

TENDER DOCUMENTS

SUBSECTION 6.44 SIGNAGE STRUCTURES

TABLE OF CONTENTS

	PAGE
SUBSECTION 6.44 SIGNAGE STRUCTURES	1
6.44.1 GENERAL	1
6.44.2 Measurement units	1
6.44.3 REFERENCE STANDARDS	1
6.44.4 MATERIALS	2
6.44.5 EXECUTION OF WORK.....	4
6.44.6 QUALITY CONTROL	10
APPENDIX 6.44-I REQUIREMENTS FOR BOLT TIGHTENING	

SUBSECTION 6.44 SIGNAGE STRUCTURES

6.44.1 GENERAL

- 6.44.1.1 This subsection describes the requirements relating to the signage structure works covered by this Contract.
- 6.44.1.2 Any specific requirements pertaining to the signage structure works covered by this Contract are indicated on the plans and in Section 4 *Special Technical Conditions*.
- 6.44.1.3 The requirements relating to reinforcing steel are described in subsection 6.31 *Reinforcing Steel for Concrete*.
- 6.44.1.4 The requirements relating to formwork are described in subsection 6.32 *Formwork*.
- 6.44.1.5 The requirements relating to cast-in-place concrete are described in subsection 6.33 *Cast-in-Place Concrete*.
- 6.44.1.6 The requirements relating to steelwork are described in subsection 6.41 *Steelwork*.
- 6.44.1.7 The requirements relating to aluminum work are described in subsection 6.43 *Aluminum Work*.
- 6.44.1.8 The requirements relating to the manufacture of the precast concrete bases are described in subsection 6.39 *Precast Concrete Elements*.

6.44.2 MEASUREMENT UNITS

- 6.44.2.1 The measurement units and respective symbols thereof used in this subsection are described as follows:

Measurement Unit	Designation	Symbol
area	square meter	m ²
stress, pressure	kilopascal	kPa
stress, pressure	megapascal	MPa
length	meter	m
length	millimeter	mm
mass	kilogram	kg
temperature	Celsius degree	°C
volume	liter	L

6.44.3 REFERENCE STANDARDS

- 6.44.3.1 The Contractor shall carry out all signage structure work in accordance with the requirements of the following standards and documents to which the provisions of this Contract are added:

6.44.3.1.1 (ACNOR(CSA)) Canadian Standards Association:

- CAN/CSA S6 *Canadian Highway Bridge Design Code*.

6.44.3.1.2 (ASME) American Society of Mechanical Engineers:

- ASME B1.1-2003 *Unified Inch Screw Threads, (UN and UNR Thread Form).*

6.44.3.1.3 (ASTM) ASTM International:

- ASTM F593 *Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.*

6.44.3.1.4 (MTQ) Ministère des Transports du Québec:

- MTQ – *Cahier des charges et devis généraux (CCDG) – Construction et réparation;*
- MTQ – *Normes – Ouvrages routiers – Tome III – Ouvrages d’art, chapitre 6 Structures de signalisation, d’éclairage et de signaux lumineux;*
- MTQ – *Normes – Ouvrages routiers – Tome V – Signalisation routière;*
- MTQ – *Normes – Ouvrages routiers – Tome VII – Matériaux, Chapitre 4 Liants et enrobés bitumineux:*
 - Norme 4301 *Traitements de surface.*
- MTQ – *Normes – Ouvrages routiers – Tome VII Matériaux :*
 - Norme 5101 *Armature pour les ouvrages en béton;*
 - Norme 6201 *Boulons, tiges d’ancrages, écrous et rondelles en acier.*

6.44.4 MATERIALS

6.44.4.1 CONCRETE

6.44.4.1.1 The concrete shall comply with subsection 6.33 *Cast-in-Place Concrete.*

6.44.4.1.2 Unless otherwise indicated on the plans, the concrete of the foundation block shall be standard 35 MPa concrete. The concrete of the anchor block shall be of the same type as that of the reinforced concrete elements of the major structure into which it is incorporated. The concrete for the support cushion shall be standard 15 MPa concrete.

6.44.4.2 REINFORCING STEEL

6.44.4.2.1 The reinforcing steel, galvanizing thereof and mechanical junctions of the bars shall meet the requirements of subsection 6.31 *Reinforcing Steel for Concrete.*

6.44.4.3 STEEL

6.44.4.3.1 The structural steel shall comply with subsection 6.41 *Steelwork.*

6.44.4.3.2 The anti-corrosion protection of the metal structures shall meet the requirements for hot-dip galvanizing and for painting of subsections 6.41 *Steelwork* and 6.42 *Painting Work.*

6.44.4.3.3 The structures shall be uniform in colour over the entire surface thereof. Where this requirement cannot be met, these elements shall be covered with a new layer of anti-corrosion protection.

6.44.4.4 ALUMINUM

6.44.4.4.1 The aluminum shall comply with subsection 6.43 *Aluminum Work*.

6.44.4.4.2 With the exception of overhead signage structures with aluminum box sections, the aluminum structures shall be made of parts with no longitudinal welds.

6.44.4.4.3 Where a part is equipped with a reinforcing sleeve, the part shall be fabricated in such a way that the sleeve and the reinforced part are well bonded.

6.44.4.4.4 The surface finish shall be uniform and have an “80 grit” clean shine. The sharp edges shall be rounded, and the surfaces shall be coated with silicone wax.

6.44.4.4.5 Dust and grease shall be removed from the aluminum structures.

6.44.4.5 ANCHOR ELEMENTS

6.44.4.5.1 Steel anchor rods, bolts and washers

6.44.4.5.1.1 The stainless steel anchor rods, bolts and washers shall comply with MTQ standard 6201 and standard ASTM F593. Where a breakaway device requires a specific anchor rod, the rod shall meet the requirements applicable to that device.

6.44.4.5.1.2 The threading of the anchor rods and bolts shall comply with standard ASME B1.1 and shall be Class 1A or Class 1B, as applicable.

6.44.4.5.2 Bolts

6.44.4.5.2.1 The U-bolts and structural bolts used to assemble the aluminum signage structures shall meet the following requirements:

6.44.4.5.2.1.1 type 304 or 316 stainless steel U-bolts with a 19 mm metric diameter;

6.44.4.5.2.1.2 type 304 or 316 stainless steel structural bolts with a 19 mm metric diameter;

6.44.4.5.2.1.3 the bolts shall be tightened according to the tightening torques specified in Appendix 6.44-1 *Requirements for Bolt Tightening*.

6.44.4.5.3 Insert sheath

6.44.4.5.3.1 The insert sheath shall meet the requirements indicated on the plans for the breakaway device that requires it.

6.44.4.5.4 Stub

6.44.4.5.4.1 The stub shall meet the requirements indicated on the plans for the breakaway device that requires it.

6.44.4.5.5 Breakaway device

6.44.4.5.5.1 A breakaway device includes the breakaway base and, based on the type of structure indicated on the plans, the flexible joint and friable connector.

6.44.4.5.5.2 The Contractor shall use a breakaway support included in the list of products approved by the MTQ, if the support is of one of the following types:

6.44.4.5.5.2.1 monolithic post planted directly into the ground (“L6X-1 structures”);

6.44.4.5.5.2.2 post assembled to a socket by insertion (“L6X-2 structures”);

6.44.4.5.5.2.3 post assembled to a socket with a sleeve (“L6X-3 structures”);

6.44.4.5.5.2.4 post assembled to a socket with a slip-plane base (“L6X-4 structures”);

6.44.4.5.5.2.5 safety cabinet;

6.44.4.5.5.2.6 electrical service cabinet;

6.44.4.5.5.2.7 friable coupler system for lateral supersignage structure (“L2X structures”);

6.44.4.5.5.2.8 friable coupler system for lighting structures.

6.44.4.5.5.3 For the approved breakaway supports, the Contractor shall meet the requirements of this subsection as well as those indicated on the plans.

6.44.4.5.6 Identification plate

6.44.4.5.6.1 The identification plate shall be fabricated from a 0.8 mm thick 3003-H14 aluminum alloy. It shall be chromate-treated before being given one coat of black Series 630 DURACRON thermosetting enamel with a 15 % sheen for all structures other than the pull boxes, for which the enamel shall be red. The enamel shall be baked at 232°C.

6.44.5 EXECUTION OF WORK

6.44.5.1 GENERAL

6.44.5.1.1 For each structure, the Contractor shall comply with the location and elevations indicated on the plans. The Contractor shall, before carrying out the work, conduct the worksite surveys and obtain the Engineer’s authorization of the location and elevations of the structures.

- 6.44.5.1.1.1 The Contractor shall, for each signage structure to be installed, ensure that the dimensions of the new vertical supports allow the signage panel's minimum vertical clearance indicated on the plans. The minimum vertical clearance is the distance comprised between the signage panel underside and the highest point of the underlying pavement.
- 6.44.5.1.2 The signage structures shall be designed, fabricated and installed in accordance with standard CAN/CSA S6.
- 6.44.5.1.3 The Contractor shall check on site any existing facilities that need to be thereby modified or that may impede the performance of the work. The Contractor shall also check, on worksite, all the dimensions relating to the exact spans and heights of the overhead structures and other supports. The Contractor may not claim any damages for errors or omissions in the dimensions indicated on the plans.
- 6.44.5.1.4 The information shown on the plans is intended to guide the Contractor. The Contractor is responsible for providing shop drawings compliant with the final structures.
- 6.44.5.1.5 This subsection does not necessarily contain a full and detailed description of all accessories needed to perform the Contractor's work. The Contractor shall therefore supply and install, according to the rules of best practice, all accessories required to carry out a complete work in accordance with the requirements of this subsection.
- 6.44.5.1.6 The foundation block or anchor block shall be constructed according to the plans and subsections 6.31 *Reinforcing Steel for Concrete*, 6.32 *Formwork*, 6.33 *Cast-in-Place Concrete* and 6.39 *Precast Concrete Elements*.
- 6.44.5.1.7 The structure comprise the entire steel structure, the anchor elements, breakaway devices and all accessories.
- 6.44.5.1.8 The Contractor shall provide the Engineer with a design note containing the design details as well as the details of the support structure erection. The design indicated on the plans is provided to the Contractor for information purposes and the design shall be validated and completed by the Contractor. The design note shall include the calculations of the mechanical strength and fatigue resistance of the support structure. The design note and documents showing the erection details shall be signed and sealed by an engineer member of the *Ordre des ingénieurs du Québec* (OIQ). The signage structures supplied by the Contractor shall not have any capacity reserves unless otherwise indicated on the plans.
- 6.44.5.1.8.1 A structural capacity reserve, equivalent to the greater of 10 m² or 25 % of the total surface area of the proposed signage panels, shall be considered when designing the overhead or lateral roadway signage structures to allow for the addition or future modification of signage panels on the structure.
- 6.44.5.1.9 Where breakaway devices are incorporated into a friable structure, the shop drawings shall also state the pertinent information indicated on the plans.

- 6.44.5.1.10 The outer base projection of the anchor elements shall meet the aboveground projection criteria of the residue of a breakaway support.
- 6.44.5.1.11 The design and installation of the structures shall comply with subsections 6.41 *Steelwork* and 6.43 *Aluminum Work*, as applicable.
- 6.44.5.1.12 The conditions under which the materials are stored shall comply with the manufacturer's recommendations.

6.44.5.2 CERTIFICATE OF CONFORMITY

- 6.44.5.2.1 For each delivery of breakaway supports, the Contractor shall provide the Owner with a certificate of conformity containing the following information:
 - 6.44.5.2.1.1 name of the supplier;
 - 6.44.5.2.1.2 name of the manufacturer;
 - 6.44.5.2.1.3 date of fabrication;
 - 6.44.5.2.1.4 place of fabrication;
 - 6.44.5.2.1.5 identification of the approved components used in the structures to be built;
 - 6.44.5.2.1.6 identification of the marking;
 - 6.44.5.2.1.7 certification of the composition of the materials used to fabricate the parts;
 - 6.44.5.2.1.8 characteristics of the parts including, without limitation, the nominal dimensions, steel grade and aluminum alloy;
 - 6.44.5.2.1.9 heat number and results of the tests and analyses;
 - 6.44.5.2.1.10 production batch number.

6.44.5.3 FOUNDATION ELEMENTS

6.44.5.3.1 Cast-in-place foundation block

- 6.44.5.3.1.1 The excavation and backfilling shall be carried out in accordance with the indications on the plans and specifications in regards to the excavation and foundation preparation.
- 6.44.5.3.1.2 Where applicable, the Contractor shall put a support cushion in place in accordance with the indications on the plans and subsection 6.81 *Base and Sub-Base*.
- 6.44.5.3.1.3 The minimum bearing capacity of the soil at the bottom of the excavation shall be 170 kPa. Where that requirement is not met, the Contractor shall put a support cushion in place, according to the laboratory's recommendations. The bearing capacity of the existing soil shall be determined by a laboratory selected and paid by the Contractor.

- 6.44.5.3.1.4 The Contractor shall construct the seat of the foundation block with the accuracy required to ensure that the coupling flanges between all components of the structure to be installed fit perfectly.
- 6.44.5.3.1.5 The anchor elements of the structure shall, before placement of the concrete, be placed in the forms using a template. The Contractor shall ascertain the position of the axes of the vertical supports to be anchored in the foundation block or anchor block. The templates used to place the anchor elements shall have alignment marks to ensure that the posts, poles and triangulated supports are parallel and vertical.
- 6.44.5.3.1.6 In the case of gantries, the vertical supports shall be aligned, and the horizontal support axis shall be perpendicular to the axis of each vertical member.
- 6.44.5.3.1.7 The levelling of the top of the foundation block and the outer base projection of the anchor elements shall meet the criteria governing the aboveground projection criteria of the residue of the breakaway support.
- 6.44.5.3.1.8 For single-span overhead signage gantries, the Contractor shall ensure that the foundation block or anchor block is levelled in such a way that they are even with the seat of the truss or box girder. For double-span girders or girders with one (1) or two (2) cantilevers, the Contractor shall take into account the cambers of the girder and the bearing on the middle support, which may not be level with the bearing points on the edge supports.
- 6.44.5.3.2 Precast foundation block
- 6.44.5.3.2.1 The Contractor shall take all the necessary steps in order to properly position the anchors of the corresponding overhead signage structures in the precast overhead signage structure blocks. Before the installation, the Contractor shall, without however being limited to:
- 6.44.5.3.2.1.1 submit to the Engineer, for review, the fabrication method of the foundation block, the location of the fabrication and demonstrate that he is able to control all aspects to achieve the quality required by the Owner;
- 6.44.5.3.2.1.2 provide for a lifting and transportation mechanism that does not use the permanent bolts intended for anchoring the structures. No block may be moved if the compressive strength of the concrete is less than 20 MPa;
- 6.44.5.3.2.1.3 remove any lifting system installed on the prefabricated foundation block used for transportation. These systems shall be removed down to 25 mm below the concrete surface and the holes shall be sealed with cementitious mortar after placement of the blocks on worksite in accordance with subsection 6.33 *Cast-in-Place Concrete*.
- 6.44.5.3.3 Tumulus
- 6.44.5.3.3.1 Where a tumulus is required, it shall be constructed in accordance with subsection 6.87 *Earthworks* and as indicated on the plans.

- 6.44.5.3.3.2 The embankments of a tumulus and the adjacent terrain shall be sodded by turf laying (P-1) according to subsection 6.89 *Landscaping*.
- 6.44.5.3.4 Surface treatment around a foundation block
- 6.44.5.3.4.1 Where a surface treatment around a foundation block is indicated on the plans, it shall comply with MTQ standard 4301.
- 6.44.5.3.4.2 A TS2 granular material shall be spread and compacted to a thickness of 150 mm. An asphalt emulsion compatible with the granular material shall be applied at the rate of 1.40 L/m². A TS4 granular material shall be applied to the surface at the rate of 15 kg/m² and lightly compacted.
- 6.44.5.4 SIGNAGE STRUCTURE
- 6.44.5.4.1 Implementation
- 6.44.5.4.1.1 The modules or sections of the structure shall be handled and placed using a crane, slings and lift loops. The manufacturer of the structure shall indicate which points may be used for lifting. All components shall be handled, stored and transported in such a way as to eliminate the risk of damage.
- 6.44.5.4.1.2 Unless otherwise indicated on the plans, the posts, poles and triangulated vertical supports shall be placed vertically.
- 6.44.5.4.1.3 The structure shall be installed according to the requirements for the steel structure and in accordance with the plans, the shop drawings and the manufacturer's recommendations.
- 6.44.5.4.1.4 The Contractor shall obtain authorization from the Engineer before modifying or cutting the structure on worksite. Boring holes on worksite is prohibited.
- 6.44.5.4.1.5 It is prohibited to use a power or percussion tool to tighten the bolts. To tighten bolts that require a specific tightening torque, the Contractor shall use a properly calibrated torque wrench.
- 6.44.5.4.1.6 The identification plate shall be fixed by means of stainless steel rivets or metal screws. The identification shall be placed on every vertical support and every section of a truss, box girder, bracket and other horizontal support of the structure.
- 6.44.5.4.1.7 The antivibration device shall be permanently installed.

6.44.5.4.2 Welding

6.44.5.4.2.1 The butt welds and longitudinal welds on an aluminum part are prohibited.

6.44.5.4.2.2 The welded assemblies between a post and an anchor plate shall be carried out by inserting the post into the anchor plate and by making two (2) peripheral fillet welds. In the case of aluminum assemblies, the post walls shall be pressed against the edge of the anchor plate. The permissible deviation between the post and the inner edge of the anchor plate is 0.5 mm over the entire circumference. These assemblies may also be made by full penetration peripheral welds with a fillet weld as groove weld solder buildup.

6.44.5.4.3 Factory pre-assembly of bolted joints

6.44.5.4.3.1 The truss girders and monotubular girders construction joints with coupling flanges shall be factory pre-assembled. Identification numbers shall be engraved onto the coupling flanges engraved before the joints are disassembled and a corrosion-resistant coating is applied.

6.44.5.5 EXISTING STRUCTURES

6.44.5.5.1 The removal and demolition of existing structures shall meet the requirements of subsection 6.21 *Demolition and Removal* in addition to the following:

6.44.5.5.1.1 the structures shall be disassembled with care so as not to damage any components to be preserved, where applicable. Unless otherwise indicated on the plans, the Contractor shall bring the structures back to the Owner's Jacques Cartier Bridge Maintenance Centre.

6.44.5.5.1.2 where indicated on the plans, the Contractor shall level the ground with top soil and carry out mechanical seeding (M-1) according to the requirements for mechanical seeding or hydroseeding of subsection 6.89 *Landscaping*.

6.44.5.5.1.3 Where the foundation blocks to be demolished do not impede the construction of the structures covered by this Contract, the Contractor shall demolish the foundation blocks to 1 m below the finished ground level (existing natural ground). Where the blocks to be demolished impede or prevent the construction of a structure covered by this Contract, the entire block shall be demolished.

6.44.5.5.1.4 The Contractor shall dismantle all components of the existing structure, including the overhead signage panels, vertical supports and hardware.

6.44.5.5.1.5 The Contractor shall transport off-site and dispose of all dismantled components that are not being recovered.

6.44.5.5.1.6 Unless otherwise indicated on the plans, the overhead signage panels shall be re-installed temporarily for the entire duration of the work.

- 6.44.5.5.1.7 The Contractor shall submit a plan signed and sealed by a member of the OIQ showing the details of the signage panel, the type of installation, the required hardware and the location where it plans to temporarily install the overhead signage panel.
 - 6.44.5.5.1.8 Such installation shall be carried out in accordance with subsection 6.14 *Traffic Control and Temporary Signage* and, more specifically, with Article 6.14.8 *Information Signage*, and as directed by the Engineer.
 - 6.44.5.5.1.9 After having obtained authorization from the Engineer, the Contractor may dismantle and immediately reinstall the overhead signage panel.
 - 6.44.5.5.1.9.1 At no time shall a signage structure remain without a signage panel, except for the time required for the immediate replacement of the signage panels.
 - 6.44.5.5.1.10 At the end of the work, the Contractor shall completely dismantle the signage panel and temporary installation thereof, transport it outside the worksite and dispose of it, or reinstall it according to plans and subsection 6.71 *Overhead Signage*.
 - 6.44.5.5.1.11 The structures shall be disassembled with care so as not to damage any components to be preserved.
- 6.44.5.5.2 The dismantling work of each existing structure and signage panels as well as the installation of each new structure and signage panels thereof shall be carried out in a single operation, during a same night.

6.44.6 QUALITY CONTROL

6.44.6.1 Weld inspection

- 6.44.6.1.1 The welds on the signage structures shall undergo the following examinations in addition to the other tests required in Contract:
 - 6.44.6.1.1.1 a butt weld in a part shall be fully (100 %) checked by ultrasounds or X-rayed;
 - 6.44.6.1.1.2 a full penetration weld shall be fully (100 %) checked by ultrasounds or X-rayed;
 - 6.44.6.1.1.3 a longitudinal partial penetration weld shall be checked by magnetic particle inspection on a distance equal to 25 % of the length of the weld beads;
 - 6.44.6.1.1.4 a fillet weld on a steel support structure shall be checked by magnetic particle inspection on a distance equal to 25 % of the length of the weld beads.
- 6.44.6.1.2 Where the assembly of parts for signage structures is carried out, in whole or in part, in a factory other than that of the manufacturer, the non-destructive examinations of the welds shall be conducted at the factory of the manufacturer of the signage structures. The Contractor shall submit the x-rays and the report of the non-destructive examinations of the welds to the Engineer.

END OF SUBSECTION

APPENDIX 6.44-I

REQUIREMENTS FOR BOLT TIGHTENING

(5 PAGES)

REQUIREMENTS FOR BOLT TIGHTENING

PREPARATORY ACTIVITIES

- 1) The Contractor shall, at least fourteen (14) days prior to commencing the work on site, submit its bolting procedure to the Engineer, which shall be signed by an engineer who is a member of the *Ordre des ingénieurs du Québec* (OIQ).
- 2) During the work, the Contractor's engineer may ask an engineer, member of the OIQ, under his responsibility to carry out on-site inspections and issue certificates of compliance for the tightening of the bolts. In the bolting procedure, this engineer shall be designated as the "representative" of the Contractor. The Contractor shall, prior to the start of the work, inform the Engineer in writing, who will be the representative of the Engineer of the Contractor.
- 3) The Contractor's engineer, or its representative, both responsible for the tightening of the bolts verifications, and the Contractor's foreman responsible for steelwork shall attend a meeting with the representatives of the Owner before the bolting work begins. The meeting shall be held at least seven (7) days prior to the bolt installation, but not before the Engineer has received the bolting procedure, thereby deemed complete. The agenda of the meeting shall, notably, include:
 - the review of the bolting procedure;
 - the calibration device that the Contractor intends to use;
 - the Contractor's working methods and the procedure it intends to use for checking the tension in the bolts by means of the calibration device;
 - the on-site storage of the bolts;
 - the stopping points and control points specified by the Engineer;
 - the name and qualifications of the representative of the Contractor's engineer designated to validate the tightening stages.

ON-SITE ACTIVITIES

- 1) The bolts, including the nuts and washers, shall be protected from dust and moisture. Only the sufficient number of bolts intended to be installed during a work shift shall be removed from the storage site. Bolts shall not be cleaned of their lubricant. The bolts that have accumulated rust or sand shall be cleaned and lubricated again before use thereof.

- 2) A calibration device shall be present at all times on the site of the bolting work. This device shall have been calibrated by a certified company, within twelve (12) months preceding the expected date of use thereof. The calibration device shall be used, among other things, to:
- confirm the adequacy of the complete assembly, including the type and lubrication level of the bolts;
 - validate that the materials used to manufacture the bolts meet the standards and that the bolts are not counterfeit or have not been weakened;
 - ensure a good understanding of the bolting procedures by the Contractor's work teams;
 - validate the procedures proposed by the Contractor to carry out the snug tightening;
 - note and provide to the Engineer, with the help of a torque wrench, the mean values of torques corresponding to the turn of the nut at final tightening in accordance with Table 10.18 of standard CAN/CSA-S6-06, adding 5° of additional rotation of the nut. These values shall be provided for a minimum of three (3) bolts for each batch of bolts.
- 3) The only tightening method accepted for this Contract is the turn-of-the-nut method.
- 4) The Contractor shall first proceed with the snug tightening of the bolts, which is intended to bring the plate surfaces into perfect contact. For this Contract, the snug tightening shall be considered as an initial tension in the bolts of approximately 15 % of the minimum value indicated in Article 10.24.6.3 of standard CAN/CSA-S6-06 (please refer to Table I below). The Contractor shall note that in some cases, the snug tightening may require more than one tightening cycle. The snug tightening shall move from the most rigid part of the assembly towards the free edge of the assembly plates. Unless otherwise specified by the Engineer, it is prohibited to use an air impact wrench for the snug tightening operation.
- 5) Once the snug tightening has been completed, the Contractor shall notify the Engineer thereof in writing. The assemblies affected by the snug tightening being the subject of the notice shall be clearly identified in the latter.
- 6) The tests conducted by means of the calibration device shall allow the confirmation that the method provided by the Contractor is capable of producing a tension in the bolts that is at least 5 % greater than the minimum value indicated in Article 10.24.6.3 of standard CAN/CSA-S6-06 (please refer to Table I – below);

- 7) The snug tightening of approximately 10 % of the bolts of each assembly, with a minimum of three (3) bolts for assemblies with less than ten (10) bolts and a minimum of six (6) bolts for the other assemblies, shall be checked by the Contractor's engineer or his designated representative, in the presence of the Engineer. The snug tightening of a bolt is deemed compliant when the bolt can be loosened by means of a spud wrench of a length of at most 400 mm. The snug tightening of an assembly is deemed compliant when all bolts tested are equally compliant. When the snug tightening of a bolt is not compliant, the bolt shall be replaced. The snug tightening of all the other bolts of the joint shall be checked and every non-compliant bolt shall also be replaced; the compliant bolts of this joint may be loosened. The snug tightening operation shall then be redone and the checking procedure shall be followed again.
- 8) All bolts and nuts shall be marked in the 12 o'clock position, half-diameter of the bolt and adjoining nut, by the Contractor's engineer or designated representative. When this step of the bolt tightening procedure is deemed satisfactory by the Engineer, the latter gives the Contractor a written notice authorizing him to proceed with final tightening of the assemblies.
- 9) Following the snug tightening and authorization issued in accordance with paragraph 8 above, the Contractor shall proceed to the final tightening of the bolts, by turn-of-the-nut or bolt head when the bolt is equipped with washers, according Table 10.18 of standard CAN/CSA-S6-06, that is, one third (1/3) turn for bolts of a length equal to or less than four (4) diameters and one half (1/2) turn for bolts of a length greater than four (4) diameters, but less than 200 mm. The final tightening shall progress systematically from the most rigid part of the assembly towards the free edge of the plates.
- 10) Once the final tightening of an assembly is completed and at the end of each work shift, the Contractor shall, in the presence of the Engineer and using a torque wrench, check 10 % of the bolts of each assembly, but not less than two (2) bolts per assembly. If no nuts or bolt heads rotate when the torque is applied, the tightening is compliant. If, on the contrary, the torque makes the nut or bolt head, or even a single bolt being in the course of being checked, turn, the tightening is not compliant. In such a case, all the assembly bolts shall be checked, tightened and checked again.
- 11) When the final tightening is completed on a whole assembly, the Contractor's engineer or his representative shall give the Owner a certificate confirming the compliance of each assembly. That notice shall indicate that the bolt tightening was carried out in compliance with each step of the bolting procedure submitted by the Contractor, shall identify the targeted assembly and specify the dates and times of the inspections conducted by the engineer who signed the certificate.

12) The checking of the snug tightening, the checking of the marking the bolts and nuts, the checking of the final tightening as well as the preparation and signature of the certificate shall be done by the engineer who signed the bolting procedure or his representative. In addition, a certificate, signed by the engineer who signed the bolting procedure, certifying that all bolt tightening work has been performed in accordance with the Contractor's procedures, shall be submitted to the Engineer at the end of the work.

Table I - Snug tightening and final turn-of-nut tightening

Bolt (type and dia.)		Nominal dia.	Area	Minimum final turn-of-nut tightening (kN)*				Snug tightening (kN) 15% of the min. final turn-of-nut tightening	
Metric	Imperial	mm (in.)	(mm ²)	A325	A325M	A490	A490M	A325 or A325M	A490 or A490M
	1/2"	12.70 mm (0.5")	127	53	...	67	...	8	10
	5/8"	15.88 mm (0.625")	198	85	...	107	...	13	16
M16	...	16 mm	201	...	91	...	114	14	17
	3/4"	19.05 mm (0.75")	285	125	...	157	...	19	24
M20	...	20 mm	314	...	142	...	178	21	27
	7/8"	22.23 mm (0.875")	388	174	...	218	...	26	33
M22	...	22 mm	380	...	176	...	220	26	33
M24	...	24 mm	452	...	205	...	257	31	39
	1"	25.40 mm (1")	507	227	...	285	...	34	43
M27	...	27 mm	573	...	267	...	334	40	50
	1-1/8"	28.6 mm (1.125")	641	249	...	356	...	37	53
M30	...	30 mm	707	...	326	...	408	49	61
	1-1/4"	31.75 mm (1.25")	792	316	...	454	...	47	68
	1-3/8"	34.93 mm (1.375")	958	378	...	538	...	57	81
M36	...	36 mm	1018	...	475	...	595	71	89
	1-1/2"	38.1 mm (1.5")	1140	458	...	658	...	69	99

*70% of the minimum tensile strength specified in the ASTM Standard (see S6-06 article 10.24.6.3)