations does not drain, the Contractor shall correct the problem by;

- providing a means of sub-surface drainage
- utilizing elevated planting techniques where some of the planting soil will be placed into a partial excavation and the remainder on the surface to meet the depth requirement for growing medium, or
- considering alternate planting sites.

754.35 Time of Planting - All planting operations shall be performed during the normal planting season for each type of material, and within the milestone dates provided in the Contract, unless otherwise authorized in writing. During the specified timeframe, plant operations shall, as far as practicable, take advantage of soil and weather conditions favourable to the work.

Planting into frozen ground is not acceptable.

754.36 Planting Procedures - Trees and Shrubs

General Procedure - Plants shall be installed so that after settlement they will be at the same planting depth they were at in the field or in containers. The soil mark on the stem is an indication of this, and it shall be flush with the finished level allowing for settling of the topsoil after planting and settlement. The entire root ball shall be covered with growing medium.

Once the bottom of the planting hole is scarified and the initial lift of backfill topsoil is placed, the holes shall be pre-watered and allowed to drain prior to installation of plant material.

Plants shall be set plumb in the planting beds or in the centre of the pits except where the plant's character requires variation from this.

The growing medium shall be placed in layers around the roots or ball, preferably by hand. Each layer shall be firmed to eliminate air void and ensure good soil contact with the roots. The process shall be carried out carefully to avoid injuring the roots or ball, or disturbing the position of the plant.

Trees requiring staking shall have support stakes placed carefully between the roots before backfilling. Specifications for tree supports are described in DBSS 754.

After the planting hole is filled with soil to ground level, the plant shall receive a thorough watering. A final backfill layer shall be applied to form a saucer-like berm around the circumference of the planting hole in order to catch and hold rainwater. This rain basin shall be maintained until final acceptance of the work.

Once planting and mulching is complete, the Site shall be cleaned of all excess soil, rock and debris.

Specific Planting Requirements:

Bare Root Stock - The roots of bare root plant material shall be soaked in water prior to planting. During installation, the plant roots shall be evenly spread out over a cone of soil in the bottom of the hole, and the plant supported to the correct depth as backfilling takes place. The plant shall be gently shaken in a vertical motion to ensure that soil particles sift into the root system and establish close contact with the roots

Container Stock - Non-perishable, impervious containers such as plastic pots and tubs shall be removed from plants before planting. Once plants are removed from these containers, root systems shall not be disturbed with the exception of unraveling any roots starting to spiral around the root ball.

Bio-degradable containers such as peat or paper fibre pots shall not be removed before planting, but shall be thoroughly soaked with water prior to placement in the holes. This will ensure that containers absorb subsequent watering and not repel it due to the presence of a dry barrier. The rim of such containers shall be not be exposed to the air, and when necessary, shall be removed after planting.

Balled and Burlapped Stock - When backfill soil is placed to approximately two-thirds of the root ball height, the ties on the sacking shall be cut and the top portion of the burlap folded back carefully to avoid disturbing the integrity of the root ball. The sacking shall not be removed. The remainder of the hole will then be backfilled and firmed.

Where wire baskets are used to encase and support the root ball of supplied plant material, these shall not be removed. The top of the wire basket shall be cut away or completely folded back and buried without disturbing the integrity of the root ball.

Forestry Seedlings - Planting of forestry seedlings shall be in accordance with the Silvicultural Policy and Procedures Manual, Volume 3, of the British Columbia Ministry of Forests and Range.

Tree Support - All trees of a size requiring staking or guy wiring shall be supported in accordance with the details and instructions provided on SS Drawings SP754-04 through SP754-07. All hardware required shall be installed without damage to plants.

Trees that are dislodged during the Contract period shall be uprighted and re-secured as required. Trees that are damaged shall be replaced by the Contractor.

754.37 Seeding - Application of seed, fertilizer, and other materials shall be at the rates specified in the Special Provisions.

The requirements for construction shall be in accordance with DBSS 757 Revegetation Seeding.

754.38 Sodding - The required fertilizer shall be applied at the rates specified in the Contract and Design, and worked well into the topsoil prior to laying the sod.

Sod shall be laid within 24 hours after delivery unless proper storage arrangements can be made.

The sections of sod shall be laid close together with joints staggered. No open joints are to be visible, and no pieces are to overlap.

Sod shall be laid smooth and flush with the adjoining grass areas, adjacent hard surfacing, and the tops of curbs and planting bed liners, unless otherwise shown on the Design. All necessary cutting shall be done using sharp implements.

On slopes of approximately 2.5 to 1 and steeper, the sod shall be laid lengthwise across the slope, and the material secured with wooden stakes driven flush with the sod at intervals not exceeding 0.5 metres. There shall be at least three stakes per individual sod piece. On slopes of gradients between 2.5 and 1.5 to 1, the bottom three rows of sod and every third subsequent row shall be secured with stakes. For slopes steeper than 1.5 to 1, every sod course shall be staked.

Sodded areas shall be rolled or suitably tamped to ensure a good bond with the topsoil, and then subsequently protected from heavy foot traffic or equipment travel.

Unless otherwise indicated, sodded areas shall be evenly watered within 12 hours of installation, and with sufficient quantity to saturate the grass and the upper portion of the topsoil.

754.39 Watering - All trees, shrubs, groundcovers, vines, and designated grass areas, shall be watered immediately after planting, and regular watering shall continue as required for plant health until final acceptance of the work.

754.40 Pruning - Pruning shall be limited to the minimum necessary to remove dead or injured tissue and branches interfering with desirable growth habit and overall health of the plant.

Pruning shall be done in accordance with proper horticultural practice, using clean, sharp tools appropriate to the task and in a manner that preserves the natural character of the plant.

754.41 Mulching - When specified in the Design or the Contract, individual tree pits and planting beds shall be mulched.

SECTION 754

PLANTING OF TREES, SHRUBS, AND GROUND COVERS

Mulching of tree pits and planting beds shall be carried out after watering, to an even depth of 50 mm after settlement, unless otherwise specified on the Design or the Contract.

754.42 Clean-up - All plant containers and waste materials resulting from landscaping and planting operations shall be removed from the Site and appropriately disposed of.

754.43 Conditions for Acceptance - The Contractor shall ensure that the following conditions are met for all planted and grassed areas:

- a) Topsoil quality, fertility levels, depths and surface conditions are as set out in the Design and Contract;
- b) All plants are of the species and varieties specified and planted in the locations shown on Design;
- c) All plants are healthy and growing vigorously. Seeded grass areas are sufficiently established into the underlying growing medium, are free of thin and bare patches, and are relatively free of weeds: not more than 5% in lawn areas, and not more than 15% in rough grass areas;
- d) The water content in the topsoil is adequate, i.e. – when irrigation is provided,
- e) Trees are supported, as specified;
- f) Pruning is complete, in accordance with proper horticultural practice and to the satisfaction of the Designer and Quality Manager;
- g) All planting beds and tree pits are free of weeds;
- h) Mulch is in place, as required and;
- i) Unmulched areas are cultivated to leave a loose, friable, water-permeable surface;
- j) Maintenance procedures set out in DBSS 754.71 have been carried out.

MAINTENANCE

754.71 Maintenance - The following maintenance operations shall be performed as required, from the time of landscape installation, until the Actual Completion Date :

- a) Water shall be applied in sufficient quantity and by appropriate method to maintain optimum soil moisture conditions for healthy plant establishment, without

causing surface soil erosion.

- b) Weed control will be carried out, as required to prevent competition with establishing planted material and to maintain the aesthetic appearance of landscaped areas. The presence of weeds in plantation beds, individual planting pits, and designated lawn areas, is limited to a maximum of 5% of the surface area at any given time, unless otherwise stated in the Contract. The use of herbicides for the control of weed growth is not permitted.
- c) Mowing shall be carried out at regular intervals, as required, to maintain grass in the areas designated, and at the height(s) specified in the Contract. Edges of areas designated “Lawn” shall be neatly trimmed. Excess clippings shall be removed immediately after mowing and trimming.
- d) Fertility levels in planted and grassed areas shall be maintained in accordance with the requirements of the plant material.
- e) Bark Mulch shall be maintained to the depth specified in the Design.
- f) For non-mulched areas, the soil surface shall be cultivated, as required, to keep it loose and friable.
- g) Insect and disease control shall be carried out as required. The Contractor shall secure all necessary Pesticide Use Permits in accordance with Ministry of Environment regulations, and possess a valid Pesticide Service License. When required, the Contractor shall provide a Pest Management Plan to MoE.
- h) Establishment pruning to encourage proper shape and health of plants by removing dead, or broken and interfering branches and diseased or damaged tissue.
- i) Maintenance of tree stakes, guy wires and tree ties to prevent plant dislodgement and damage to trunk and branches.
- j) All plant material shall be alive and maintained in a healthy growing condition during the entire establishment period. Plant material which has died or is not healthy, and does not perform its function, shall be removed and replaced by the Contractor at the earliest opportunity, weather and season permitting. Grassed areas that show deterioration or bare spots shall be repaired immediately. All repair and/or replacement shall be in accordance with the original specifications and requirements.

SECTION 757

REVEGETATION SEEDING

DESCRIPTION

757.01 Scope - This Section refers to those portions of the work that are unique to the supply and application of seed, fertilizer, mulch, tackifier, and other materials used for revegetating disturbed areas, and that are not designated for treatment under DBSS 754, Planting of Trees, Shrubs, and Ground Covers. This Section must be referenced and interpreted simultaneously with all other Sections pertinent to the works described herein.

757.02 References - Guidelines for Hydroseeding in Proximity to Hydro Lines, Canada Seed Act, and BC Weed Control Act & Regulation.

MATERIALS

757.11 Handling and Storage - All seed, mulch, fertilizers and other dry materials shall be stored in a dry, weather proof storage place and shall be protected from damage by heat, moisture, rodents or other causes until the time of seeding. Supplier labels or other identification are not to be removed or defaced.

757.12 Seed

757.12.01 Supply of Seed - All seed specified shall be supplied by the Contractor and obtained from a recognized source.

757.12.02 Seed Type and Grade - All seed supplied either as individual species, or as a seed mix, shall comply with the requirements of the Canada Seed Act and Regulations, and the grade standards for that particular crop kind. Grass and legume seed shall meet or exceed Common No.1 grade prior to mixing with other species. Seed shall be free of propagules of plant species designated as noxious weeds under the BC Weed Control Act & Regulations.

All legume seed shall be inoculated with an adapted bacterial culture to ensure nitrogen fixation.

Seed mixes used for general roadside revegetation, and for the general conditions and areas indicated, shall be as shown on the table "Standard Grass Seed Mixes For Revegetation of British Columbia Highway Roadsides", unless otherwise specified in the Contract.

When specified, wildflower and shrub seed shall be supplied to the requirements of the Contract and Design.

757.12.03 Seed Analysis Report - The Contractor shall provide valid Certificates of Analysis for each species and seed lot used in a mix. These shall set out details of the seed as specified in the "Canadian Methods and Procedures for Testing Seed".

757.12.04 Packaging and Labelling - Seed shall be supplied in the original sealed packages, with legible labels securely attached, and providing the following information:

- Supplier's name and address
- Analysis of seed mixture – the grade, and the name and percentage by weight of individual seed species
- Percentage of Pure Live Seed (PLS) for each species
- Lot number and crop year for each species in the mix
- Net weight (mass)
- Date and location of packaging

757.13 Fertilizer - Fertilizer shall comply with the provisions of the Canada Fertilizers Act and Fertilizer Regulations. Fertilizer shall be supplied as noted on the table "Standard Grass Seed Mixes For Revegetation of British Columbia Highway Roadsides" unless otherwise specified in the Contract.

757.14 Hydraulic Mulch - Hydraulic mulch shall be a wood fibre type, specifically designed for hydraulic seeding, and having demonstrated satisfactory past performance for this purpose. The product shall be dyed green for appearance and ease of monitoring application.

Mulch shall be supplied in packages bearing the manufacturer's label, clearly indicating the weight and product name.

Mulch may contain a tackifier, which shall adhere to mulch to prevent separation during shipment and to avoid chemical agglomeration during mixing in hydraulic mulching equipment.

757.15 Water - Water used for hydraulic seeding operations shall be free of impurities that would inhibit germination and growth or may be harmful to the environment. Unless otherwise noted in the Contract, the Contractor shall be responsible for securing a water source for hydraulic application of materials, including obtaining use permits under the Water Act if water is to be drawn from waterbodies, and for all cost to supply.

757.16 Other Materials - Tackifiers, Bonded Fiber Matrix coverings, erosion control blankets, soil amendments and other materials shall be supplied to the specifications in the Contract.

EQUIPMENT

757.21 General - Equipment used shall be capable of applying the materials uniformly over the designated areas.

Equipment shall not cause soil rutting or other site damage.

757.22 Hydraulic Seeding/Mulching Equipment -

Equipment shall have the tank volume identified by an identification plate or sticker, which shall be affixed in plain view.

The hydraulic seeder/mulcher shall be capable of sufficient agitation to mix the materials into a homogenous slurry, and to maintain the slurry in a homogeneous state until application.

Equipment shall be adequately sized to the task, to complete work efficiently within the time frame specified, and to permit application of materials without excess water being applied, or undue time lapse between operations. Hydraulic mulchers should be capable of producing slurry viscosities containing approximately 18 to 30kg of mulch per 500 litres of water.

Extension hoses or pipes shall be provided to reach areas not accessible from the hydraulic seeder.

CONSTRUCTION

757.31 Scheduling - Work shall be scheduled to ensure a minimum duration of on-Site storage of materials, minimum compaction of topsoil, and prompt mulching operations.

The work shall be co-ordinated with the schedule of other trades, and be well integrated with specific requirements such as Sediment and Drainage Management Plans, which may be provided for any given project.

757.32 Protection - Existing Site equipment, roadways, landscaping, reference points, monuments, markers, utilities and structures shall be protected from damage.

757.33 Timing of Material Application - Material application shall be carried out in accordance with the milestone dates provided in the Contract, and after fine grading has been completed and the areas prepared.

757.34 Methods - The methods chosen for material application shall be at the Contractor's discretion, unless otherwise specified in the Contract.

757.35 Rates of Application - Application of fertilizers, seed mixtures, mulch and other materials shall be at the rates specified in the Contract and by the Designer.

757.36 Record of Application - The Contractor shall maintain a record of all pertinent application information on the form supplied by the Ministry for this purpose, or similarly provided by the Contractor. Refer to Sample Form "Daily Seeding/Application Record".

757.37 Application Method for Mechanical Drop or Broadcast Dry Seeding - Seed shall be applied in two intersecting directions, except where conditions dictate seeding in one direction only.

Seeding shall overlap adjoining ground cover by 300mm.

Refer to the Contract for specific instructions for installation of wildflower, shrub and other seed as may be applicable.

757.38 Hydraulic Application of Materials

757.38.01 General - The hydraulic seeder/mulcher shall be operated in compliance with Ministry safety standards including those detailed in the publication "Guidelines for Hydroseeding in Proximity to Hydro Lines."

Materials shall not be sprayed on objects not expected to support plant growth.

The Contractor shall be responsible for any overspray or damages incurred during hydroseeding.

757.38.02 Mixing - The required quantities of seed, fertilizer, mulch, tackifier and other material shall be charged into the tank accurately by weight or by an acceptable system of mass calibrated volume measurement.

The materials shall be thoroughly mixed into a homogeneous water slurry prior to application.

All seed shall be added last when mixing. Pellet inoculated seed shall be applied immediately after placement into tank, and if this is not possible, dry application methods must be used. Other seed shall not be left in the tank for unreasonable lengths of time prior to application, i.e. – exceeding one or two hours, particularly when in contact with fertilizer solution.

757.38.03 Application - The mulch and tackifier components of hydraulically applied mixtures will generally be applied in stages. The initial pass of the hydraulic seeder will distribute the correct amount of seed and fertilizer for the area being done, as well as up to one third of the required mulch/tackifier. The subsequent pass(es) will complete the mulching/tacking process to the required rate.

REVEGETATION SEEDING

SECTION 757

Mulch shall be applied to form an even, uniform mat blended 150 mm into adjacent vegetated areas or previous mulch applications.

757.39 Related Work - Additional related work such as the application of erosion control blanket or other coverings, and harrowing or discing of soil following material application, shall be as specified in the Contract and by the Design.

757.40 Clean-up - All surplus and waste materials resulting from seeding operations shall be removed from the job site..

Hydraulic seeding and/or mulching overspray that may cause problems on areas or objects not designated for re-vegetation, shall be removed in an appropriate manner.

757.41 Not Used

757.42 Repairs - Seeded areas that show thin application or bare spots shall be re-treated with the specified materials at the Contractor's earliest opportunity, weather and season permitting.

MINISTRY OF TRANSPORTATION AND HIGHWAYS

SHEET # _____

PROJECT # _____

DAILY SEEDING/APPLICATION RECORD

DATE	LOAD #	AREA COVERED IN HECTARES			SEED APPLIED* (IN KG.)			OTHER MATERIALS* (IN KG.)			REMARKS
		GRASS	MULCH	REFERT	GRASS	RVE	OTHER	FERT	MULCH	TACK	
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										
	14										
	15										
	16										
	17										
	18										
	19										
	20										
	Total of Sheet										

**Provide details of seed mixes and other materials, as required, in this space:*

THIS SHEET CERTIFIED CORRECT:

FOR MINISTRY _____

FOR CONTRACTOR _____

DATE: _____

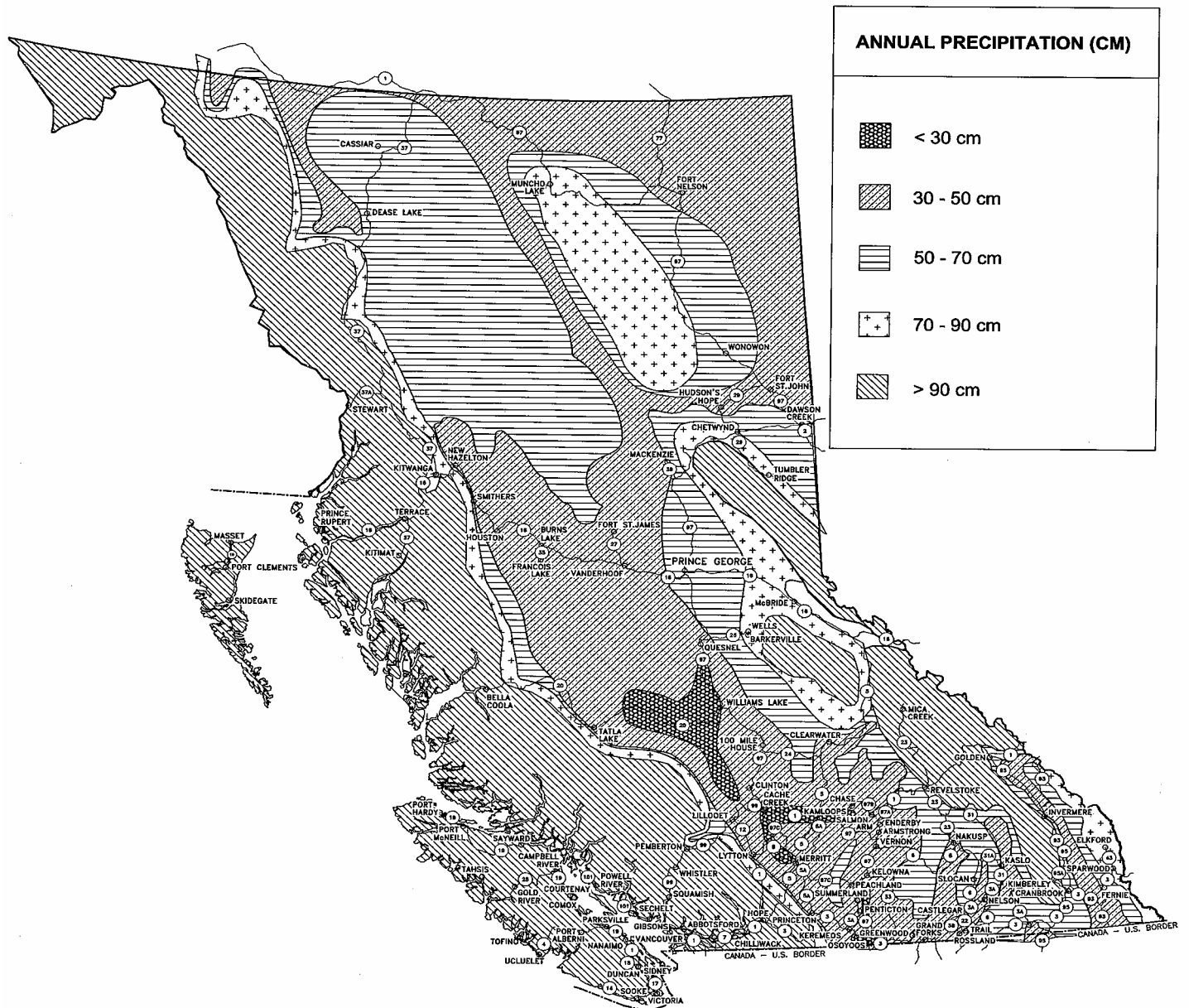
**STANDARD GRASS SEED MIXES FOR
REVEGETATION OF BRITISH COLUMBIA HIGHWAY ROADSIDES (BY WEIGHT)**

CLIMATIC AREA	STANDARD MIXES (by weight)	APPLICATION
South Coast	<u>Vancouver Island / Coast Mix</u> Perennial Ryegrass 26% Creeping Red Fescue 24% Alsike Clover 14% Hard Fescue 13% White Clover 9% Timothy 8% Canada Bluegrass 4% Redtop 2%	General seeding coastal locations where mean annual precipitation is > 90 cm. Fertilizer: 16-32-6
	<u>Interior Forestland Mix</u> Intermediate Wheatgrass 32% Alfalfa ("Rambler") 20% Perennial Ryegrass 15% Annual Ryegrass 15% Hard Fescue 10% White Dutch Clover 5% Canada Bluegrass 2% Redtop 1%	General seeding inland where mean annual precipitation is >50 cm. Fertilizer: 16-32-6
	<u>Interior Dryland Mix</u> Crested Wheatgrass 40% Tall Wheatgrass 25% Slender Wheatgrass 20% Hard Fescue 15%	General seeding inland where mean annual precipitation is < 30 cm. Fertilizer: 16-32-6
Thompson – Okanagan	<u>Interior Forestland Mix</u> Intermediate Wheatgrass 32% Alfalfa ("Rambler") 20% Perennial Ryegrass 15% Annual Ryegrass 15% Hard Fescue 10% White Dutch Clover 5% Canada Bluegrass 2% Redtop 1%	General seeding inland where mean annual precipitation is >50 cm. Fertilizer: 22-11-11
	<u>Interior Dryland Mix</u> Crested Wheatgrass 40% Tall Wheatgrass 25% Slender Wheatgrass 20% Hard Fescue 15%	General seeding inland where mean annual precipitation is < 30 cm. Fertilizer: 22-11-11
	<u>Alkaline Tolerant Blend</u> Crested Wheatgrass 35% Sherman Big Bluegrass 20% Hard Fescue 20% Canada Bluegrass 15%	General seeding in alkaline soils. Fertilizer: 22-11-11
Kootenays	<u>Interior Forestland Mix</u> Intermediate Wheatgrass 32% Alfalfa ("Rambler") 20% Perennial Ryegrass 15%	General seeding inland where mean annual precipitation is >50 cm.

CLIMATIC AREA	STANDARD MIXES (by weight)	APPLICATION
	Annual Ryegrass 15% Hard Fescue 10% White Dutch Clover 5% Canada Bluegrass 2% Redtop 1%	Fertilizer: 22-11-11
	<u>Kootenay Dryland</u> Tall Wheatgrass 45% Crested Wheatgrass 20% Alfalfa ("Rambler") 15% Hard Fescue 7% Sheep Fescue 5% Alsike Clover 5% Canada Bluegrass 2% Redtop 1%	General seeding inland where mean annual precipitation is < 50 cm. Fertilizer: 22-11-11
Northern (Prince George Area)	<u>North East General Mix</u> Smooth Bromegrass 40% Creeping Red Fescue 20% Timothy 15% Alfalfa 15% Alsike Clover 10%	General seeding inland where mean annual precipitation is > 50 cm. Fertilizer: 26-16-8
	<u>North East Dryland Mix</u> Crested Wheatgrass 35% Intermediate Wheatgrass 25% Alfalfa 15% Smooth Bromegrass 10% Creeping Red Fescue 10% Alsike Clover 5%	General seeding inland where mean annual precipitation is < 50 cm. Fertilizer: 26-16-8
Northern (Terrace Area)	<u>North West General Mix</u> Smooth Bromegrass 70.6% Alfalfa 18.0% Creeping Red Fescue 3.9% Alsike Clover 3.4% Timothy 2.9% Kentucky Bluegrass 1.1%	General seeding inland where mean annual precipitation is > 50 cm. For use in CWH and ICH biogeoclimatic zone. Fertilizer: 22-11-11

CLIMATIC AREA	STANDARD MIXES (by weight)	APPLICATION
	<p><u>Northern Coastal Mix:</u></p> <p>Alfalfa 46.6% Intermediate Wheatgrass 14.0% Smooth Bromegrass 10.3% Kentucky Bluegrass 9.0% Sheep Fescue 8.2% Birdsfoot Trefoil 6.2% Timothy 5.7%</p> <p><u>Northern Mix:</u></p> <p>Hairy Vetch 57.3% Crested Wheatgrass 16.4% Alfalfa 13.1% Creeping Red Fescue 5.3% Orchardgrass 3.8% Birdsfoot Trefoil 3.1% Kentucky Bluegrass 1.1%</p> <p><u>Ditch Vegetation Seed Mixture</u></p> <p>Crested Wheatgrass 38.7% Alfalfa 30.9% Creeping Meadow Foxtail 15.8% Birdsfoot Trefoil 6.9% Reed Canarygrass 4.8% White Clover 1.6% Kentucky Bluegrass 1.2%</p>	<p>General seeding coastal locations where mean annual precipitation is > 90 cm.</p> <p>For use in CWH biogeoclimatic zone (QCI, Prince Rupert to Pacific)</p> <p>Fertilizer: 22-11-11</p> <p>General seeding coastal locations where mean annual precipitation is > 90 cm.</p> <p>For use in ICH and BWBS biogeoclimatic zones.</p> <p>(ICH – Pacific to Moricetown, Kitwanga to Thomas Creek 220 km N)</p> <p>(BWBS – Thomas Creek to Yukon border)</p> <p>Fertilizer: 22-11-11</p> <p>For use in revegetating roadside ditches following ditch maintenance operations.</p> <p>Fertilizer: 22-11-11</p>
Vancouver Island	<p><u>Vancouver Island / Coast Mix</u></p> <p>Perennial Ryegrass 26% Creeping Red Fescue 24% Alsike Clover 14% Hard Fescue 13% White Clover 9% Timothy 8% Canada Bluegrass 4% Redtop 2%</p>	<p>General seeding coastal locations where mean annual precipitation is > 90 cm.</p> <p>Fertilizer: 18-18-18</p>

MEAN ANNUAL PRECIPITATION



SECTION 766

IRRIGATION

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

DESCRIPTION

766.01 Scope - The work consists of the supply of all material, labour and equipment to install a complete and operating irrigation system as shown on the Design. The Contractor shall be responsible for obtaining all permits required.

766.02 Site Security - The Contractor shall be responsible for maintaining all security at the project Site at all times, and shall ensure that no damage or breakage occurs to stockpiled materials or to the partially installed irrigation system. The Contractor shall make good all damage resulting from acts of vandalism throughout the period of installation and subsequent maintenance.

766.03 Electrical Trades - The Contractor shall contact the Electrical Trades Supervisor prior to performing work on any existing Ministry owned equipment. All AC electrical connections shall be done by a qualified electrician.

766.04 Drawings and Instructions - The Contractor shall install the irrigation system in accordance with the Design and the Contract.

The Contractor shall maintain a daily record of construction activities. Upon completion of the Contract, the Contractor shall incorporate all accumulated information relevant to the Contract into the required as-built Drawings. The as-built Drawings shall be reproducible, and shall be compiled by a competent professional draftsman.

The Contractor shall prepare drawings showing the final location and make of all heads, emitter locations, pipe layout, electrical information, wiring, controller station numbers, operating instructions, spare parts lists, and other pertinent information.

Completion will not be certified until adjustments and Drawings are approved.

766.05 References - Codes & Standards - In the absence of other instructions, the provisions of all the following codes and standards shall apply: The National Building Code of Canada; Current CSA Specifications for copper, steel and plastic pipe; AWWA Specification, current editions.

MATERIALS

766.11 General - Shipping, handling and installation of materials shall be to manufacturer's recommended instructions, and best work practice. Particular care shall be taken to avoid scratches and nicks on the plastic pipe. Pipe must be properly stacked and stored in a clean place on the Site, keeping dirt out of the pipe at all times.

766.12 Pipes and Fittings - Galvanized pipe, Schedule 40, with galvanized fittings, shall be used inside culverts. The pipe shall be connected to the plastic main or lateral 450 mm clear of the culvert.

Plastic pipe shall be used for the submain and laterals of the irrigation system. Plastic pipe shall be semi-rigid extruded from PVC (Polyvinyl Chloride) resin, Type 1, grade 2, normal impact.

The minimum classes to be used are listed in Table 766-A.

Fittings shall be PVC plastic, Schedule 40 or 80, designed for solvent welding to PVC pipe.

All fittings must have 1/2 to 2/3 interface fit to ensure a fully seated joint. Individual fittings shall be selected to ensure a proper fit or they will be rejected.

All pipe and fittings shall be continuously and legibly marked with at least the following information:

- Manufacturer's name or trademark;
- Pressure rating;
- Type of material.

Pipe that is not marked will be rejected and shall be removed from the Site by the Contractor.

766.13 Cement - Pipe cement for solvent welding shall be of the type and make recommended by the pipe manufacturer, supplied to the Site in sealed containers clearly marked with the name of the manufacturer and the lot number. The Contractor shall comply with the manufacturer's instructions and safety procedures.

766.14 Sprinkler Heads - Risers for turf heads, lawn heads, impact heads, shrub heads and quick-coupling (QC) valves shall be swing joint type, fabricated from Schedule 80 PVC or Schedule 40 galvanized pipe and fittings, as detailed in the Specifications. Teflon tape shall be used on all threaded connections.

Sprinkler heads shall be as detailed on the Design.

SECTION 766

IRRIGATION

TABLE 766-A MINIMUM CLASSES OF PLASTIC PIPE

Up to 25 mm diameter	Class 200 for excavated trenches
30 mm diameter and larger	Class 160 for excavated trenches
All sizes	Class 200 for pipe flow

766.15 Valves - Automatic valves shall be as detailed on the Design and the same make shall be used throughout. Automatic valves shall have flow control stems.

Valves shall be installed in Carson Industries No. 1419 valve boxes or other approved alternative complete with extensions and covers, as required. The top of all valve box covers shall be flush with the finished grade.

766.16 Controllers - Automatic controllers shall be supplied to operate the electrically controlled automatic valves. Controllers shall be 24 volt A.C. outlet, Class 2 rating, compatible with the valves used. Controllers and automatic valves shall be by the same manufacturer, unless otherwise noted. Controllers and transformers must bear CSA or Provincial stamps of approval. Controllers shall be as detailed on the Design.

Controllers shall be installed in Ministry standard controller box 30-A-120/240V, weatherproof, stainless steel service panel SN1765A as shown on SS Drawing SP635-2.4.8, or pre-approved equal complete with a Masterlock No. 15 padlock and two sets of keys for the lock.

766.17 Wiring - Wire between controllers and automatic valves shall be of a type approved for direct burial. Where control wires are exposed or pass through culverts, they shall be installed in rigid electrical conduit.

Wire shall be minimum 14 gauge single strand T.W.U.

766.18 Selected Native Fill - Native fill selected for backfilling shall be free of stones, gravel, wood or any other debris.

CONSTRUCTION

766.31 General - Damaged Material - Damaged material shall not be used. The Contractor shall take care to prevent dirt from entering the pipe.

Plastic pipe shall not be repaired by patching. Where pipe has been damaged, the damaged section shall be removed and a new section shall be installed complete with new fittings.

766.32 Line Location - The Contractor shall ensure that

all irrigation pre-ducts for passage of irrigation lines under roadways, medians, traffic islands and other surface impediments have been installed and are clearly marked at all entry points.

No irrigation line shall be installed parallel to and directly over another irrigation line or line of another trade. Lines laid in the same trench shall be a minimum of 50 mm apart. No pipe shall be installed closer than 300 mm to any parallel electric conduit as shown on SS Drawing SP635-1.5.2.

766.33 Compaction - Before laying the pipe, the Contractor shall be satisfied as to the extent of compaction in the lawn and planting areas.

766.34 Excavation - Excavated soil shall be carefully placed adjacent to the trench for convenient backfilling. Topsoil and subsoil shall be piled separately to avoid contamination of the topsoil.

Stones or other objects larger than 75 mm at their widest point shall be removed from the trenches. Holes below grade lines, caused by the removal of stones, must be filled in and compacted uniformly with the adjacent trench.

766.35 Laying the Pipe - Pipe shall be laid by trench excavation or by an approved vibrating pipe plough. Plastic pipe shall be laid on sand or selected native fill to a compacted depth of 50 mm. A further 75 mm of sand or selected native fill shall be placed over plastic pipes prior to backfilling. Pipes shall be run in straight lines between fittings. Pipe must not be supported at intermediate points on stones, bricks or other hard material.

All mains and laterals shall have a minimum cover of 400 mm of soil as measured from the top of the pipe to the finished grade.

Lawn and planting areas shall be disturbed as little as possible.

The Contractor shall manicure the finished grade over all mains and laterals upon completion of the pipe installation. All debris, rocks over 50 mm diameter, etc, that have been brought to the grade surface shall be removed to the Contractor's own tip. The area over all trenches shall be fine graded and shall conform to DBSS 751.34.

766.36 Connections - The Contractor shall make connection to the existing water supply where shown on the Design. The Contractor shall ensure that the recommended operating pressure of the irrigation system is not exceeded by the water pressure at the source, by installing pressure regulators as required.

766.37 Inspection and Testing - After the pipe is in place in the bottom of the trench with risers in place, the risers shall be capped where the sprinklers will be attached and all pipe fittings exposed. The maximum pressure shall be applied to the system and maintained for a minimum of one hour.

All fittings shall be visually inspected and any that leak

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shall be cut out and replaced. Leaks shall not be repaired by patching. The test pressure shall be maintained for one hour after replacing any defective sections. The section shall be re-inspected as before.

The system shall be flushed out to remove dirt and then the sprinklers shall be attached using Teflon tape or pre-approved non-setting pipe thread compound.

766.38 Backfill - After approval by the Quality Manager, the trenches shall be backfilled, maintaining pressure in the line. If there is any indication of a leak, the defective section shall be located and replaced.

The trenches shall be carefully backfilled with the subsoil, followed by the topsoil. Both shall be compacted to the same density as the soil in the trench walls to minimize differential settlement. Backfill around turf heads with 0.03 m³ of sand.

766.39 Controller Installation - The location of the controllers shall be determined on Site in the areas indicated on the Design. The Contractor shall have a qualified electrician connect the controllers to the electrical supply.

766.40 Adjustments - The sprinkler system shall be adjusted section by section to give satisfactory coverage to all areas. Pressure at the heads and/or Q.C. valves shall be as noted on the Design. Turf heads, lawn heads and Q.C.

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valves shall be set flush with the final turf grade by adjusting the swing joint riser, as required. During the landscape warranty period, the Contractor will return twice and adjust the heads, as required, to be flush with the final turf grade.

These callbacks shall be done within five days of notification by the Ministry Representative and shall be considered part of the Contract requirements.

766.41 Surplus Material - Surplus material shall be removed from the Site.

766.42 Conditions for Acceptance - Completion will not be certified until adjustments are completed, as-built Drawings prepared, and a copy of the inspection certificate issued by the Ministry of Competition, Science and Enterprise indicating compliance with the Electrical Code is provided.

766.43 General - The Contractor shall monitor the operation of the system and carry out all minor repairs and required adjustments to the spray coverage of irrigation heads and operating times.

The irrigation system shall be properly winterized at the appropriate time of the season.

SECTION 769

PROTECTION AND RETENTION OF VEGETATION

DESCRIPTION

769.01 Scope - This Section refers to the protective measures required to safeguard vegetation from construction operations, equipment and vehicles, where vegetation is not designated for removal under the Contract, and covers the installation of barriers.

769.02 Related Work – DBSS 165, Protection of the Environment; DBSS 200, Clearing and Grubbing; DBSS 201, Roadway and Drainage Excavation; DBSS 751, Topsoil and Landscape Grading.

769.03 Definitions

Specimen Trees - means trees so designated in the Contract Documents.

Native Vegetation - means areas of existing and/or indigenous shrubs, trees and groundcover.

Dripline - means the location on the ground surface directly beneath a theoretical line described by the tips of the outermost branches of trees.

Barrier - means fence consisting of approved material, supported by steel posts and being a minimum of 2.0 m high, without breaks or unsupported sections.

The Contractor's operations shall not cause flooding, sediment deposits or deposition of debris in "Vegetation to Remain" areas.

Where construction procedures substantially alter natural drainage patterns, interim drainage or irrigation shall be provided as necessary to compensate for construction interference.

Construction procedures, stockpiling of materials or debris burning or disposal shall not be undertaken adjacent to designated trees and/or native vegetation retained.

Unless the Contract requires work within the dripline of trees designated to remain, equipment shall not be operated within that dripline. When the Contract requires work within the dripline of trees designated to remain, operation of equipment within that dripline area shall be kept to the minimum necessary to perform the work required. Tree roots shall be protected from compaction by temporary placement of hogfuel or other lightweight insulative material, as required by the Designer or Quality Manager.

Equipment or vehicles shall not be parked, repaired or refuelled, construction materials shall not be stored and earth materials shall not be stockpiled within the dripline area of any tree designated to remain.

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769.11 Water - Water shall be free of impurities that would inhibit germination and growth or may be harmful to the environment.

The Contractor shall supply the water.

769.12 Fertilizer - Fertilizer shall be supplied to the specifications of the Contract and to DBSS 751.18.

CONSTRUCTION

769.31 Operational Constraints - The Contractor's operations shall not damage vegetation designated for retention.

Existing vegetation shown on the Design or designated in the Contract to be retained shall be marked by the Contractor.

Areas designated in the Contract or by the Design as "Vegetation to remain" areas are not to be disturbed, cleared or logged.

769.32 Clearing and Grubbing - No clearing and grubbing shall be conducted for a radius of 3 m from the trunks which lie on the edge of clearing and grubbing zones.

Trees to be removed shall be felled toward the centre of an area, away from selectively cleared or retained vegetation.

769.33 Barriers for Existing Vegetation Protection - Barriers for vegetation protection shall be erected prior to commencement of construction operations, at locations specified in the Contract or Design, to provide a continuous barricade between vegetation and the area of work. The barriers shall be maintained erect and in good repair throughout the duration of construction operations, and shall be removed upon completion of the work, and disposed of outside the project by the Contractor.

The barrier shall be placed at the dripline of trees or forest edges unless this is inadequate space to provide a 1.5 m buffer zone between the barrier and the limit of grading. The barrier shall be placed within the dripline if necessary to provide a buffer zone of up to 1.5 m. Under no circumstance shall it be placed less than 0.75 m from the circumference of the trunk. When the trunks of trees are

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less than 4.5 m apart, the trees shall be considered a group, and the barrier shall be placed to form a continuous barricade.

A barrier is not required where an existing fence will serve the same purpose. At such locations, the barrier shall terminate at the existing fence so that a continuous barricade is provided between the trees and the area of work.

769.34 Pruning and Repair of Specimen Trees -

Specimen trees and trees safeguarded by barriers shall be repaired as follows..

One third of the tree branches shall be selectively removed to reduce transpiration and compensate for dieback of roots in fill conditions and damage to the root system in cut conditions.

Within five calendar days of damage, branches 25 mm or greater in diameter that are broken as a result of the Contractor's operations shall be cut back cleanly at the break, or to within 10 mm of their base, if a substantial portion of the branch is damaged.

PROTECTION AND RETENTION OF VEGETATION

Roots 25 mm or larger in diameter that are exposed by the Contractor's operations, shall be cut back cleanly to the soil surface within five calendar days of exposure.

Bark that is damaged by the Contractor's operations shall be neatly trimmed back to uninjured bark, without causing further injury, within five calendar days of damage.

MAINTENANCE

769.71 Watering - The retained specimen trees shall be watered three times during the summer or as stated in the Contract or by the Design. The area immediately below the tree crown shall be soaked sufficiently to reach the feeder roots.

769.72 Fertilizing - Where specified, fertilizer shall be applied at a rate of 50 gr/mm of calliper to existing specimen trees to be retained. The calliper measurement shall be taken 0.3 m above the grade. The fertilizer shall be applied once early in the growing season unless specified otherwise.

SECTION 903

TIMBER - MATERIALS

903.01 General - All timber shall be graded in accordance with the current Standard Grading Rules of the National Lumber Grades Authority. Timber must be grade stamped with the exception of unfinished or rough timber, which may prove too difficult to stamp, in which case a grading certificate may be requested. Timber materials may be used in the completed Work only when explicitly identified in the Contract as an acceptable product.

903.02 Species and Grade - Timber species and Grade shall be as specified on the Design and in accordance with the Contract.

903.03 Inspection - All timber may be inspected before shipment to the construction site, or at the construction site, or both. The Contractor shall provide the necessary facilities to enable the Quality Manager and Ministry Representative to expeditiously examine as many pieces as are deemed necessary. All material rejected shall be replaced. Inspection of timber before shipment shall not be a bar to its subsequent rejection at the construction site if found to fail any requirements of this specification.

No material shall be shipped prior to inspection or until a release for shipment has been issued by the Quality Manager.

SECTION 904

TIMBER (TREATED AND UNTREATED) - FABRICATION AND HANDLING

904.01 General - All timber shall conform to the requirements of DBSS 903, Timber - Materials. Timber to be treated shall be treated in accordance with DBSS 908, Preservative Treatment - Wood Products. Except as modified herein, preservative treated wood products shall be handled in accordance with CSA Standard 080-M4.

Timber materials may be used in the completed Work only when explicitly identified in the Contract as an acceptable product.

904.02 Framing - All the cutting, boring, framing, match marking, etc. required on all timber shall be done by competent bridge framers in a thorough manner, in accordance with good work practice. It shall be done such that surfaces in contact shall bear evenly and fully; no shims or open joints are permitted. All measurements shall be accurate. Gains and daps shall have plane, smooth surfaces.

904.03 Bridge Iron - The Contractor will supply all iron that is necessary for use in the framing operations. Materials shall conform to the requirements of DBSS 911.

904.04 Handling of Untreated Timber - All materials shall be handled with reasonable care. Timber shall not be bashed, bruised, gouged, cracked, split or otherwise damaged. Minor damage, in the opinion of the Quality Manager and Ministry

Representative, shall be repaired; severely damaged materials will be rejected and replaced.

904.05 Preparation of Timber Before Treatment - All cutting, such as boring, chamfering, framing, gaining, surfacing, trimming etc., shall be done prior to treatment.

In the event that cutting becomes absolutely necessary after treatment, the cut surfaces shall be saturated with preservative according to CSA Standard 080-M4 Paragraph 1.5.

904.06 Condition After Treatment - After treatment, timber with checks exceeding the limiting sizes specified for the appropriate grade shall be rejected (see DBSS 903, Timber-Materials).

904.07 Handling of Treated Timber - Pointed tools or equipment such as dogs, hooks, peavies, etc. shall not be used on the side surfaces of treated timber. The use of pointed tools shall be confined to the end grain and shall be such as to avoid damage to the pressure-treated surface.

Treated timber shall not be dragged along any surface.

SECTION 905

TIMBER - GLUED LAMINATED

905.01 General - The requirements of the current CSA Standard 0122 - Specification for Glued Laminated Softwood Structural Timber shall apply to all glued laminated members. Wood species shall be as specified on the Design, except that if the members are to be pressure treated in accordance with CSA 080-28 (See DBSS 908) they may only be of Coast Region Douglas Fir or Western Hemlock.

Timber materials may be used in the completed Work only when explicitly identified in the Contract as an acceptable product.

905.02 Classification - Unless otherwise specified in the Contract and the Design, the appearance grade shall be Industrial and the service grade shall be Exterior. The stress grade shall be as shown on the Design.

905.03 Quality Control - Laminations shall be grade-marked and the marking shall be visible until the glue has been applied.

The shear tests described in Appendices "A" and "B" of CSA Standard 0122 shall be carried out by the Quality Manager. Copies of the shear test results shall be forwarded to the Ministry Representative if requested.

Vacuum-pressure cycle tests may be carried out by the Quality Manager, and the Contractor shall supply the Quality Manager with a full section cut-off, 75 mm long, from each end of the member for this purpose.

905.04 Incising - The end bearing surfaces of members shall be incised prior to pressure treatment.

905.05 Handling of Treated Glued Laminated Members - Members shall be protected to avoid damage due to handling: dogs, hooks, peavies or other equipment shall not be used on the side surfaces

of treated timber. All handling of treated timber with pointed tools shall be confined to end grain and shall be such as to avoid damage to the original pressure-treated surface.

Subject to the approval of the Quality Manager and Ministry Representative, the Contractor shall make good superficial damage of treated timber by the methods outlined in the current edition of CSA Standard 080 - Wood Preservation. Timber which, in the opinion of the Quality Manager or Ministry Representative, cannot be made good by such methods will be rejected.

905.06 Storage of Glued Laminated Members - Members lying in storage shall be supported evenly on a flat surface. When stored for a prolonged time, they shall be gapped to permit air circulation.

905.07 Inspection - All timber and all phases of the work including pressure treatment, if applicable, may be inspected by the Quality Manager or the Ministry Representative. The Quality Manager shall be given 48 hours notice of commencement of gluing and pressure treating, if applicable. The Contractor shall provide the necessary facilities to enable the Quality Manager or the Ministry Representative to expeditiously examine as many pieces as are deemed necessary by the Quality Manager or the Ministry Representative. All material rejected shall be replaced. Inspection of glued laminated timber before shipment shall not be a bar to its subsequent rejection at the Site if found to fail any requirements of the Contract.

No material shall be shipped prior to inspection or before a release for shipment has been issued by the Quality Manager.

SECTION 906

ROUND TIMBER PILES

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

906.01 Scope - This Section covers the quality and manufacture of untreated and pressure-treated round timber piles.

Round timber piles may be used in the completed Work only when explicitly identified in the Contract as an acceptable product.

Where convenient, the requirements contained in this Section use the wording of the current CSA Standard CAN3-056-M "Round Wood Piles", in particular for term definition (see Appendix A) and the majority of measurement and material requirements.

Preservative treatment of piles shall conform to the requirements of DBSS 908, Preservative Treatment - Wood Products.

906.02 Species

906.02.01 Untreated Piles - This specification does not restrict the species used for untreated piles except as may be specified in the Design or in the Contract.

906.02.02 Pressure Treated Piles - Species of piles to be pressure treated shall be as specified in the Design and in the Contract and restricted to those for which pressure treating

specifications are included in CSA Standard 080, Wood Preservation. Pressure treatment of piles shall be according to DBSS 908.

906.03 Size - The size of a pile shall be designated by length and either minimum and maximum butt diameter or minimum and maximum tip diameter, or both. Sizes of piles normally available are shown in Table 906-A.

906.04 Diameter

- a) All measurements of diameter shall be made inside the bark.
- b) The diameter of treated piles shall be measured after treatment.
- c) Butt diameters shall be measured at the extreme butt.
- d) Tip diameters shall be measured at the extreme tip.
- e) The diameter of a pile shall be determined either by measuring the circumference in millimetres and dividing the result by 3.14 or by taking the average of the maximum and minimum diameter.
- f) A variation of -15 mm in the diameter at the tip or at the butt but not in both, shall be allowed in not more than 25% of the piles when the specification of four or more piles is to be determined.
- g) If allowances are specified on the order, they shall

TABLE 906-A SIZES OF TIMBER PILES

Size Designation	36	33	30	27	24
Minimum Diameter at Extreme Butt or Large End (mm)	360	330	300	270	240
Length in Metres	Minimum Diameter at Small End Tip (mm)				
Up to 6	250	250	230	200	180
6 to 11	250	230	200	180	150
12 to 14	230	200	180	150	-
15 to 18	200	180	180	-	-
19 to 21	200	180	150	-	-
22 to 27	180	150	-	-	-
28 to 32	150	130	-	-	-

Note: Diameters are minimum except for tolerance permitted in DBSS 906.04 (f). Maximum diameter at butt shall not exceed 500 mm for any pile size.

SECTION 906

ROUND TIMBER PILES

supersede DBSS 906.04 (f).

906.05 Length

- a) Pile lengths shall be measured in metres.
- b) A variation of ± 150 mm from designated lengths will be permitted, unless allowable over and under lengths are stated on the order.

906.06 General Material Requirements - Piles shall be cut from sound live trees. Sides and end surfaces of the piles shall be free of ice, snow and mud, and exposed for visual inspection.

Untreated piles shall be sound and close-grained.

Treated piles shall:

- have not less than 25 mm sapwood, and shall be cleanly peeled;
- not be cored until 24 hours after treatment;
- be cored in the middle third of the length of the pile.

906.07 Prohibited Defects

- Through checks
- Bird holes
- Cross-breaks of grain (cracks)
- Decay
- Nails, spikes and other metal or foreign substance.
- Holes in treated piles (except holes for test purposes, which shall be properly plugged). Holes for brailing purposes shall be drilled prior to treatment.
- Shakes in the tip.
- Splits in the tip
- Insect damage
- Any abnormal change in cross-section (including ground swell)
- Knot clusters
- Unsound scars (cat faces)
- Short crooks (see Drawing SP906-01)
- Reverse sweep (see Drawing SP906-02)
- Burst - unsound piling which have 15 mm or more of a concentration of oil in the deadwood.

906.08 Permitted Defects

- Firm red heart
- Hard stain
- Compression wood

906.09 Limited Defects

- a) Checks caused by treating and normal seasoning shall not exceed the following:
 - i) Checks in the tips of the pile from the pith to the circumference shall not be wider than 10 mm at the circumference.

ii) If checks are wider than 10 mm but not deeper than $1/3$ of the diameter of the pile, not more than three of these checks shall occur in the circumference of the pile at that point. If checks are deeper than $1/3$ of the diameter of the pile but not to the heart, and not wider than 10 mm, then only two such checks shall occur in the circumference of the pile at that point. The sum of all the widths of checks in a pile shall not exceed $1/4$ of the diameter where they occur.

b) Sound Knots will be permitted as follows:

i) For piles 15 m and less in length, knots up to 100 mm in diameter will be permitted provided that the sum of all knot diameters does not exceed $1/3$ of the diameter of the pile at the section where they occur;

ii) For piles more than 15 m in length, knots between:

- mid-length and butt shall conform to the requirements for piles of 15 m or less;
- mid-length and the tip, up to 120 mm in diameter, will be permitted provided that the sum of all knots does not exceed $1/2$ of the diameter of the pile at the cross-section where they occur.

c) Shakes in the butt end of a pile are permitted provided that they are not closer than 50 mm to the surface of the pile and the length of any single shake, or the total length of any number of shakes measured along the line of the shake does not exceed $1/3$ of the measured diameter of the butt.

d) Splits in the butt end of a pile are permitted provided that they are not longer than the diameter of the butt.

e) Sweep is permitted provided that it cannot be classified as short crook or reverse sweep and provided that:

i) For piles less than 20 m in length, a straight line joining the mid-point of the butt and the mid-point of the tip does not at any intermediate point pass outside the surface of the pile;

ii) for piles 20 m and up to 24 m in length, a similar straight line does not lie more than 30 mm outside the surface of the pile; or

iii) for piles over 24 m in length, a similar line does not lie more than 60 mm outside the surface of the pile.

Note: See SS Drawing SP906-01

f) Holes for untreated piles less than 10 mm in average

diameter will be permitted provided that:

- i) they are scattered over the surface of the pile; and
- ii) the sum of the average diameter of all holes in any square 300 mm x 300 mm of pile surface does not exceed 40 mm and the depth of any one hole does not exceed 40 mm.
- g) Spiral Grain shall not exceed 1/2 turn in any 6 m length of pile.

906.10 Manufacturing Requirements - All piles shall be cut above the ground swell and have a uniform taper throughout their whole length.

Completely overgrown knots rising more than 30 mm above the pile surface, branch stubs, and partially overgrown knots shall be trimmed close.

Peeling of piles by hand or machine shall be done carefully so as not to gouge or otherwise damage the surface of the pile, and the reduction in thickness of sapwood shall be the minimum possible.

Sawing of butts and tips shall be cut perpendicular to the axis of the pile. Bevelling at the ends of the piles shall not be permitted.

906.11 Storage - Piles shall be stacked in treated or other non-decaying skids of such dimensions, and so arranged as to support the piles without producing noticeable distortion of any of them. A cover should be put over them to protect against the elements.

906.12 Handling - Handling damage will be unacceptable if it reduces the depth of sapwood so as to render the pile untreatable.

- a) All piles shall be handled with reasonable care. Piles shall not be bruised or otherwise damaged. Minor damage shall be repaired and severely damaged piles shall be replaced as per DBSS 906.12 (d).
- b) During lifting, long piles shall be supported at a sufficient number of properly located points to prevent damage due to excessive bending.
- c) Dogs, hooks, peavies or other equipment shall not be used on the round surface of treated piling, except in the last one metre of the butt end.
- d) The Contractor shall make good any superficial damage of treated piles by methods outlined in the current edition of CSA 080 "Specification of Wood Preservation". Piles, which, in the opinion of the Quality Manager and Ministry Representative, cannot be made

good by such methods, will be rejected.

906.13 Inspection - All piles may be inspected before shipment to the Site, at the Site or both. The Contractor shall provide the necessary facilities to enable the Quality Manager, Ministry Representative or authorized Inspector to expeditiously examine all parts of each pile. All piles rejected shall be replaced. Inspection of the piles before shipment shall not be a bar to their subsequent rejection at the Site if found to fail any requirements of this Section.

The Quality Manager and Ministry Representative shall be informed by the Contractor in sufficient time before treatment, and, in all cases, before shipment to the Site, so that necessary inspection may be carried out.

Treated piles being supplied from previously treated stock shall have been clearly stamped with the applicable Charge Number or other positive identification, and the appropriate treatment records shall be made available to the Quality Manager and, if requested, the Ministry Representative for inspection. All piles being supplied from previously treated stock shall be subject to re-inspection.

Piles to be supplied from previously treated stock which have been stored in water shall, if ordered by the Quality Manager or Ministry Representative, be removed from the water if such action is required to provide adequate inspection. At the Contractor's option, such inspection may be carried out at the Site. All piles rejected at the Site shall be removed and replaced at the Contractor's expense.

906 APPENDIX A - Definitions

Check: separation of the wood along the grain, the greater part of which occurs across the rings of annual growth.

Through check: a check, which extends from surface to surface of the pile, usually through the pith centre.

Compression wood: wood which has grown abnormally as often occurs on the lower side of branches and inclined trunks of coniferous trees.

Compression wood:

- is denser and harder than normal wood but may be lower in strength for its mass.
- is characterized by relatively wide annual rings, usually eccentric.
- has a relatively high proportion of summerwood (frequently more than 50% of the width of the annual rings in which it occurs).
- exhibits little contrast in colour between springwood and summerwood, and
- shrinks excessively lengthwise as compared with normal wood.

Crack: separation of the wood cells across the grain (this may be due to internal strains resulting from unequal longitudinal shrinkage or to external forces).

Decay (rot, dote): the disintegration of the wood substance, due to the action of wood-destroying fungi (rot and dote mean the same as decay).

Grain: the direction, size, arrangement, and appearance of fibres in a pile.

Spiral grain: a type of growth in which the fibres take a spiral course about the bole of a tree instead of the normal vertical course. The spiral may extend right-handed or left-handed around the tree trunk. The amount of spiral grain in a pile is measured as the distance in metres, along the axis of the pile in which one complete twist of the spiral occurs, and is expressed as, for example, 1 turn in 12 m.

Hole: an opening, perforation or cavity in a pile.

Bird holes: holes and damage caused by woodpeckers and other species of birds.

Plugged holes: holes that have been filled by forcing in another piece of wood.

Insect damage: result of boring in the pile by insects or insect larvae. Scoring or channelling of the surface is not classified as insect damage.

Knot: that portion of a branch or limb that has become incorporated into the body of a tree.

Knot cluster: two or more knots grouped together as a unit with the fibres of wood deflected around the entire unit.

Knot diameter: the diameter of a knot as it appears on the surface of a pile measured in a direction at right angles to the lengthwise axis of the pile.

Unpeeled: no attempt is made to remove the bark from the pile, but does not mean that all of the bark is on the pile as it may be scuffed, knocked, or worn off after the pile is cut.

Rough peeled: all of the outer bark is removed from the pile.

Clean peeled: all of the rough bark is removed from the pile, and all of the inner bark from at least 80% of the surface of the pile, no piece of inner bark more than 200 mm long remains on the surface of the pile, and there is at least 30 mm of clean wood surface between any two strips of inner bark.

Red heart: a condition caused by fungus (*Fomes pini*, *Trametes pini*) which occurs in the living trees of some conifers. It is characterized in the early stages of infection by a reddish or brownish colour in the heartwood. Later the wood in the living tree disintegrates (decays) in small, usually distinct areas that develop into white-lined pockets.

Firm red heart: the early stages of infection, characterized by a reddish or brownish colour in the heartwood, which does not affect the strength of the pile.

Scar (cat face): a depression in the surface of the pile resulting from a wound where healing has not re-established the normal cross-section of the pile.

Shake: a separation along the grain, the greater part of which occurs between the rings of annual growth.

Short crook: a localized deviation from straightness which, within any section 2 m or less in length, is more than 70 mm (see Drawing SP906-01).

Sound: free from decay and insect holes.

Split: a lengthwise separation of the wood due to the tearing apart of the wood cells which usually extends from surface to surface of the pile.

Stain: a discolouration on or in the wood other than its natural colour, caused by the action of certain moulds and fungi.

Hard stain: a stain, which is not accompanied by softening or other disintegration of the wood.

Sweep: the deviation of the pile from straightness (see Drawing SP906-01).

Reverse sweep: a deviation from straightness, which changes direction or reverses direction in the length of the pile (see Drawing SP906-02).

SECTION 908

PRESERVATIVE TREATMENT - WOOD PRODUCTS

908.01 Materials - Timber, piles and glued laminated members shall conform to the requirements of:

DBSS 903, Timber - Materials; DBSS 904, Timber (Treated and Untreated) - Fabrication and Handling; DBSS 905, Timber -Glued Laminated; DBSS 906, Round Timber Piles as applicable.

Preservative shall conform to the requirements of the current CSA Standard 080-M, "Wood Preservation".

Timber materials may be used in the completed Work only when explicitly identified in the Contract as an acceptable product.

908.02 Treatment - All aspects of preservative treatment shall conform to the requirement of CSA Standard 080.1-M "Preservative Treatment of All Timber Products by Pressure Processes".

The type of preservative, conditioning, treatment, penetration and retention shall be appropriate for the species, size and end use of the product, and shall be as specified in the Design and in the Contract.

Note: The type of preservative, treatment and retention will normally be selected by reference to Table 908-A as applicable.

Should it be necessary to use species, commodities or end uses not included in the above standards, then the preservative, treatment and retention shall be selected by reference to CSA Standards 080.4-M, 080.6-M, 080.9-M, 080.11-M, 080.15-M, 080.16-M, 080.25-M, as applicable.

Glue laminated beams shall be treated in accordance with CSA Standard 080.28-M "Preservative treatment of Coast Region Douglas Fir and Western Hemlock structural glued

- laminated members and laminations before gluing by the pressure processes." (See DBSS 905.)

Fence posts shall be treated in accordance with CSA Standard 080.5-M "Preservative treatment of posts by pressure processes."

Preservation treatment by the thermal process shall be done in accordance with and to the requirements of current CSA Standard 080-M, "Wood Preservation", and shall be limited to the products and species covered in CSA 080.7-M, 080.8-M and 080.10-M.

908.03 Inspection - The Quality Manager and Ministry Representative shall be given a minimum of 48 hours notice prior to commencement of the treating process. All facilities and reasonable assistance shall be afforded by the supplier, free of cost, to the Quality Manager and the Ministry Representative for the proper execution of the work. They shall have free entry at all times while Work is being performed, to all parts of the treating plant which concern the treatment (and all related work) of the materials ordered.

No material shall be shipped prior to inspection or a release for shipment has been issued by the Quality Manager.

TABLE 908-A TYPE OF PRESERVATIVE, TREATMENT AND RETENTION

CSA Standard 080.14 - M	Pressure preserved wood for highway construction. Table I.	
CSA Standard 080.3 - M	Preservative treatment of piles by Pressure Processes.	
	Table I	Land and Fresh Water Piles
	Table II	Marine Piles
	Table III	Foundation Piles
CSA Standard 080.2 - M	Preservative treatment of lumber, timber, bridge ties, and mine ties by pressure processes. Table I.	
CSA Standard 080.18 - M	Pressure treated piles and timbers in marine construction.	
	Table I	Piles and Timbers
	Table II	Timber Substructure and Superstructure

SECTION 909

TREATED WOOD FENCE POSTS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

909.01 General - This Section covers the quality and manufacture of wood fence and gateposts, braces and droppers.

Wood posts and the like for fences and gates shall be supplied pressure treated in the sizes, species and grading all as required by the Purchase Order, Work Order, Contract, Drawing or Specifications in conformity with this Section and as generally shown on the applicable SS SP741 Drawings.

Note: CSA Standards may be obtained from:

Canadian Standards Association, Standards Sales,
178 Rexdale Road, Rexdale, ON M9W 1P3

909.02 Species - Round fence posts (including line, straining, corner, intersection, gate and end posts) and any required round wood braces and droppers shall be Lodge Pole Pine (Western Jack Pine). Use of other species such as cedar, either split or whole, will not be acceptable.

909.03 Size and Measurement

a) Round fence posts and braces shall be classified as to size on the basis of the smaller diameter and length. The diameter specified shall be minimum with a tolerance of +20 mm and the length shall not vary by more than 25 mm from that specified.

b) The maximum permitted taper shall be such that the larger diameter shall not exceed that of the specified diameter by more than 25 mm over a 2 m length of post or brace. The maximum permitted taper shall be proportional for posts and braces of lengths other than 2 m.

c) All dimensions shall apply inside the bark and to the fully seasoned and treated fence posts or braces.

d) In cases where the post or brace is not truly circular, the diameter shall be obtained by measuring the circumference and dividing by 3.14.

909.04 Prohibited Defects

All round fence posts and braces shall be free of the following defects:

- Decay
- Shakes in the top or butt
- Cracks, splits, through checks
- Spike knots and knot clusters
- Unsound scars
- Reverse sweep

909.05 Limited Defects

All round fence posts and braces are permitted limited defects as follows:

- Seasoning checks less than 10 mm in width if less than 500 mm in length, or less than 5 mm in width if more than 500 mm in length
- Sound scars permitted except within 150 mm from the ends
- Sound, tight, well-spaced knots permitted provided they do not exceed 35 mm in diameter
- Sweep less than 2% of the length of the post
- Short crook less than 2% of the length of the post
- Insect damage consisting of holes 1.6 mm or less in diameter and surface scoring or channelling are permitted. All other forms of insect damage are prohibited.

Note: Defects listed above are as defined in DBSS 906 - Appendix A.

909.06 Manufacturing Requirements -

Round Fence Posts and Braces - Ends of posts and braces shall be cut square to the specified length and unless otherwise specified on the Purchase Order, Work Order, or Drawings, one end of posts shall be machine pointed before treatment to permit driving of posts. The diameter at the point shall be not less than 18 mm and not more than 35 mm, and the taper shall extend over a length of 150 mm to 200 mm of the post, or opposite sides shall be tapered to a "chisel point" of similar basic dimensions.

Posts and braces shall be clean peeled with minimum removal of sapwood for their full length and all rough bark and inner bark removed.

All knots or projections shall be shaved smooth and flush with the surface of the surrounding wood.

All round fence posts and braces shall be air seasoned in accordance with CSA Standard 080-M1 Paragraph 1.31 to a moisture content of 15% to 22% before pressure treatment. Where it can be demonstrated that the subsequent pressure treatment performance will be comparable, the Designer or Quality Manager may permit conditioning by steaming for a total of not more than six hours at a temperature not in excess of 115°C.

909.07 Sawn Lumber Posts and Braces - Gate posts and braces not stipulated as round, together with any anchor cleats shall be Standard and better S4S Lodgepole Pine/Western Jack Pine or Coast Douglas Fir, to the current N.L.G.A. grading rules and in the required lengths and sizes.

909.08 Fence Droppers Wood droppers to stabilize barbed wire fencing (Type C) between posts may be:

- Round Fence Posts Lodgepole Pine/Western Jack Pine of 50 mm (smaller) diameter, or
- 25 mm x 50 mm Sawn Lumber, Standard and better S4S Lodgepole Pine/Western Jack Pine or Coast Douglas Fir, to the current N.G.L.A. grading rules.

All droppers 1100 mm \pm 25 mm long for 4-wire Type C fences and 1200 mm \pm 25 mm for Type C and C2 fences shall be selected for freedom from knots and other imperfections injurious to strength.

Approved proprietary grooved wood droppers with necessary wire clips may be specified or approved for high-tensile smooth-wire fencing.

Note: For Type C fencing proprietary prefabricated galvanized sheet metal and clip droppers may be approved as an alternative to the above wood droppers. Galvanized twisted wire fence stays may be specified or permitted only for the extension of normal fence heights to deer height and the like.

909.09 Pressure Treatment - All round fence posts, braces and round droppers shall be pressure treated in accordance with CSA Standard 080.5 "Preservative Treatment of Posts by Pressure Processes", except that the sample zone for assay shall be 0 to 16 mm from the surface and the requirement that all borings for use in the extraction sample shall have at least 25 mm of sapwood shall be waived. If species other than Lodgepole Pine are approved, these exceptions may be altered.

All sawn fence posts, braces, anchor cleats and droppers shall be pressure treated in accordance with CSA Standard 080.2 "Preservative Treatment of Lumber, Timber, Bridge Ties and Mine Ties by Pressure Processes".

The preservatives and retention of preservatives shall conform to the recommendations of CSA Standard 080.14 Table I "Minimum Retention of Preservatives in Pressure Treated Wood for Highway Construction" under the heading "Fence Posts - All Species" as listed in Table 909-A, and meet the requirements of the relevant CSA Standards in the P-Series.

TABLE 909-A PRESERVATIVES AND RETENTION OF PRESERVATIVES

PRESERVATIVE	MINIMUM RETENTION
Creosote	80.0 kg/m ³
Creosote-Petroleum	95.0 kg/m ³
Pentachlorophenol (Hydrocarbon Solvent) (Type A, or Type D - Methylene Chloride)	4.0 kg/m ³
Ammoniacal Copper Arsenate (ACA)	6.4 kg/m ³
Chromated Copper Arsenate (CCA)	6.4 kg/m ³

909.10 Inspection - All processing of the material shall be documented through the Supplier's QM Plan and sampled through the Contractor's QM Plan. Ministry and Contractor

inspectors and auditors shall have free entry to the treating plant while the work is being performed.

No material shall be shipped prior to inspection or the written release for shipment by the Contractor

Material inspected before shipment shall not bar its subsequent rejection after delivery if found to fail any requirements of this Specification. Rejected material shall be replaced at the Supplier's expense including shipping charges and removal of rejected materials, if applicable.

Note: Inspection of material already in bundles ready for shipment shall be considered as "incomplete", and the material will be subject to final inspection only when the bundles are opened immediately prior to use.

The Supplier shall advise the Contractor, within timelines determined by the Contractor, before the material is ready for inspection prior to shipment.

SECTION 911

STEEL AND IRON

911.01 Scope – This standard only applies to materials used in the maintenance and rehabilitation of existing log and timber bridges and log or timber components such as log crib retaining walls, timber piers, wood sign structures, etc.

911.02 Materials - These materials shall be in accordance with the current editions of the following Specifications:

- Structural Steel, CSA Specification CAN/CSA-G40.21 Grade 260 or better
- Steel Bolts, ASTM Specification A 307
- Steel Nuts, ASTM Specification A563
- Carbon Steel Castings, ASTM Specification A 27/A 27M
- Iron Castings, ASTM Specification A 48/A 48M
- Pipe Steel, ASTM Specification A 53/A 53M

911.03 Tension and Lateral Rods - Tension and lateral rods shall be of structural steel. Upset ends shall be upset by hand or machine and welds will not be allowed. The dimensions of upset ends shall be made as shown on the plans. When upsetting by machine, the ends shall be upset to a little oversize, after which they should be heated to welding temperature and then swedged to the proper size. The nuts shall be made hexagonal, U.S. Standard sizes and threads. The threads on rods and nuts shall be full, smooth, uniform and of the same pitch throughout. They shall be such that the nuts can be run on by hand the full length of the threads on the rods without showing undue or uneven slackness.

911.04 Machine Bolts - Machine bolts shall conform to ASTM Standard A 307.

911.05 Carriage Bolts - Carriage bolts shall conform to ASTM Standard A 307. They shall be of the common type with button head, square neck and square or hex nut.

911.06 Drift Bolts or Pins - Drift bolts or pins shall be of structural steel. They shall be cut from plain, round bars unless otherwise called for on the Design. The ends of drift pins or bolts shall be
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tapered or shaped so that the pin may be easily driven into pre-bored holes in the wood being fastened.

911.07 Dowels - Dowels shall be of structural steel. They shall be cut from plain round bars and any ragged ends shall be removed.

911.08 Lag Screws - Lag screws shall conform to ASTM Standard A 307. They shall have square heads and cone points.

911.09 Plate Washers or Wrought Washers - Plate washers or wrought washers shall be of structural steel or wrought iron; they shall be round or square as may be called for on the Design. Round washers shall be according to Canadian Manufacturer's Standards. Square washers shall be made to the dimensions called for on the Design.

911.10 O.G. Washers - O.G. washers shall be of cast iron. The proportions of these washers adopted by some of the manufacturers differ somewhat in detail, but to be acceptable the diameter should not be less than four times the diameter of the bolt for which it is to be used and the thickness should be approximately equal to the diameter of the bolt.

911.11 Special Castings - Special castings shall be true to pattern, free from excessive shrinkage or overrun, be made in accordance with the Design and be free from defects. Castings, which show defects after machining, will be rejected notwithstanding any previous acceptance at the manufacturer's works.

911.12 Steel Splice-Joint Fastenings - Plates and bars, etc., for these joints shall be of structural steel. All parts shall be made in accordance with the Design. Bolt holes shall be drilled from the solid or sub-punched and reamed. In sub-punched and reamed work, the holes shall be punched 3/16" smaller and after assembling, reamed 1/16" larger than the nominal diameter of the rivet.

911.13 Galvanizing – Galvanizing, if required, shall be in accordance with CSA Specification CAN/CSA-G164.

911.14 Plates - The various plates designated on the plans as gib, bearing, bed, joint, lateral, etc., shall be of structural steel.

911.15 Welding - Welding shall conform to the requirements of CSA Specification W 59.

911.16 Pipe Fastenings - Pipe fastenings shall be of extra strong (Schedule 80) pipe. Nuts shall be hexagonal machine lock nuts, U.S. Standard as to outside dimensions and threads. The threads on nuts and pipes shall be full, smooth, uniform and of the same pitch; they shall be such that they can be run on by hand the full length of the thread on pipe without undue or uneven slackness.

911.17 Cleaning and Painting – Painting of steel and iron components shall be in accordance with DBSS 216.11, Painting of Steel Structures. No paint shall be applied to surfaces which are to be encased in concrete.

911.18 Machine Finished Surfaces - Machine finished surfaces and threaded ends of tension and lateral rods shall be coated with a mixture of white lead and tallow, applied hot, as soon as the

surfaces and threads are finished and accepted by the Quality Manager.

911.19 Inspection - All materials and quality of work shall be subject to inspection by the Quality Manager. The manufacturer shall allow the Quality Manager and the Ministry Representative free access to the shops at all times when work on the materials is being done and the manufacturer shall provide every reasonable facility to assist the Quality Manager in the inspection of both material and quality of work. The Quality Manager shall have power to reject material or quality of work which do not come up to the requirements of the Design or the Contract. Rejected material or poor quality of work shall be replaced promptly or made good by the manufacturer. Tests will be made only when and as specified by the Designer or the Quality Manager.

911.20 Shipping - The threaded ends of all rods shall be protected from damage by wrapping with burlap or equally effective covering.

SECTION 913

REINFORCEMENT FOR CONCRETE

913.01 Requirements - Concrete reinforcement shall conform to the requirements of the following CSA Standards:

- G30.3 Cold-Drawn Steel Wire for Concrete Reinforcement
- G30.4 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
- G30.5 Welded Steel Wire Fabric for Concrete Reinforcement
- G30.14 Deformed Steel Wire for Concrete Reinforcement
- G30.15 Welded Deformed Steel Wire Fabric for Concrete Reinforcement
- G30.17 Welded Steel Plain Round Bar or Rod Mats for Concrete Reinforcement
- G30.18-M Billet Steel Bars for Concrete Reinforcement

The type and grade required shall be as specified in the Contract and as shown in the Design.

SECTION 917

WIRE ROPE

917.01 Wire Rope - Wire Rope shall conform to the requirements of CSA Standard G4-M "Steel Wire Rope for General Purpose and for Mine Hoisting and Haulage."

SECTION 931

PORTLAND CEMENT

931.01 General- Portland Cement shall conform to the requirements of CAN/CSA-A3001, "Cementitious Material for use in Concrete"

The Type shall be as specified in the Contract and as shown in the Design and as required from Table 931-A.

TABLE 931-A TYPES OF PORTLAND CEMENT

NAME	TYPE	APPLICATION
Normal	GU	For use in general concrete construction when the special properties of the other types are not required.
Moderate*	MS	For use in general concrete construction when moderate resistance to sulphate action is required..
Moderate**	MH	For use in general concrete construction when moderate heat of hydration is required.
High Early Strength	HE	For use when high early strength is required.
Low Heat of Hydration	LH	For use when low heat of hydration is required.
Sulphate Resistant	HS	For use when high sulphate-resistance is required.
* Moderate with respect to sulphate-resistance.		
** Moderate with respect to heat of hydration.		

SECTION 933

ADMIXTURES FOR PORTLAND CEMENT CONCRETE

933.01 Scope - This Section covers general requirements for air entraining and chemical admixtures and Specification requirements for pozzolan admixtures.

933.02 Applicable standards. The standards listed in Table 933-A shall apply unless specified otherwise herein or in the Contract. All referenced standards shall be to the current editions at time of Award.

TABLE 933-A Applicable Standards

ASTM-C 260	Air-entraining Admixtures for Concrete
ASTM-C 494	Chemical Admixtures for Concrete
CAN/CSA A3000	Cementitious Materials for Use in Concrete
CAN/CSA A23.1	Concrete Materials and Methods of Concrete Construction

933.03 Air-Entraining and Chemical Admixtures

a) Air-entraining admixtures shall conform to the requirements of ASTM Standard C 260, Air-Entraining Admixtures for Concrete.

b) Chemical Admixtures shall conform to the requirements of ASTM Standard C 494, Chemical Admixtures for Concrete.

933.04 Pozzolan Admixtures

933.04.01 Definitions) Type N Pozzolan - A natural pozzolan consisting of siliceous or aluminosiliceous material in finely divided form and in the presence of moisture chemically reacts at ordinary room temperatures with calcium hydroxide, released by the hydration of portland cement, to form compounds possessing cementing properties.

ii) Type F Pozzolan - A finely divided residue that results from the combustion of pulverized coal and

that is carried from the combustion chamber of a furnace by exhaust gasses.

933.04.02 General - When types N or F pozzolans are used in concrete either as a cement replacement, addition, or both, they shall contribute to the beneficial physical and chemical properties of the hardened concrete through pozzolanic activity. Before a pozzolan is accepted for use in concrete, pozzolan shall first meet the physical and chemical requirements herein specified.

If suitable, the pozzolan shall then be evaluated upon its performance in laboratory concrete trial mixes at various usage rates. Any pozzolan, which does not produce the specified effects or produces adverse effects to concrete shall not be used.

933.04.03 Sampling and Testing - Types N and F pozzolans shall be sampled and tested for chemical and physical properties in accordance with ASTM-C 311 "Sampling and Testing of Fly Ash or Natural Pozzolans for use as a Mineral Admixture in Portland Cement Concrete", unless otherwise specified in the Contract.

933.04.04 Chemical Requirements - The chemical requirements for types N and F pozzolans shall be as shown in Table 933-B.

933.04.05 Physical Requirements

i) Fineness - The fineness of either types N or F pozzolan will be determined in accordance with ASTM C 311 Section 21, "Fineness, Amount Retained When Wet-Sieved on a 45 μ m (No. 325) Sieve" and/or ASTM C 204 for "Fineness of Hydraulic Cement by Air Permeability Apparatus". In this latter procedure, fineness shall be determined by use of the Blaine permeability apparatus except that pozzolan will be used in place of cement.

The degree of fineness of either type N or F pozzolan shall be that which produces the optimum pozzolanic activity with the Portland cement with which the pozzolan is to be used. The pozzolanic activity index shall however not be less than 75% of the control at 28 days. After six months storage, pozzolans shall be retested for

fineness. The fineness requirements shall be as specified in the Design and the Contract.

ii) Water Requirements - Water requirements of mortar made with the pozzolan in accordance with ASTM C 311 Section 33 shall not be greater than 115% of water used in the control mix.

iii) Drying Shrinkage - Increase in drying shrinkage of mortar bars made and tested in accordance with ASTM C 311 Section 22 shall not be greater than 0.03%.

iv) Soundness - When tested for soundness in accordance with ASTM C 311 the expansion or contraction after autoclaving shall not be greater than 0.08%.

933.04.06 Performance Evaluation of Types N or F Pozzolans in Concrete

i) Only pozzolans which meet the physical and chemical requirements as specified in the Contract shall be evaluated for use in concrete.

ii) Evaluation of pozzolans in concrete shall be made with laboratory concrete trial mixes

preferably with concrete ingredients to be used in the Work where the pozzolanic concrete is to be used.

iii) Evaluation shall be made by comparing test results of the pozzolanic mixes with test results of similar concrete mixes without pozzolan.

iv) Tests, which the Quality Manager or the Ministry Representative may specify to evaluate the performance of a pozzolan in a specific concrete, are given in Table 933-C.

933.04.07 Basis of Evaluation - Types N and F pozzolans shall be evaluated in concretes by comparing results of tests performed on "job design" portland cement concrete with similar class portland cement concrete without pozzolan. Types N and F pozzolans will only be considered for acceptance when they produce equal or better test results than those obtained with similar class concrete without pozzolan. When accepted, types N and F pozzolans shall only be used at dosage rates determined from test results and accepted by the Designer and Ministry Representative.

TABLE 933-B CHEMICAL REQUIREMENTS FOR TYPES N AND F POZZOLANS

CHEMICAL REQUIREMENTS:	POZZOLAN TYPE	
	N	F
Silicon dioxide (SiO ₂) plus aluminum oxide (Al ₂ O ₃) plus iron oxide (Fe ₂ O ₃), minimum %	70.0	70.0
Sulphur trioxide (SO ₃), maximum %	4.0	5.0
Moisture content, maximum %	3.0	3.0
Loss on ignition, maximum %	10.0	12.0
Magnesium oxide (MgO), maximum %	5.0	5.0
Available alkalis, as Na ₂ O, maximum %	1.5	1.5

TABLE 933-C TESTS FOR EVALUATING THE PERFORMANCE OF A POZZOLAN IN A SPECIFIC CONCRETE

QUALITY REQUIREMENTS	TITLE OF TEST	TEST DESIGNATION
Air Entrainment	Limits of Amount of Air-Entraining Admixture in Concrete	ASTM C 311 Section 23
Bleeding	Bleeding of Concrete	ASTM C 232
Setting Time	Time of Setting of Concrete Mixtures by Penetration Resistance	ASTM C 403
Compressive Strength	Concrete Test Specimens Making and Curing in the Laboratory	ASTM C 192
Flexural Strength	Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)	ASTM C 78
Drying Shrinkage	Length Change of Hardened Cement Mortar and Concrete	ASTM C 157
Thermal Volume Change	Early Volume Change of Cementitious Mixtures	ASTM C 827
Alkali Reaction	Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction	ASTM C 441
Resistance to Freezing and Thawing	Resistance of Concrete to Rapid Freezing and Thawing	ASTM C 666
Resistance to De-icing Chemicals	Scaling Resistance of Concrete Surfaces Exposed to De-icing Chemicals	ASTM C 672

SECTION 941

PRECAST REINFORCED CONCRETE BARRIERS

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the "Standard Specifications For Highway Construction" 2006 edition.

941.01 Scope - This Section covers the quality and manufacture of precast reinforced concrete roadside and median barriers for highway and other off-highway traffic confinement use.

The concrete traffic barrier units shall be supplied in the sizes and types as required by the Purchase Order, Work Order or Design in strict conformity with this Section and pertinent Standard SS Drawings of the SP941 Series.

941.02 Concrete Quality

- a) Concrete quality shall conform to CSA Standard CAN3-A23.1-M except where amended hereafter.
- b) A compressive strength test result is defined as the average of the strengths of three 28 day compressive test cylinder breaks with standard cylinders of 150 mm diameter and 300 mm high size.
- c) The strength level of the concrete represented by the test shall be considered satisfactory if the test result equals or exceeds 30 MPa and no individual cylinder strength is less than 27 MPa. If this condition is not met, the concrete will be considered to have failed the strength requirements. No other form of testing to prove the relative strength at a later date will be allowed without the approval of the Ministry Representative.
- d) Cylinders shall be cast by the Contractor at the time of placing concrete. Frequency of testing will one set of four cylinders per day or per 50 m³, whichever is more frequent.
- e) Calcium chloride or admixtures containing calcium chloride shall not be used in the concrete.
- f) Concrete shall meet the following additional requirements:
 - i) Minimum cement content of 320 kg per cubic metre.
 - ii) Maximum water/cement ratio of 0.45.
 - iii) Coarse aggregate of a nominal maximum size not exceeding 28 mm.
 - iv) Slump of 50 mm \pm 20 mm.
 - v) Entrained air of 5 to 8%.

941.03 Reinforcing Steel, Attachment Hardware & Miscellaneous Items

- a) Welded steel wire mesh reinforcement shall be supplied and installed in each section as shown on the Standard SS Drawings, and in accordance with DBSS 412. Additional reinforcement may be installed to assist handling during the precasting operations but shall be subject to prior approval by the Designer.
- b) Reinforcing steel for bent and hooked connections shall conform to CSA CAN3-G40.21-M Grade 260W and shall be carefully bent to the radii detailed and installed as shown on the Standard SS Drawings.

Bending shall be done by methods that will not produce fracture or other injury. The metal heating shall not be to a higher temperature than that producing a "dark cherry red" colour. After heating, the metal shall be cooled as slowly as possible. Following the bending, the surface of the metal shall be carefully inspected for evidence of fracture, and any fractured pieces shall be replaced.

Contrary to Note 2 on SS Drawing SP941-04.01.01, prior to delivery, exposed surfaces of connections shall be prepared for and given a heavy application of zinc rich coating to CGSB Standard 1-GP-181M.

- c) Pick-up points for handling units shall be formed with accurately placed rigid P.V.C. pipe recessed 15 mm from both finished surfaces as detailed.

941.04 Optional Features - Where barrier is ordered with drainage slots or grouting holes or both, they shall be accurately cast-in as detailed. Facilities for the installation of anti-glare screens will be detailed as and when required.

941.05 Placing and Finishing of Concrete

- a) Concrete shall be placed in the forms and carefully consolidated in strict accordance with CSA CAN3-A23.4-M, Clause 19.
- b) Curing and protection shall be carried out strictly according to CSA CAN3-A23.4-M Clause 21.
 - i) Curing shall be considered complete when test cylinders reach the specified 28 day compressive strength provided such strength is reached not later than 28 days after the barriers are cast.
 - ii) Steam curing is permissible for either the entire curing period or portion thereof and shall be carried out in accordance with CSA CAN3-A23.4-M

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Clause 21.4.

- iii) At no time during or at completion of the curing period shall the temperature differential between the concrete surface and the ambient temperature be greater than 20°C.
 - iv) If steam is used for a portion of the curing period, additional normal curing shall be carried out after the steam curing, according to CSA CAN3-A23.4-M Clause 21.3 until such time as strength tests of concrete test cylinders that have been both steam and normally cured with the barriers reach the specified concrete strength.
- c) Exposed surfaces shall be uniform in texture and colour as produced from well maintained steel form surfaces and proper vibration methods without excessive surface fines or laitance.
- d) Defects of the exposed surface will normally be cause for the rejection of any unit except where such are within the permissible limits or are subject to making good as follows:
- i) Unobtrusive defects of any kind where their total area is not in excess of 2% of the exposed surface area of the unit.
 - ii) Air holes not greater than 3 mm in diameter and not more than 20 in any isolated 300 mm X 300 mm area.
 - iii) Sharp arises at the edges of the exposed surfaces where necessary shall be softened by careful rubbing or grinding.
 - iv) Patching of isolated small holes, cavities and similar self-confining defects may be permitted when authorized in writing by the Quality Manager.
- e) Patching, only when authorized, shall have the

PRECAST REINFORCED CONCRETE BARRIERS

defective area well saturated with water and the defect prepared with cement paste and filled with mortar. The mortar, properly proportioned of the same sand and cement as the original concrete and reasonably colour matched to the cured dry unit with the addition of white cement where necessary, shall be pre-shrunk for about one hour before retempering and use. The patching mortar shall be well tooled in, finished flush and smooth and the area covered to cure adequately.

- f) End connection surfaces shall be cleared out.
- g) All concrete surfaces prior to shipment shall be accurate to detail and, in particular at the end connections, true to dimension tolerances.

941.06 Tolerances - Tolerances allowable in concrete dimensions of the barriers shall be ± 3 mm except as otherwise indicated on the detail drawings.

941.07 Procedure of Manufacture - The Supplier shall notify the Contractor in advance concerning the date when the order is to be manufactured, so that detailed inspection can be carried out. All processes shall be open for inspection and approval by the Quality Manager and the Ministry Representative

The manufacturer's name or trade mark, year of manufacture and form number shall be embedded on the end of each unit in a manner, size and depth that they are permanently legible.

Authorized patching or making good may be inspected before shipment or upon delivery and the rejected unit(s) shall be replaced at no cost.

941.08 Handling - In handling the finished product, the concrete and connecting devices shall not be damaged or distorted.

SECTION 952

CONTRACTOR SUPPLY ASPHALT AND PAVING MATERIALS FOR HIGHWAY USE

Note: For any SS Drawing (SP XXX - XX) referenced in this Section refer to the like-numbered Drawings in the “Standard Specifications For Highway Construction” 2006 edition.

952.01 Scope

- a) This Section describes the requirements for the different types and grades of asphalt and paving materials to be supplied by the Contractor for highway use as set out in the Contract.
- b) The materials so described are generally classified as follows:
 - Asphalt Cements
 - Cutback Asphalts
 - Asphalt Emulsions
 - Tall Oil Pitch
 - Emulsified Products
- c) The term “Supplier” referred to in this section shall mean the party or parties supplying the Contractor with materials covered under this specification.
- d) The Ministry’s *Recognized Products Book*, referenced herein, may be found on-line at:

http://www.th.gov.bc.ca/publications/eng_publications/geotech/rpb.htm

952.02 Quality Management Requirements

952.02.01 Quality Control Plan

- a) The supplier shall develop and maintain a proven quality control plan in accordance with the provisions of this Specification and the Contract. The plan shall ensure that adequate inspection coverage is maintained throughout the entire process of manufacture and shipping. All supplies processed or manufactured within the supplier's plant or procured from any other source shall receive sufficient inspection to ensure conformance specifications, and evidence of such inspections shall be provided to the Quality Manager and Ministry Representative upon request.
- b) Supplies not conforming to contractual requirements shall not be offered for highway use.
- c) It shall be a responsibility of the Contractor to ensure that all materials supplied satisfy the related Environmental and Health and Safety Regulations.

- d) Product discharged directly into tank cars or tank trucks from "in line blending" facilities will be sampled as required to ensure uniformity and satisfy quality requirements.

952.02.02 Quality Control Procedure - The supplier shall furnish the Contractor with an outline of the quality control procedures, for inclusion in the Quality Management Plan, detailing the method of implementing the requirements of this Specification. This outline shall include the following operations:

- sampling and testing
- storage and handling
- shipping
- recording and reporting.

952.02.03 Technical Requirements - The Contractor shall ensure that the supplier provides the following:

- a) **Batching and Batch Analysis:** Each batch of product covered by this Specification shall be given a batch number, and sampled and tested in accordance with the applicable Specification.

The batch analysis must show the Specification requirements for the product tested, test method employed, and the pertinent test results, as listed on Appendix A.

- b) A Viscosity Chart (Absolute) with the initial load and for each subsequent batch. If inline blending is utilized a new viscosity chart shall be issued should any change in viscosity occur.

952.03 Sampling and Testing

- a) The supplier shall retain adequate sampling equipment, employ satisfactory sampling procedures, and maintain sampling program and records. The Contractor shall obtain samples for quality assurance.
- b) Test methods for asphalt and paving materials shall conform to the standard ASTM tests listed in Table 952-A.
- c) On request by the Ministry Representative, the Contractor shall provide samples, from the supplier, of the product in quantities, not less than 4 ℓ, as may be required for independent testing.

952.04 Delivery of Asphalt and Paving Materials

- a) The Contractor must ensure the supplier delivers

asphalt and paving materials in good condition and at correct temperature to the specified delivery point

b) Every bill of lading must show:

- Type of product
- Batch number
- Mass
- Relative density at 15°C
- P.G. Specification (for information only)

c) Trucks shall be equipped with a submerged sampling valve system installed generally as shown on Drawing SS SP952-01 for each compartment in which asphalt material is to be carried out.

d) Delivery temperature of the shipment shall meet the viscosity requirement shown in Table 952-B.

e) Asphalt Emulsions and emulsified products shall be kept at temperatures above 5°C.

Note: In no case shall asphalt materials or Tall Oil Pitch be

TABLE 952-B VISCOSITY REQUIREMENTS FOR SHIPMENT DELIVERY TEMPERATURE

CLASS OF MATERIAL	KINEMATIC VISCOSITY, mm ² /s
Cutback Asphalt for Surface Spraying	100 - 200
Cutback Asphalt and Asphalt Cement for Plant Mixing	100 - 500
Tall Oil Pitch	20 - 40

received at a viscosity outside the specified viscosity range.

952.05 Asphalt Cement - Asphalt cements shall:

- a) Be products prepared by the refining of petroleum oils.
- b) Be homogeneous, free from water and shall not foam when heated to 175°C.
- c) Conform to the requirements specified in Table 952-C and Table 952-D.

Upon request, the Contractor shall forward a 4 ℓ sample of the product to the Ministry Representative.

NOTE: Values for penetration and viscosity are point values only. Intermediate values for Group A, B and C grades shall be obtained by interpolation between the tabulated values on a straight line basis. Minimum viscosity at 60°C for other penetrations within each group can be read from the corresponding straight line on Drawing SS SP952-02.

952.06 Cutback Asphalts

- a) Cutback asphalts shall consist essentially of petroleum derivatives and shall be substantially free from water and other impurities.
- b) Cutback asphalts shall be of the type and grade described in Tables 952-E to 952-H.

952.07 Asphalt Emulsions - Asphalt materials in the form of aqueous emulsions shall be of:

- Anionic Type
- Cationic Type
- High Float Type

952.08 Anionic Type Emulsion for Road Purposes - Anionic type of emulsion requirements are as follows:

TABLE 952-A TEST METHODS

TITLE OF TEST	TEST DESIGNATION	
		ASTM
Penetration		D 5
Absolute Viscosity of Asphalts		D 2171
Kinematic Viscosity of Asphalts		D 2170
Effect of Heat and Air on Asphalt		D 1754
Distillation of Cutback Asphalt		D 402
Residue of 100 Penetration		D 243
Relative Density of Asphalt Cement and Cutback Asphalt		D 70
Ductility		D 113
Float Test		D 139
Flash Point by Tag Open Cup		D 1310
Flash Point by Cleveland Open Cup		D 92
Solubility in Trichloroethylene		D 2042
Water in Asphalt		D 95
Softening Point in Ethylene Glycol		D 2398
Saybolt Furol Viscosity		D 88
Testing Emulsified Asphalts		D 244

CONTRACTOR SUPPLY ASPHALT AND PAVING MATERIALS FOR HIGHWAY USE

SECTION 952

- The asphalt emulsion shall be homogeneous.
- It shall show no separation of asphalt after thorough mixing within 30 days (crack filler 20 days) after delivery, provided separation has not been caused by freezing.
- The emulsion shall conform to the requirements listed in Table 952-I.

952.09 Cationic Type Emulsions for Road Purposes –
Cationic type emulsions shall conform to the requirements listed in Table 952-J and shall be uniform throughout.

952.10 High Float Emulsified Asphalt - Storage stability -
High float emulsified asphalt shall show no separation of asphalt within 30 days after delivery and shall be

homogeneous after thorough mixing.

The emulsion shall conform to the requirements listed in Table 952-K.

952.11 Tall Oil Pitch (TOP) - Tall oil pitch, co-product of the pulp and paper industry is a residual fraction from the crude tall oil vacuum distillation process. It shall be a dark brown resinous and viscous material insoluble in water but miscible with asphalt. Where required, TOP will be added to asphalt cement in a ratio defined by the mix design, usually between 5 - 10%. Only TOP products listed on the Ministry's *Recognized Products Book* shall be permitted for use on Ministry projects.

The TOP shall conform to the requirements listed in Tables

TABLE 952-C GRADES OF ASPHALT CEMENT

PENETRATION GRADE ASPHALT CEMENT	80 - 100		150 - 200		200 - 300		TEST METHOD ASTM
Requirements	Min	Max	Min	Max	Min	Ma	D 5
Penetration at 25°C 100 g and 5 s, 0.1 mm	80	100	150	200	200	300	
Group A Group B Group C	Minimum viscosity values defining boundaries for groups A, B, & C are listed in Table 952-D and illustrated in Drawing SP952-04						
Flash Point, °C Cleveland Open Cup	230	---	220	---	175	---	D 92
Thin Film Oven Test % Loss in Mass	---	0.85	---	1.3	---	1.5	D 1754
Penetration of Residue at 25°C 100 g, 5 s, 0.1 mm, % of Original Penetration	55	---	50	---	45	---	After T.F.O.T.
Solubility in Trichloroethylene % by Mass	99.5	---	99.5	---	99.5	---	D 2042
Ductility, 25°C 5 cm/min, cm	100	---	100	---	---	---	D 113
Ductility, 15°C 5 cm/min, cm	---	---	---	---	100	---	

TABLE 952-D VISCOSITY AND PENETRATION VALUES DEFINING GROUP BOUNDARIES

Penetration 25°C	80	100	150	200	300	TEST METHOD - ASTM
						D 5
	Minimum Viscosity at 60°C					
Group A	150	115	70	50	31	D 2171
Group B	110	85	---	---	---	
Group C	75	55	---	---	---	

952-L and 952-M.

952.12 Emulsified Products - Emulsified products consist of emulsified Tall Oil Pitch and proprietary asphalt based emulsions. Only products on the Ministry's *Recognized Products Book* shall be permitted for use on the Ministry projects. Each batch of the product delivered to the job site

shall be accompanied by the written statement from the manufacturer or supplier confirming that the product formulation complies with the original, previously approved formulation. Emulsified Tall Oil Pitch and asphalt based emulsified products shall conform to the requirements listed in Tables 952-N and 952-O.

TABLE 952-E SLOW CURING CUTBACK ASPHALT

REQUIREMENTS	GRADE					
	SC - 70		SC - 250		SC - 3000	
	Min	Max	Min	Max	Min	Max
Flash Point °C	65	---	80	---	105	---
Kinematic Viscosity at 60°C, mm ² /s	70	140	250	500	3 000	6 000
Residue from Distillation to 360°C, volume % by difference	70	90	80	94	95	---
Distillation Residue, Kinematic Viscosity at 60°C, mm ² /s	400	7 000	800	10 000	4 000	35 000
ASPHALT RESIDUE:						
Residue of 100 Penetration, % by Mass	50	---	60	---	80	---
Ductility of 100 Penetration residue at 25°C, cm	100	---	100	---	100	---
Solubility in Trichloroethylene	99.0	---	99.0	---	99.0	---
Water, % by Mass or Volume	---	0.5	---	0.5	---	0.5

TABLE 952-F MEDIUM CURING CUTBACK ASPHALT

REQUIREMENTS	GRADE			
	MC - 30		MC - 250	
	Min.	Max.	Min.	Max.
Flash Point °C	38	---	65	---
Kinematic Viscosity at 60°C, mm ² /s	30	60	250	500
Distillation Test, % of Total Distillate to 360°C: to 225°C	---	25	---	10
Distillation Test, % of Total Distillate to 360°C: to 260°C	40	70	15	55
Distillation Test, % of Total Distillate to 360°C: to 315°C	75	93	60	87
Residue from Distillation to 360°C, volume % by difference	50	---	67	---
PROPERTIES OF RESIDUE FROM DISTILLATION:				
Penetration at 25°C, 100 g, 5 s, 0.1 mm	120	250	120	250
Ductility at 25°C, cm	100	---	100	---
Solubility in Trichloroethylene	99.0	---	99.0	---
Water, %	---	0.2	---	0.2

TABLE 952-G RAPID CURING CUTBACK ASPHALT

REQUIREMENTS	GRADE					
	RC - 30		RC - 70		RC - 250	
	Min	Max	Min	Max	Min	Max
Flash Point °C	---	---	---	---	27	---
Kinematic Viscosity at 60°C, mm ² /s	30	60	70	140	250	500
Distillation Test, % of Total Distillate to 360°C: to 190°C	15	---	10	---	---	---
Distillation Test, % of Total Distillate to 360°C: to 225°C	55	---	50	---	35	---
Distillation Test, % of Total Distillate to 360°C: to 260°C	75	---	70	---	60	---
Distillation Test, % of Total Distillate to 360°C: to 315°C	90	---	85	---	80	---
Residue from Distillation to 360°C, volume % by difference	50	---	55	---	65	---
TEST ON RESIDUE FROM DISTILLATION:						
Penetration at 25°C, 100 g, 5 s, 0.1 mm	80	120	80	120	80	120
Ductility at 25°C, cm	100	---	100	---	100	---
Solubility in Trichloroethylene, % by mass	99.0	---	99.0	---	99.0	---
Water, %	---	0.2	---	0.2	---	0.2

Note: The material shall not foam when heated to the spraying and mixing temperature range recommended by the Canadian General Standards Board

TABLE 952-H CUTBACK ASPHALT PRIMER RM20

REQUIREMENTS	Min.	Max.
Kinematic Viscosity at 60°C, mm ² /s	20	35
Distillation Test, % of Total Distillate to 360°C: to 190°C	---	60
Distillation Test, % of Total Distillate to 360°C: to 225°C	40	---
Distillation Test, % of Total Distillate to 360°C: to 260°C	70	---
Distillation Test, % of Total Distillate to 360°C: to 315°C	85	---
Residue from Distillation to 360°C, volume % by difference	50	---
TEST ON RESIDUE FROM DISTILLATION:		
Penetration at 25°C, 100 g, 5 s, 0.1 mm	80	200
Ductility at 25°C, cm	100	---
Solubility in Trichloroethylene	99.0	---
Water, %	---	0.2

TABLE 952-I REQUIREMENTS FOR ANIONIC TYPE EMULSIONS

REQUIREMENT	TYPE OF EMULSION									
	RS - 1		RS - 2		MS - 2		SS - 1		CRACK FILLER	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol: at 25°C	20	100	---	---	100	---	20	100	50	200
Viscosity, Saybolt Furol: at 50°C	---	---	75	300	---	---	---	---	---	---
Residue by Distillation, %	57	---	62	---	62	---	57	---	65	75
Settlement, 1 Day, %	---	1.5	---	1.5	---	1.5	---	1.5	---	1.5
Demulsibility: 50 mL of 0.1 N CaCl ₂ %	---	---	---	---	---	30	---	---	---	---
Demulsibility: 35 mL of 0.02 N CaCl ₂ %	60	---	60	---	---	---	---	---	30	---
Sieve Test, % Retained on 1 mm	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10
Cement Mixing Test, %	---	---	---	---	---	---	---	2.0	---	---
TESTS ON RESIDUE:										
Penetration at 25°C, 100 g, 5 s	100	200	100	200	100	200	100	200	60	100
Solubility in Trichloroethylene %	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---
Ductility at 25°C, cm	60	---	60	---	60	---	60	---	60	---

TABLE 952-J REQUIREMENTS FOR CATIONIC TYPE EMULSIONS

REQUIREMENT	TYPE OF EMULSION			
	CRS - 1K		CRS - 2K	
	Min	Max	Min	Max
Saybolt Furol Viscosity at 50°C	30	125	174	400
% Residue by Distillation	62	---	68	---
Settlement 1 Day, %	---	1.5	---	1.5
Sieve Test, % Retained on 1 mm Mesh	---	0.1	---	0.1
Oil Portion of Distillate, % of Total Volume	0	3	0	3
Particle Charge	POSITIVE		POSITIVE	
TESTS ON RESIDUE				
Penetration at 25°C, 100 g, 5 s	100	250	100	150
Solubility in Trichloroethylene %	97.5	---	97.5	---
Ductility at 25°C, cm	60	---	65	---

TABLE 952-K REQUIREMENTS FOR HIGH FLOAT EMULSIFIED ASPHALTS

REQUIREMENT	GRADE:											
	HF-100S		HF-150S		HF-250S		HF-350S		HF-500M		HF-1000M	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Residue by Distillation, % By Mass	62	---	62	---	62	---	65	---	65	---	65	---
Oil Distillate % By Volume	1	4	0.5	4	1	6	1.5	6	1	6	1	7
Saybolt Viscosity, Furol Seconds at 50°C	35	150	35	150	35	150	75	400	50	---	50	---
Sieve Test, % Retained on 1 mm Sieve	---	0.1	---	0.1	---	0.1	---	0.1	---	0.1	---	0.1
Coating Test %	90	---	90	---	90	---	---	---	---	---	---	---
Settlement 1 Day, % By Mass	---	1.5	---	1.5	---	1.5	---	1.5	---	1.5	---	1.5
Demulsibility: 50 mL 5.55 g/L CaCl ₂ , % By Mass	75	---	75	---	---	---	---	---	---	---	---	---
Workability @ 10°C	---	---	---	---	---	---	---	---	---	---	Pass	---
TEST ON RESIDUE												
Penetration at 25°C, 100 g, 5 s	*		**		**		**		---	---	---	---
Viscosity at 60°C, Pa·s	*		**		**		**		8	20	2	8
Float Test at 60°C, s	1200	---	1200	---	1200	---	1200	---	1200	---	1200	---
Solubility in Trichloroethylene, %	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---

* See Drawing SS SP952-02

** See Drawing SS SP952-03

TABLE 952-L TALL OIL PITCH VISCOSITY AND PENETRATION DATA

REQUIREMENTS	Min.	Max.
Results on original sample		
Absolute Viscosity, 60°C, PaCs	1	2
Kinematic Viscosity, 135°C, mm ² /s	25	35
Penetration, 4°C/100g, 5 sec, 0.1 mm	150	250
Results after Thin Film Oven		
Loss in weight, %	---	0.65
Absolute Viscosity, 60°C, PaCs	---	3
Kinematic Viscosity, 135°C, mm ² /s	---	60
Penetration, 4°C, 100 g, 5 sec, 0.1 mm	75	---

TABLE 952-M TALL OIL PITCH DATA

REQUIREMENTS	Min.	Max.
Softening Point, °C (ASTM D 36)	---	35
Flash Point, Cleveland Open Cup, °C (ASTM D 92)	250	---
Fire Point, Cleveland Open Cup, °C (ASTM D 92)	275	---
Boiling Point, °C	320	---
Specific Gravity	0.94	0.98
Vapour Pressure, mm Hg	---	1
PH	3.75	4.25
Wood Extractive, %	98	---
Ash, % (ASTM D 803)	---	0.8
Moisture, % (ASTM D 803)	---	0.1
Fatty Acids, %	7	9
Resin Acids, %	5	7
Unsaponifiables, %	39	44
Neutrals, %	42	46
Acid Number	20	30

TABLE 952-N EMULSIFIED TALL OIL PITCH

REQUIREMENTS	Min.	Max.
Viscosity, SF, 25°C, s	10	30
Residue by Distillation, % by weight	40	---
Oil Distillate, % by volume	---	0.1
Settlement 24hrs, %	---	1.5
pH	6	8
Particle Charge	Negative	
Miscibility with Water	Pass	
Specific Gravity, 20°C	Approx. 1.0	
Boiling Point, °C	100	
Freezing Point, °C	0	
Vapour Pressure, mm Hg	20	
Odour and Appearance - distinctive resinous Odour, light yellow colour		
TEST ON RESIDUE - Shall conform to the requirements for Tall Oil Pitch listed in table 951-L		

TABLE 952-O EMULSIFIED PRODUCTS

REQUIREMENTS	Min.	Max.
Viscosity, SF , 25°C, s	10	60
Residue by Distillation, % by weight	40	---
Oil Distillate, % by Volume	---	5
Settlement 24hrs, %	Pass	
Miscibility with Water	Pass	
TEST ON RESIDUE		
Penetration, 25°C, 100 g, 5 sec, 0.1 mm	40	200

APPENDIX A

The following data is required from the supplier:

ASPHALT CEMENTS

Grade and Type (when required)

A. Original Asphalt

Density @ 15°C, kg/L

- Viscosity @ 135°C
- Viscosity @ 60°C
- Penetration @ 25°C, 100 g/5 s
- Solubility in Trichloroethylene
- Ductility @ 25°C
- Flash Point C.O.C.
- % Retained Penetration after T.F.O.T.
@ 25°C

B. Residue After T.F.O.T.
(when Type A required)

- Penetration @ 25°C
- Penetration @ 10°C
- Penetration @ 4°C

NOTE: Viscosity - Temperature chart also required for each batch.

CUTBACK ASPHALTS

A. Cutback Asphalts as Supplied

- Flash Point, T.O.C. (C.O.C. above 79°C)
- Density @ 15°C, g/cm³
- Viscosity @ 60°C, mm²/s
- Distillate, % by volume of Total
 - Distillate to 360°C
 - Distillate to 190°C
 - Distillate to 225°C
 - Distillate to 260°C
 - Distillate to 315°C
- Residue from Distillation to 360°C
- Volume % by Difference

B. Properties of Residue

- Penetration @ 25°C
- Ductility @ 25°C
- Solubility in Trichloroethylene, %

C. Residue of 100 Penetration by Mass

- Ductility of 100 Penetration at 25°C, cm

EMULSIONS

A. Original Emulsion

- Saybolt Furol Viscosity @ 25°C
- Saybolt Furol Viscosity @ 50°C
- % Residue by Distillation
- Settlement in 5 Days, %
- Oil Portion of Disillate

B. Tests on Residue

- % to Total Volume
- Float Test @ 60°C, s
- Penetration @ 25°C, 100 g/5 s
- Ductility @ 25°C

SECTION 991

CALCIUM CHLORIDE AND SODIUM CHLORIDE

991.01 Calcium Chloride - Calcium chloride, for highway purposes, shall conform to CGSB Specification 15-GP-1M Calcium Chloride. It shall be supplied as Type I Regular (77%) bulk (flake) or sacked, or as liquid at 35% solution concentration, as specified.

991.02 Sodium Chloride - Sodium chloride, for highway purposes, shall conform to CGSB Specification 15-GP-9M Sodium Chloride, Pavement De-icer but it shall be supplied as shown in Table 991-A.

991.03 Chemical Contamination of Road Salt - When applied as specified, the de-icing chemicals shall not contain substances that exceed the current environmental guidelines, Provincial or Federal, and shall not cause harm to flora and fauna.

Note: CGSB Specifications are obtainable from:
Canadian Government Specification Board,
Ottawa, ON K1A 0S5

TABLE 991-A GRADATION FOR SODIUM CHLORIDE

SCREEN SIZE	PERCENT PASSING
12.0 mm (1/2")	100
9.00 mm (3/8")	90 - 100
4.75 mm (#4)	35 - 85
2.40 mm (#8)	15 - 55
1.20 mm (#16)	5 - 30
0.600 mm (#30)	0 - 10