Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
281	Individual	Under 910.04.02.02 Post-Tensioning Working Drawings, I suggest that is be made clear that the details for the ducts must include the appropriate friction and wobble coefficients to be used in the design calculations. These are very important coefficients that can impact the engineer's tensioning calculations if the contractor changes suppliers or uses a different supplier from what was assumed during design. The contractor should also be advised that the jacking forces specified in the Contract Documents is subject to change upon review of the working drawings.	**The friction and wobble coefficients for the supplied duct are added as a requirement on the post-tensioning working drawings.** **Friction and wobble coefficients used in design are assumed, and any discrepancies between the design and the actual values should be resolved through the working drawings review.**
285-1	Tensacciai srl (TENSA)	**910.04.02.04** **Couplers** **910.04.02.04.01** **General** At least 3 weeks prior to the commencement of the work, a copy of the post-tensioning system manufacturer's catalogue giving complete data on the coupler material, installation procedures, and test reports from the manufacturer certifying that the strength and fatigue requirements have been satisfied shall be submitted to the Contract Administrator. Should it be "Anchorages"? Seems to me that what is down in the following paragraphs is more related to anchorages than just couplers.	**The clause heading and two clauses under it, General and Testing, apply only to couplers.**
285-2	Tensacciai srl (TENSA)	**910.04.02.04.02** **Testing** Dynamic tests are not required on bonded tendons, unless the anchorage is located or used in such a manner that repeated load applications could be expected on the anchorage. A dynamic test for tendons shall be performed on a representative anchorage and coupler specimen and the results submitted to the Contract Administrator. The tendon shall withstand, without failure, 500,000 cycles from 60 to 66% of its minimum specified ultimate strength and also 50 cycles from 40 to 80% of its minimum specified ultimate strength. The period of each cycle shall be the change from the lower stress level to the upper stress level and back to the lower. The specimen used for the second dynamic test may be the same one used for the first dynamic test. Systems using multiple strands, wires, or prestressing steel bars may be tested using a test tendon of smaller capacity than the full-sized tendon. The test tendon shall duplicate the behaviour of the full-sized tendon and generally shall not have less than 10% of the capacity of the full-sized tendon. I suggest allowing also use of ETAG 013 Annex B.2 "Resistance to fatigue" testing	**Clause is revised to refer to require dynamic testing only when specified by the design, and to refer to more recent standards for fatigue testing across anchorages.**
285-3	Tensacciai srl (TENSA)	**910.05.02.02** **Plastic Ducts** Plastic ducts, including their splices, shall be made of polyethylene or polypropylene according to PTI/ASBI M50.3 and shall be vapour-tight and remain so after tendon installation and stressing. Plastic for the external post tensioning ducts shall be code letter D or E for colour and ultraviolet (UV) stabilizer according to ASTM D3350. The plastic duct shall be manufactured according to ASTM D2239 from virgin material. Plastic ducts shall not be used when the specified radius of curvature of the tendon is less than 10 m. The ducts shall be capable of being curved to the specified radius without damage. The duct wall thickness shall not be less than 1 mm for the specified minimum radius of curvature, after a tendon movement of 750 mm under a tendon stress of 80% of the specified strength. For curved ducts, the radial force, as exerted on the duct wall by a single strand, shall not exceed 40 kN/m. The plastic ducts shall meet the following requirements: a) For ducts with an inside diameter of 50 mm or less, a 3 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20 °C. b) For ducts with an inside diameter of more than 50 mm, a 6 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20 °C. This value seems to be set regardless of the size of the tendon. Especially for smaller size of tendons, curvature radius below 10 m is easily achievable still being compliant with requirements set in FIB Bulletin 75 (see §6.8 – 6.9; Annex A.8 and A.9). Ducts up to 130 mm used with 37 strands are also capable of achieving curvature radii below 10 m. I would remove the sentence and refer to requirements set in FIB Bulletin 75.	**The sentence is deleted and replaced with guidance to the designer in other MTO publications.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
285-4	Tensacciai srl (TENSA)	c) The duct shall not deform more than 3 mm under a point load of 445 N applied through a No. 10 reinforcing steel bar located between the corrugation ribs at a temperature of not less than 20 °C. d) Material thickness shall be as follows: i. Corrugated, internal duct shall have a minimum of 2.0 mm wall thickness or meet the requirements of FIBBUL 75 Table 8.1, with ETAG 013 approval. Corrugated duct shall have at least 2 longitudinal flow channel ribs throughout the cross section. ii. External ducts shall have an external diameter to wall thickness ratio of 17 or less. **910.05.02.03 Ducts at Deviators** Ducts within a deviator for post-tensioning tendons shall be galvanized steel pipe according to ASTM A53, Type E, Grade B, with a wall thickness of not less than 3 mm. The duct shall be formed to conform to the alignment of the tendon. ETAG 013 does not refer to FIB Bulletin 75 but instead to older outdated FIB Bulletin 7. There is no ETAG 013 approval on corrugated plastic ducts. It would be useful to get information on the technical reason behind this requirement. It may restrict use to only one brand of ducts in the market. In fact, such kind of ducts with longitudinal flow channels is patented (or patent pending) as far as I know.	**Reference to ETAG 013 will be deleted, along with the requirement for the longitudinal flow channels.**
285-5	Tensacciai srl (TENSA)	**910.07.04 Installation** **910.07.04.01 Post-Tensioning System** Half-shell duct supports shall be used to support the inside radius of curvature for bonded rounded ducts when the radius of curvature is less than 20 m. Monostrand jacks shall not be used to stress tendons with six or more strands. MTO form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator after the installation of the post-tensioning system is complete and prior to placing the concrete. The next operation shall not proceed until MTO form PH-CC-702, Notice to Proceed, has been received from the Contract Administrator. (see also previous comment) Since all sizes available in the market meet requirements set in FIB Bulletin 75 leading to curvature radius below 10 m, this requirement of half shell duct supports may potentially be applied in several cases where this is not standard practice worldwide.	**MTO will maintain the requirement for half shell supports in areas of moderately lower curvature based on FIB 75 guidance considering different regional practices (e.g lower clear spacing vertically between ducts).**
286-1	Freycan Major Projects Ltd	**910.02** Technically, this specification is covering both internal bonded post-tensioning and external post-tensioning provided with bare strand and cementitious grout Please note that ETAG 013 has been superseded by EAD 160004-00-0301.	**The specification is intended to cover internal tendons only as specified in 910.01 Scope. The specification will be revised to cover internal bonded tendons only.**
286-2	Freycan Major Projects Ltd	**910.04.01.02 Design of Anchorage Zone** Introduction of existing official certification of PT anchorage such as EAD 160004-00-0301, could be valuable in order to ease the acknowledgement by designers of the anti-bursting design. **Potential Wording** Existing International Standard across the world are available. Demonstration by the PT system suppliers, or by an independant Certified authority (recognized by the ILAC network) to one of the following shall be considered as acceptable: - EAD 160004-00-0301 - Post Tensioning Kits for prestressing tendons, (Certification document is the European Technical Assesment). - AASHTO	**CSA S6 provides appropriate guidance, and the specification aligns with the requirements of S6. Certification of the system is required elsewhere in the specification.**
286-3	Freycan Major Projects Ltd	**910.04.02.04.01 General** Introduction of existing official certification of PT anchorage such as EAD 160004-00-0301, could be valuable in order to ease the acknowledgement by designers of system compliance.	**Refer to the response to comment 285-1 and 285-2. MTO will consider this for future revisions.**
286-4	Freycan Major Projects Ltd	**910.04.02.04.02 Testing**	**Refer to the response to comment 285-1 and 285-2.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
		It might be controversial to leave the requirement for a dynamics test to an interpretation such as "in such manner that a repeated load applications could be expected on the anchorage. Typically, external tendons might be deemed to be subjected to repeated load applications	
286-5	Freycan Major Projects Ltd	**910.05.01.01 General** **Potential Wording** Proposition to add: the Post Tensioning anchorage system shall comply with at least one of the following standards for static load: - EAD 160004-00-0301 - Post Tensioning Kits for prestressing tendons, (Certification document is the European Technical Assesment). - AASHTO	**MTO will consider this for future revisions.**
286-6	Freycan Major Projects Ltd	**910.05.01.02 Anchorages** It could be worth to add that dynamic testing carried out in the frame of an approval process or other projects can be used as an evidence as long as it is third party witnessed to avoid significant testing costs to overload small projects. As only plastic duct is allowed but plastic duct cannot be used when radius is below 10m, there is no option for application requiring tight radius such as U-shaped tendons in pier caps or vertical loop etc… **Potential Wording** Proposition to add: the Post Tensioning anchorage system shall comply with at least one of the following standards for static load: - EAD 160004-00-0301 - Post Tensioning Kits for prestressing tendons, (Certification document is the European Technical Assesment). - AASHTO	**We think this comment applies to unbonded tendons. The reference to unbonded tendons is deleted from this section.**
286-7	Freycan Major Projects Ltd	**910.05.02.04** Typical diameter for vent available from renown supplier is 3/4 inch (slightly lower than 20 mm)	**Specification will be updated to reflect standard vent sizes available**
286-8	Freycan Major Projects Ltd	**910.05.03.02** 55 MPa **Potential Wording** To be corrected into 35 Mpa as per PTI M55.1-12	**On some projects, the designer specifies concrete strengths higher than 35 MPa. It is unlikely that strength would ever be an issue for the products included in the specification if all other grouting tests are successful.**
286-9	Freycan Major Projects Ltd	**910.06.02** * Item d) is this applicable to the measuring device of the mixing machine. * 1 MPa Potential Wording Please add: In case of strongly deviated or vertical tendons the pressure safety valve may need to be reset to an higher value which may be as high as 2 MPa * Suitable equipment to grout a number of ducts simultaneously shall be readily available. This requirement is too vague and must be removed or clarified.	**The calibration applies to the mixer.** **Refer to response to comment 287-5. Guidance to designers is geared towards avoiding strongly deviated tendons.** **Last sentence in 910.06.02 is deleted.**
286-10	Freycan Major Projects Ltd	**910.07.04.01** Fusion welding shall not be permitted for internal duct but it is a common, economical and reliable practice for external duct which are not provided with proprietary coupler.	**The specification applies to internal bonded tendons only.**
286-11	Freycan Major Projects Ltd	**910.07.06.03** It is also a standard practice to produce and store enough grout to fill a whole tendon, However, in case of large tendon, the 15 min mark might fall short.	**The specification has been revised to allow 30 minutes between mixing and pumping.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
286-12	Freycan Major Projects Ltd	**910.06.04** c) .. **Potential Wording** …or digital pressure gauge shall be used. f) is too vague. **Potential Wording** Please replace by: The pressure reading shall be done in static configuration in order to prevent the measure of being impacted by dynamic effect g) **Potential Wording** If digital pressure gauge are used such requirements does not apply.	**Specification will be updated to reflect comments**
286-12	Freycan Major Projects Ltd	**910.07.03** * Prestressing steel shall be free of rust or pitting prior to grouting and injected within allowable timebar. In such a case there should be no need to check corrosion state of the stressed strand inside the duct which is not a usual and convenient practice. In case allowable timebar cannot be met, temporary protection shall be renewed, and corrosion state might be checked * Dry air **Potential Wording** amend into dry air (RH<=50%)	**Based on recent studies, vapour phase corrosion inhibitor has been removed as an option and dry air with 40% relative humidity is specified to maintain temporary corrosion protection.**
286-13	Freycan Major Projects Ltd	**910.07.04.01** * Pushing or pulling of strands through …..cut ducts. **Potential Wording** Shall be replaced by … 'that will limit the snagging of strand into the duct' as maintening parallelism of strand cannot be generally guaranted over long tendon provided with large units. * Monostrand shall not be used to stress tendons with two or more strands unless they are used in a flat duct.	**The specification is revised to remove mention of parallelism, and to restrict monostrand jacks to tendons in flat ducts.**
286-14	Freycan Major Projects Ltd	**910.07.06.01** **Potential Wording** To be added: If grouting cannot be performed withing specified duraton, a temporary protection can be applied by the contractor in order to extend the delay between threading and grouting. This temporary protection can include : soluble oil solution, corrosion inhibitor, or blowing dry air (RH<=50%).	**This requirement is captured under 910.07.03**
286-15	Freycan Major Projects Ltd	**910.07.07.01.02** a) **Potential Wording** Amend into: This test shall include a flowability follow up for the complete duration of the intended workability period. **910.07.07.01.03** a)…measured trial batch values. **Potential Wording** To be added: … and not below 7s. c)…be equal or greater than… **Potential Wording** To be replaced by : within ±3% of value measured in the mixer	a) **This clause is intended to cover the trial batch only so it wouldn't apply here. Production follow up tests are covered under 910.07.07.01.03a)** **The spec refers to PTI M55.1 clause 4.4.7 which covers a follow up test after 30 minutes.** **The specification is revised to include a minimum efflux time of 5s.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
			The wet density test is required to verify water cement ratio of the grout and ensure that no additional water was introduced to the grout after mixing.
287-1	Canadian BBR Inc	910.01 "This specification covers...internal..." Comment; Limiting scope to internal PT conflicts with e.g., 910.05.02.01 covering external PT ducts.	**The specification applies to internal bonded tendons only.**
287-2	Canadian BBR Inc	910.05.01.02 "...Anchorages for unbonded..." Comment; Unbonded PT are excluded from scope per 910.01.	**The specification has been updated to remove the last paragraph in clause 910.05.01.02**
287-3	Canadian BBR Inc	910.05.02.01 "Ducts for internal post-tensioning shall be corrugated plastic." Comment; Currently there is only one manufacturer (General Technologies Inc., Texas, USA) of plastic ducts for post-tensioning worldwide. There will be significant detrimental commercial and scheduling impacts if plastic ducts are mandated yet only available from one source. We strongly recommend a gradual transition from metal ducts (ubiquitous in Ontario for more than 60 years), to allow time for additional sources of plastic ducts to become available.	**The requirements of the plastic ducts have been revised to allow ducts from other manufacturers to be supplied, should a supplier choose to source them from outside of North America.** **The transition to plastic ducts is in keeping with industry best practices moving forward, and based on the number of projects tendered by MTO, is a gradual transition.**
287-4	Canadian BBR Inc	910.06.02 a) "A high-shear..." Comment; This is duplicate of the preceding paragraph.	**The duplication has been corrected.**

Ontario

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
287-5	Canadian BBR Inc	910.06.02 "The grout pump....and shall be equipped with a pressure gauge and a pressure valve set to release at a pressure of 1 MPa." Comment; Setting the requirement to 1 MPa = 145 psi is too low for the new high performance thixotropic pre-packaged grouts in Table 1. If the grout machine is set back from bridge due to site conditions, it is not uncommon to see 400-450 psi.	**The specification is modified to allow higher pressures for vertical tendons.** **For typical grouting operations, PTI M55.1 C5.6.3 indicates that thixotropic grouts require a bit more pressure to get started but then should flow the same as 'normal' grouts. Pressure above 1 MPa usually indicates a problem and high grout pressures could rupture ducts or concrete section.**
287-6	Canadian BBR Inc	910.06.02 "The grouting equipment shall be of sufficient capacity to ensure that the grouting of the longest duct can be completed within 30 minutes after mixing. The velocity of grout in the duct shall be between 6 and 12m/min and the pressure shall be compatible with the length and size of the duct." Comment; These requirements are not compatible with the new high performance thixotropic pre-packaged grouts in Table 1. Using a short to medium bridge as an example; say 19/15mm tendons at 115m long. Approximately 63 bags of Target bridge grout required per tendon. Mixing time per batch is 5 minutes (according to manufacturers specification/data sheet). When grouting longitudinal tendons, the hopper of the mixer is filled prior to commencing pumping of the tendon. Say 2 batches = 5 min mixing = 10 minutes total used. Additional 4 batches required = 20 minutes. Total mixing time = 30 minutes. Short medium bridges can be done, longer span bridges, say ramps from 403 Hamilton to 407 in Burlington, not possible. The velocity requirement proves to be better suited for all bridges; 115m bridge = 12.75 minutes (average 9m/min). From experience, this is on the fast side of grouting. Our experience is closer to 5m/min. A 115m bridge is grouted in approximately 23 minutes. If you interpret the data, you can see that the length of mixing time doesn't allow for continuous pumping if you use 5min/m as we see in practice; mixing time is longer than pumping time. This is not practical as we would have to push grout in the duct from a stopped/still condition, which is hard on the equipment. Our solution is to always utilize 2 mixers. The secondary mixer is pumped in to the hopper of the first mixer, thereby allowing for continuous pumping of grout at 5m/min.	**The specification is modified to reduce the lower end to 5 m/min.** **For tendons longer than 150 m, two parallel mixing operations or larger equipment might be required.**
287-7	Canadian BBR Inc	910.06.02 "A backup mixer in good....during grouting. Suitable equipment to grout a number of ducts simultaneously shall be readily available." Comment; Please remove last sentence. Writing "Suitable equipment to grout a number of ducts simultaneously shall be readily available". This should not be in the clause; having additional equipment and labour to grout simultaneously should be the post tensioners prerogative. Having this sentence may lead the general contractor to assume he can demand to have multiple set-ups, dictating how the post tensioner is to proceed doing the work.	**The last sentence in clause 910.06.02 is deleted.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
287-8	Canadian BBR Inc	910.07.04.01 "Prestressing steel, ducts, anchorages.....of concrete. The ducts shall be supported and secured at intervals not exceeding 0.6m and a smooth profile shall be maintained. Flat ducts shall be supported and secured at intervals not exceeding 0.5m" Comment; Spacing of support bars is (very) dependent of stirrup spacing. Typically not an issue, but if the spacing of stirrups is 0.6m, tying of flat ducts will be at 300mm which is excessive. "Monostrand jacks shall not be used to stress tendons with six or more strands." Comment; For transverse tendons at a pier, especially under the deck/winged section, it is very difficult to use a multistrand jack. The frame assembly requires both space (incl. concrete blockout of deck overhang), and partial formwork to be removed for access. We have not experienced any difficulty stressing multistrand tendons that; 1. Are relatively flat like abutment or deck transverse. 2. Have a simple parabolic curve like on single shaft piers.	**The specification is revised to require a tighter spacing only for flat ducts which are not preloaded with strand.** **The monostrand jack requirement is revised to be limited to flat tendons.** **Guidance to designers will be written to alert them of the challenges of jacking below a deck cantilever and encourage alternate detailing.**
287-9	Canadian BBR Inc	910.07.04.02 "Vents shall be installed as follows: e) For all tendons other than top slab transverse.....as a drain is located at the low point." Comment; Drains at low points historically were placed to bleed any water during fall/winter conditions, thereby trying to avoid concrete spalling form ice formation. With respect to having a low point for grouting, all tendon ducts are blown with compressed air to remove trapped water in the duct. Any remaining water is flushed naturally by the higher density grout pushing the water to the outlet vents; either high points or endpoint. As per MTO procedure in clause 910.07.06.05 "The consistency of grout.....injection vent. The outlet at the end of the tendon shall not be permanently closed until the wet density consistency meets the established acceptable range." Also, cannot access voids at time of grouting to operate drain hoses directed towards the interior of the box. Instead, the drain hoses must be directed towards the top slab in order to access them during grouting, which defeats the intended purpose.	**Provision of drains at low points follows established best practices, even after blowing with air and without flushing.** **The specification is revised to require that drain tubes be routed to permit positive drainage.**

Ontario

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
287-10	Canadian BBR Inc	910.07.04.04 "When strands are installed after concreting, a torpedo shall be passed through the longitudinal ducts prior to closing the forms to check for obstructions and after initial set of the concrete to confirm the ducts are free of any obstructions according to PTI/ASBI M50.3." Comment; Checking for blockages prior to concreting by using a torpedo is not required. 1) Blockages occur if the duct has been pierced by a foreign object (rebar) and concrete paste or aggregate has partially or completely filled the space. 2) Blockages occur if the connections (couplers) have not been secured/installed correctly. 3) Blockages occur if the duct itself has been damaged prior to installation. 4) In the longitudinal direction, both bulkheads are installed for castings to be mounted and the closing of formwork has already occurred. If concrete has been poured, passing a torpedo prior to closing of forms is impossible. Only if the duct connections are improperly installed will a torpedo provide any indication of improper placing. Other conditions, piercing of duct and bent/damaged duct, can both pass a torpedo passing through the duct.	**The clause is revised and no longer requires a torpedo prior to concreting.**
287-11	Canadian BBR Inc	910.08.02 c) Clause 910.08.02 c) No damage to prestressing steel, anchorages, ducts, vents and other system components fall under the "Acceptance of Post-tensioning System". We have a quality verification program, our foremen completes an inspection and our QVE Engineer provides a placing certificate. Confirming the ducts are free of any obstruction other than concrete aggregate or paste due to damage during the concrete pour is not required. Canadian BBR ALWAYS installs tendons prior to concrete and this is irrelevant to this contractor. Only post tensioning contractor who push strand after concrete does this apply, but pushing a torpedo prior to concrete pour still doesn't prevent possible blockages. If the intent is to check for blockages prior to trying "threading" of strand after concrete has been poured, and to prevent undo effort of remove partially installed tendon, then the clause should read; "When strands are installed after concreting, a torpedo shall be passed through the longitudinal ducts to check for obstructions to confirm the ducts are free of any obstructions according to PTI/ASBI M50.3."	**Noted. This clause within the Quality Assurance section forms the basis for acceptance of the work.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
287-12	Canadian BBR Inc	910.07.05.04 "Where the theoretical and actual elongations are significantly different, the Contractor's Engineer may request the Contractor to carry out a friction test...." Comment; A 'proper' friction test requires a baseline, meaning you need to have a straight tendon with no profile/sag to establish wobble and curvature coefficients. Data collected from stressing a flat tendon can be compared to a tendon with a profile, back calculated to establish the coefficients. Typically, the following procedure is followed; 1. Check total length of tendon and elongation mm/m of tendon. 2. Check calibration report, ram area of jacks, pressure calculation. 3. Check for strand damage/breakages/wedges seating. 4. Check consistency/variance to other tendons of similar length. 5. Check mill test reports for modulus of elasticity. 6. Check bench mark pressure, possible increase to 20% of total pressure as recommended by PTI. a. Canadian BBR uses 1000 psi as a standard bench mark. This has been company practice and creates consistency for stressing crews.	**This clause is deleted.**
287-13	Canadian BBR Inc	910.07.05.05 "In no case shall the low relaxation steel be tensioned above 85% of its tensile strength". Comment; Bridge Design Code (S6). At Jacking 0.8fpu for strand and 0.75fpu for HS Deformed bar. Suggest matching wording or provide chart with all permissible stresses; peak, anchor and transfer.	**This clause is intended to capture a maximum limit or overstressing, where required. Design jacking loads are specified on the Contract Drawings.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
287-14	Canadian BBR Inc	910.07.06 "Grouting shall carried out...or more than 14 Days from the time of first installation..." Comment; In the case of installing strands before concreting, the 14-day limit should be from time of stressing. The time from concreting to stressing can be over 14 days in some cases.	**The clause is revised to allow up to 21 days between first installation and grouting. If the time between stressing and grouting exceeds 14 days, temporary corrosion protection of prestressing steel is required per clause 910.07.03.**
287-15	Canadian BBR Inc	*910.07.06.04* "When the ambient air temperature exceeds 15°C, the grout shall be stored and protected in a shaded area. The temperature of the grout in the holding tank.....but shall not exceed 35°C." Comment; The batch trial testing conducted on site on June 2, 2022 showed that with water at 10° C (an approx. lower limit suggested by Target Products Ltd.), an ambient temperature of 16.5 to 18° C (relatively low for summer months) and the min. mixing time of 5 minutes, an average grout temperature of 31.5° C was achieved for the two 9 bag mixes. Therefore, it is unlikely that the upper limit of 30° C will be achieved in summer temperatures. The trial batch testing shows that the flow, expansion, bleeding and early compressive tests were all within the range of the Target material spec sheets. The batch flow rate testing showed a flow of 19 sec immediately after mixing and 19.5 sec 30 minutes after mixing.	**The specification states a value which is already higher than many specifications and achievable in most situations, and there is evidence that elevated grout temperatures increase bleed quantity.** **The limit has been increased from 30C to 35C to mitigate this concern.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
287-16	Canadian BBR Inc	910.08.03.02 "Compressive strength shall be considered acceptable when the lot strength is greater than or equal to the specified 28 Day compressive strength." Comment; The post tensioner follows the prescription/parameters consisting of mixing time, water ratio, temperature, flow rate, approved material manufacturer, pumping rate, equipment requirement, not withstanding direction from both the Contract Administrator and the Contractor. If all parameters have been followed, and if the grout strength is greater than the concrete strength of the bridge, acceptance should be given. The strength requirement in the late 1980's and early 1990's was based on mixing Aluminum powder and Norlig C with type 30 High Early cement. Due to the inconsistency, pre-bagged & pre-mixed grouts were introduced into the market. "Unacceptable grout shall be subject to removal and replacement." Comment; Replacement would be ideal, but realistically IMPOSSIBLE. All necessary measures mentioned throughout this document are in place for successful grouting of structures. Suggest the wording, "Unacceptable grout shall be subject to review and an approved remediation procedure, if any, shall be specified to ensure the appropriate level of protection to the post tensioning."	**Refer to response to comment 286-8. If the strength were not achieved, it would initiate a non-conformance to find the cause, and address the implications.**
288	VSL	910.02 References: ETAG 013- Obsolete. It has been replaced by EAD 160004-00-0301 Post-tensioning systems for prestressing of structures. Also, EAD 16007-00-0301 Special filling products for post-tensioning kits has been issued	**Reference to ETAG 013 will be deleted and a reference to EAD 160004-00-0301 is added.**
289	VSL	910.04.01.01 "induced slip requirement" -what does "induced slip requirement" refer to? Does it mean "wedge draw-in"? if so, it is system-dependant and covered on each system ETA or equivalent	**The specification is revised to 'design slip' to be clear that it relates to the value provided by the designer in the Contract Documents.** **The practice in Ontario is for the designer to specify a 'required slip' on the contract drawings. The required slip is consistent with values recommended in CSA S6-19. If the system cannot conform to that requirement, the Contractor would need to propose an alternate means of achieving similar overall stress limits in the tendon or submit an RFI.**
290	VSL	910.04.02.02 "where posttensioning tendons are anchored on concrete…" Only passive anchorages based on concrete embedded bulbs are considered. Other passive anchorages typologies (i.e. Anchor head + wedges + cap; i.e. anchor head + compression fitting + cap; others…) Also, "onion" anchorages (induced bulbs on strand ends) are not compatible with PL2 protection level) as per 910.05.02.01	**The specification is revised to permit other passive anchorages, but still cover this situation in case a designer specifies these. MTO has separate guidance to the designer to avoid bond-head anchorages.**
291	VSL	910.04.02.04.02 Testing Why this testing chapter falls under Couplers chapter? Shouldn't it be under anchorages chapter?	**Refer to response to comment 285-2.**
292	VSL	910.04.02.04.02 Testing	**Refer to response to comment 285-2.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
		"unless the anchorage is located or used in such a manner that repeated load applications could be expected on the anchorage." - Who decides if the anchorage is subject to dynamic loads? - Can previous representative tests used to justify the requirements? - Are ETA testing requirements (2M cycles; maxF=0.65fpk; DeltaF=80MPa) valid in lieu of?	**Previous representative tests can be used. MTO will consider revising the dynamic testing protocol for future revisions.**
293	VSL	910.04.04.05 "Mill test certificates for prestressing bars…" strand is missing. We propose to use "main tensile element" instead (as in other documents, such as FiB)	**Prestressing steel strand mill test certificated are covered under clause 910.04.02.05 and OPSS 1440**
294	VSL	910.04.02.08 Corrosion inhibitor Vapour phase corrosion inhibitors (VPCI) are banned in Florida. Some studies of failed tendons were linked to the VPCI's poor dispersive properties and non-uniform protection. Soluble oil corrosion protection products are recommended, and of widespread use around the industry	**VPCI has been removed from the specification**
295	VSL	910.05.01.01 "when anchorages and couplers for PT are tested in an unbonded condition" we are not aware of any testing procedure that tests PT in a grouted condition. - No requirement on elongation? Only on force? "After tensioning and the initial slip required to seat the strands has occurred…" slip is proportional to load applied, so total slip won't take place until final load is applied, regardless of the system "Anchorages for unbonded tendons shall not cause a reduction in the total elongation of the tendon, under ultimate load, greater than 2% measured in a minimum gauge length of 3 m." o Unbonded tendons are out of the scope of the standard, as per 910.01 o If this statement refers to bonded tendons tested in unbonded condition (as listed above), it is not clear the sense of the comment. 2% of 3m is 6 cm!!	**MTO will consider revising anchorage testing requirements for future revisions.**
296	VSL	910.05.02.01 "The ducts, including joints, shall be watertight, vapour-tight and nonreactive with concrete, tendons, or grout. The ducts and components shall meet the requirements of Post-Tensioning System Tendon Protection Level 2 (PL-2) according to PTI/ASBI M50.3" - All Tendon components (anchorages, caps, etc…) should meet the requirements of PL2 Protection level, not only the duct components "Ducts for external post-tensioning shall be made from smooth, and rigid polyethylene" external PT is out of the scope of the standard, as per 910.01	**MTO has adapted the protection level requirements deemed suitable for use in Ontario. We have considered that some requirements of PTI/ASBI, such as coating the anchorage devices, are not necessary to ensure the performance of the system based on detailing guidance to designers in other manuals.**
297	VSL	910.05.02.02 "Plastic for the external post tensioning ducts shall be code letter D or E for colour and ultraviolet (UV) stabilizer according to ASTM D3350. The plastic duct shall be manufactured according to ASTM D2239 from virgin material." - external PT is out of the scope of the standard, as per 910.01 In order to guarantee PL2 level for precast segmental schemes, a chapter about segmental couplers is missing and should be included. Segmental couplers must guarantee PL2 protection, while allowing for misalignments in between segments "Plastic ducts shall not be used when the specified radius of curvature of the tendon is less than 10 m." - minimum radius should be dependant on duct diameter + stressing force + use/no use of protective shells. For very tight radius, application of a given type of duct should be validated by testing "ii. External ducts shall have an external diameter to wall thickness ratio of 17 or less." - external PT is out of the scope of the standard, as per 910.01	**Some provisions for smooth ducts are included in the specification for future external prestressing, however unbonded and external tendons are otherwise out of scope.** **The specification does not cover segmental construction, and the scope statement is elaborated to be clear on exclusions. MTO has separate guidance to the designer to limit the radius to 10 m or above.**
298	VSL	910.05.02.03	**This clause is deleted.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
		"Ducts at Deviators Ducts within a deviator for post-tensioning tendons shall be galvanized steel pipe according to ASTM A53,Type E, Grade B, with a wall thickness of not less than 3 mm. The duct shall be formed to conform to the alignment of the tendon." - Does it refers to external tendons? If so, out of scope of the standard, as per 910.0	
299	VSL	910.05.05.01 Missing paragraph regarding Strand / wires, only prestressing bar is mentioned	**The first paragraph of the clause covers strand, by reference to OPSS 1440.**
300	VSL	910.05.05.02 Vapour phase corrosion inhibitors (VPCI) are banned in Florida. Some studies of failed tendons were linked to the VPCI's poor dispersive properties and non-uniform protection. Soluble oil corrosion protection products are recommended, and of widespread use around the industry	**The clause is generic to corrosion inhibiting coating in the form of water soluble (emulsifiable) oil. The specification is revised to prohibit VPCIs.**
301	VSL	910.06.04 "Each gauge shall be capable of indicating forces directly in Newtons or be accompanied by a conversion chart so that the imperial readings can be converted into Newtons" - Gauges usually indicate pressure, not Force. This allows use of same calibrated set of pump and gauge with different hydraulic jacks (different ram areas) . A conversion chart must be provided "Each gauge shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer." - Calibration curves must be certified by a third party. Stamping and sealing by an engineer can be logistically challenging/impossible, depending on the specific requirements of laboratories	**Noted.** **The specification is revised to remove the need for an engineer to sign of on the calibration.**
302	VSL	910.07.01 Personnel must be present also during duct installation works, apart from concreting / stressing / grouting	**The specification is revised to require supervisory personnel for installation.**
303	VSL	910.07.03 Vapour phase corrosion inhibitors (VPCI) are banned in Florida. Some studies of failed tendons were linked to the VPCI's poor dispersive properties and non-uniform protection. Soluble oil corrosion protection products are recommended, and of widespread use around the industry "All material shall be clean and free of oil, dirt, scale, and pitting." - Soluble oil corrosion protection products must be considered as a valid protection (industry widespread and standard use)	**Refer to response to comment 286-12.**
304	VSL	910.07.04.01 "Fusion welding of ducts in not permitted." - Does it also affects mirror welding?	**No Mirror Welding either.**
305	VSL	910.04.02.05 "Test results shall be provided for relaxation testing of prestressing steel bars for the same heat number as the material supplied for the work" - Does it also apply to strand?	**No**
306	VSL	910.05.01.02 "Primary tendon anchorages shall be multi-plane bearing type." - The definition "multi-plane bearing type" is a subgroup of special bearing plates, as defined in PTI-M50.3. and associated only to certain proprietary systems. We recommend to substitute the "multi-plane bearing type" wording by "special bearing plate" as per PTI-M50.3 definition.	**The intent was for primary (longitudinal) anchors of multi-strand tendons to be multi-plane type. The specification has been revised.**
307	VSL	910.05.02.01 "The diameter of a duct, or an equivalent diameter of a non-circular duct, shall not exceed 40% of the least gross concrete section thickness at the location of the duct." - This requirement is a structure design requirement, not a PT system requirement	**This requirement is removed from the specification.**
308	VSL	910.05.02.02 "Corrugated duct shall have at least 2 longitudinal flow channel ribs throughout the cross section. "	**Refer to response to comment 285-4.**

Comments received by TCP			
TCP Comment ID	**Organization**	**Comment**	**Discussion/ Response**
		- This requirement is found only on one supplier in the industry and it is not required in any other standard/codes. Neither steel duct (corrugated) or smooth duct for external tendons doesn't include any longitudinal channel ribs "The plastic ducts shall meet the following requirements: a) For ducts with an inside diameter of 50 mm or less, a 3 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20 °C. b) …" - We recommend to use Fib requirements FIBBUL 75 for qualification of the duct system, instead of a mixed requirement. The listed requirements a), b) c) seem to refer to FIBBUL 75, but not complete	**MTO will consider revising the duct stiffness requirements in a future revision.**
309	VSL	910.05.03.01 "The pre-packaged dry grout mixtures shall be used within 6 months of packaging and shall be stored on site for a maximum of 1 month" - duration on site should be increased to 6 months, with proper storage conditions. 910.06.02 Grouting equipment "Calibrated within a 6 month period preceding the work. The device shall be accompanied by a certified calibration curve that bears the seal and signature of an Engineer" - It is not understood what needs to be calibrated in a grouting pump. It should be removed.	**Due to the environment which typically exists in the field, MTO considers a maximum site storage duration of 1 month to be reasonable and achievable.** **The calibration requirements cover any sensor used in the grouting pump such as pressure transducers and flow/pressure meters etc.**
310	VSL	910.07.01 "Personnel employed or licensed by the manufacturer of the post-tensioning system shall carry out the work" - we recommend an external certificate such as PTI level 1 as minimum	**The requirement had been added to the specification.**
311	VSL	910.07.05.01 "For anchorages and couplers, samples shall be selected by the Contract Administrator on a random basis." - very unspecific. How many? Sizes? For what purpose?	**Anchorages would be sampled in exceptional cases, for example, if a defect or non-conforming material is suspected. Samples may be tested independently by the owner for Quality Assurance purposes.**

Comments received by email			
Number	**Organization**	**Comment**	**Response**

1.	**AECOM**	Sorry for not getting back to you sooner, I wanted to share some of the past issues I have noted on PT projects in Ontario. From reading the proposed spec, it appears that the pt system (strands or rods) can be installed prior to casting the deck. We had a recent experience where this was carried out and there was leakage in many of the ducts and they could not be stressed properly. Based on the elongation reports it was clear that there were locations in the ducts where concrete had leaked and the strands could not be stressed properly, even when stressing from both ends. Is the intent to allow contractors to install the strands prior to casting the deck? If that is the case I would likely recommend a note on the drawing specify that strands could not be installed until the deck was cast. On a similar note, one of the issues that came up on a post-tensioned railway bridge we designed for a municipality was the time between installing and stressing the strands. The deck was cast and the strands were installed, however the deck never reached its compressive strength. As the condition of the deck was in question, the strands were left in the deck for a long period of time. As the contractor could not confirm the condition of the strands prior to stressing and the potential to corrosion due to leakage, the strands were removed and replaced. Is there a limitation on time that strands/bars can be left in place prior to stressing, which could be significant if they are allowed to be installed prior to casting the deck. It's good to see that we are going to non-steel systems, I think the US has been doing that for some time and it has worked well. I've attached a photo of a deck panel I worked on with all plastic ducts, I can't recall if I shared it with you before:  Figure 7: deck panel ready to be cast	Thank you for your comments and sharing your experience. Moving forward, we will allow only plastic ducts which should help reduce the potential for damage or puncture of the ducts. We will closely follow the projects over the new few years. It has been the practice in Ontario for decades to install strand into ducts prior to concreting. Part of the rationale was that if there was damage during concreting, at least it would be possible to stress the strands (and hopefully dislodge that concrete as appears was not possible on your projects) instead of losing the entire tendon. I'm not sure how widespread a concern it is. As well, the strand stiffens the duct which keeps wobble friction down. Transverse flat ducts are usually 'preloaded' with strand because they are otherwise quite flexible. In our review of many current references on the subject and in discussion with suppliers, it can be acceptable to install strands either prior to concreting or after. The spec now has requirements for conditioning the tendons if the strands are left in place in a stressed condition for longer than 14 days. There are reasons, such as the case you mention, when the time between installation and grouting, or the time between stressing and grouting, might extend beyond specified or anticipated limits.

Ontario