SUBCONTRACT AGREEMENT

Between

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of **SNC-LAVALIN CONSTRUCTORS (PACIFIC) DRAGADOS CANADA, INC., ELLISDON CORPORATION**

and

THALES CANADA INC. coba THALES CANADA, TRANSPORTATION SOLUTIONS

Relating to the
Supply of Automatic Train Control Systems
Subcontracted Works for the Ottawa Light Rail Transit Project

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This SUBCONTRACT AGREEMENT ("Subcontract') made the 12th day of February 2013.

Between:

> **OLRT CONSTRUCTORS**, an unincorporated joint venture consisting of **DRAGADOS CANADA, INC.** ("**Dragados**"), a corporation organized under the laws of Canada, **ELLISDON CORPORATION** ("**EllisDon**"), a corporation organized under the laws of Ontario, and **SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.** ("**SNC**"), a corporation organized under the laws of Canada, (the "**Construction Contractor**"), having its registered office at 195 The West Mall, Toronto, Ontario M9C 5L5 (hereinafter called "**the Construction Contractor**") of the one part;

and

> **Thales Canada Inc. coba Thales Canada, Transportation Solutions**, having its registered office at 105 Moatfield Drive, Toronto, Ontario M3B 0A4 CANADA (hereinafter called the "**Subcontractor**") of the other part

Whereas the Construction Contractor has been awarded an engineering, procurement and construction contract ("**Prime Contract**") by Rideau Transit Group General Partnership, a general partnership established under the laws of Ontario consisting of between ACS RTG Partner Inc., SNC RTG Partner Inc. and EllisDon Partner Inc. ("**Project Co**") dated on or about February 12, 2013.

Whereas the Construction Contractor desires that the following portion of the Construction Works, dealing with the Supply of Automatic Train Control Systems, known as the "**Subcontracted Works**", should be executed and completed by the Subcontractor.

Whereas the Subcontractor represents having the capability, know-how, skills, financial resources and personnel required to perform and complete the Subcontracted Works in accordance with the provisions of this Subcontract.

Wherefore the Construction Contractor and the Subcontractor agree as follows.

Article I – Subcontractor's Basic Obligation

The Subcontractor shall:

(a) observe all provisions of this Subcontract in compliance with Applicable Law;

(b) perform, and ensure that the Subcontractor Personnel perform, the Subcontracted Works:

i. in compliance with Applicable Law;

ii. in compliance with all Permits, Licences and Approvals as defined in this Subcontract and so as to preserve the existence and continued effectiveness of any such Permits, Licences and Approvals;

iii. so as to satisfy the Design and Specification Requirements;

iv. in accordance with the Subcontractor's Design Data;

v. in accordance with Good Industry Practice (Works);

vi. in a manner consistent with the Quality Plans;

vii. in a timely and professional manner;

viii. with due regard to the health and safety of persons and property;

ix. subject to the other provisions of this Subcontract, in a manner which will not impair the ability of the Construction Contractor or any Construction Contractor Personnel, Project Co or any Project Co Party, the City or any City Party to comply with Applicable Law;

x. subject to the other provisions of this Subcontract, in a manner which will not impair the performance of the Governmental Activities;

xi. in accordance with all other terms of this Subcontract;

(c) in accordance with the Article IV – Back-to-Back Principle, reasonably assist the Construction Contractor and Project Co in cooperating with the City in the fulfillment of the purposes and intent of the Project Agreement, provided however that the Subcontractor shall not be under any obligation to perform any of the Construction Contractor's obligations under this Subcontract or the Prime Contract, other than in relation to the scope of this Subcontract;

(d) cooperate with and provide reasonable assistance to the Construction Contractor in developing and implementing, in accordance with Schedule 15-4 – Regulatory Standards, regulatory standards relating to the design, construction, operation, safety, security and maintenance of a light rail transit system, including the System and the Project;

(e) cooperate with and provide reasonable assistance to the Construction Contractor and Project Co in fulfilling their obligations under Schedule 38 – Extensions and Additional Phases to the Project Agreement; and

(f) enter into an Option to Purchase Agreement granting to the Construction Contractor the Option to purchase additional complete vehicle onboard equipment packages at a fixed unit price as per the duration and manner of exercise as per Schedule E attached to this Subcontract.

The Subcontractor acknowledges that the Construction Contractor is responsible for the Integration of the System and is required to cause the System to be constructed and Integrated such that Revenue Service Availability shall have occurred on or before the Required Revenue Service Availability Date. The Subcontractor shall execute the Subcontracted Works with due regard to the Integration of the System and directions that the Construction Contractor may give in respect of Integration. The Subcontractor will give the Construction Contractor the full benefit of its knowledge and experience in the Construction Contractor's efforts to achieve Integration. In particular, the Subcontractor will give notice to the Construction Contractor of any reasonable concern that it may have for the achievement of Integration.

Article II – Construction Contractor's Basic Obligation

The Construction Contractor shall :

(a) observe all provisions of this Subcontract in compliance with Applicable Law;

(b) make such payments to the Subcontractor as are specifically provided for under this Subcontract, including the Subcontract Price at the times and in the manner prescribed in Schedule B;

(c) perform those additional obligations specifically provided for in this Subcontract.

Article III – Coming into Force

Clauses 1.16.1 and 1.16.2 of this Subcontract shall come into full force and effect on the date when the Subcontract has been signed by both Parties. All other provisions of this Subcontract shall come into full force and effect when all of the following conditions are satisfied (the "**Commencement Date**"):

(a) The Subcontractor has provided the Construction Contractor with the Performance Security; and
(b) Financial Close of the Project Agreement has been achieved.

If any of these conditions (other than that referred to in subparagraph (b)) have not been satisfied by the date of Financial Close of the Project Agreement, the Construction Contractor will be entitled to terminate this Subcontract and the Subcontractor will be responsible for the Construction Contractor's Direct Losses (to the extent same are recoverable under this Subcontract) resulting therefrom. If Financial Close of the Project Agreement has not been achieved by February 28, 2013, this Subcontract shall be null and void and of no effect, unless the Parties, acting reasonably, agree in writing to extend such deadline.

Article IV – Back-to-Back Principle

Subject to the terms and conditions of this Subcontract (including without limitation, the exclusions of liability and limits of liability contained herein), the Subcontractor, shall, during

the Term of this Subcontract, take all necessary steps to enable the Construction Contractor to perform the covenants of the Construction Contractor under the Prime Contract that are reasonably related to the construction and delivery of that portion of the Design and Construction Works that comprise the Subcontracted Works and the Subcontractor's obligations pursuant thereto (as defined in this Subcontract including the Thales-Alstom Scope Split, attached to this Subcontract as Schedule N), but excluding any covenants relating to indemnification, any indemnities, and/or any warranties given by Construction Contractor (including those indemnities and/or warranties relating to the Subcontracted Work). The Subcontractor's obligation in this clause shall be referred to as the "Back-to-Back Obligation(s)". For greater certainty:

(a) Where the Construction Contractor is required to perform a covenant under the Construction Contract, to the extent that such covenant constitutes a Back-to-Back Obligation, it will be deemed to be acting reasonably in requiring the Subcontractor to comply with any such Back-to-Back Obligation;

(b) If the Subcontractor acting reasonably is in disagreement as to whether a covenant under the Construction Contract or the Prime Contract is a Back-to-Back Obligation under the Subcontract that the Subcontractor is required to perform under this Subcontract, both the Subcontractor and Construction Contractor agree to try and resolve the disagreement in good faith. Failing a mutual resolution of any disagreement, the Subcontractor will comply with a direction of the Construction Contractor to comply with the disputed Back-to-Back Obligation, in whole or in part, in which case the Subcontractor may refer the matter to dispute resolution in accordance with Clause 20;

(c) The Subcontracted Works to be performed and delivered shall be as specified in the Subcontract and attached Schedules, as may be amended from time to time in accordance with the provisions of the Subcontract;

(d) Notwithstanding the terms of the Construction Agreement or the Prime Contract and the foregoing, the Subcontractor's obligations in respect of indemnification, warranty, and liability shall only be as specified in this Subcontract;

(e) The Construction Contractor shall, subject to and in accordance with the Clause 9 of this Subcontract, be entitled to, and Construction Contractor is obliged to exercise on the Subcontractor's behalf, all rights and obligations (including the benefit of any representations and warranties of, or indemnification by, Project Co under the Prime Contract), so that the Subcontractor will be able to avail itself, through the Construction Contractor, of Project Co's rights under the Project Agreement to the extent applicable to the Subcontracted Works to the extent of harm or loss suffered by the Subcontractor; and

(f) the Parties agree that where a provision of the Prime Contract and/or the Project Agreement is inconsistent in respect of such Obligations with a provision of this Subcontract, this Subcontract shall govern.

1.0 GENERAL PROVISIONS

1.1 Definitions

In the present Subcontract, the following words and expressions shall have the meanings stated hereinafter. Capitalized terms used and not defined herein have the meaning set out in the Project Agreement.

"**Affiliate**" means an "**affiliate**" as that term is used in the *Securities Act* (Ontario) and any successor legislation thereto, and, in the case of the Subcontractor and Project Co, shall include each of its unitholders, shareholders, partners or owners as the case may be.

"Applicable Law" means:

(a) any statute or proclamation or any delegated or subordinate legislation including the OLRT Regulations;

(b) any Authority Requirement; and

(c) any judgment of a relevant court of law, board, arbitrator or administrative agency which is a binding precedent in the Province of Ontario,

in each case, that is known and in force in the Province of Ontario, or otherwise binding on respectively Project Co, any Project Co Party, the Subcontractor, the City, any City Party or any City Person.

"**Approved Purposes**" means:

(a) the performance of Governmental Activities (and operations relating to such performance), the obligations of the City under the Project Agreement and/or any other activities of the City or a Governmental Authority in connection with the System, the Lands, and any System Extension;

(b) following termination of the Project Agreement, the design, construction and/or maintenance of the System, and/or the performance of any other operations the same as, or similar to, the Project Scope; and

(c) the development by the City of transportation standards, policies and procedures.

"**Approved Subcontract Schedule**" has the meaning ascribed thereto in Sub-Clause 8.3.2. of this Subcontract.

"Automatic Train Control", "ATC", "Communication Based Train Control" and **"CBTC"** mean automatic train control systems for the Project.

"**Background Information**" means any and all drawings, reports (including Environmental Reports, Archaeological Reports, Geotechnical Data Reports, Environmental Assessments and Highway Site Information), studies, data, documents, or other information, given or made available to Project Co or any Project Co Party by the City or any City Party, or which was obtained from or through any other sources prior to Commercial Close, including without limitation, all data contained in the file entitled "Background Information" in the Data Room and that was accessible to Project Co during the Request for Proposals process.

"**Business Day**" means any day other than Saturday, Sunday, a statutory holiday in the Province of Ontario or any day on which banks are not open for business in the City of Ottawa, Ontario.

"Canadian GAAP" shall be deemed to be the generally accepted accounting principles from time to time approved by the Canadian Institute of Chartered Accountants, or any successor institute, applicable as at the date on which such calculation is made or required to be made in accordance with generally accepted accounting principles, as such principles may be amended or varied by International Financial Reporting Standards then in effect in Canada, in any case consistently applied from one period to the next.

"**Change in Law**" means the coming into effect or repeal (without re-enactment or consolidation) in Ontario of any Applicable Law, or any amendment or variation of any Applicable Law, including any judgment of a relevant court of law which changes binding precedent in Ontario in each case:

(a) except as provided for in subparagraph (b) below, after the Commercial Close; and

(b) notwithstanding subparagraph (a) above, after the Submission Date with respect to any prospective change in any Applicable Law as a result of any bill entered into federal or provincial legislature in Ontario after the Submission Date which is subsequently enacted as Applicable Law.

"**City**" means the City of Ottawa, which has entered into the Project Agreement with Project Co.

"**City Activities**" includes the provision of all governmental services and the conduct of all activities performed in or associated with light rail transit and other services of a similar nature.

"**City Event**" means any act or omission of the City or a City Party or an instruction issued by or on behalf of the City under the Project Agreement, any circumstance which is the responsibility of the City under the Project Agreement, including any Variation, Change in Law, Compensation Event, Delay Event, Force Majeure, Relief Event, breach of the Project Agreement by the City, City Event of Default, any indemnity provided by the City, any entitlement to receive interest on overdue amounts at the Default Interest

Rate, and any entitlement to have City pursue insurance claims or claims against third parties, or any other event or circumstance which may entitle Project Co to any extension of time, financial compensation or relief from obligations in accordance with the Project Agreement.

"**City Events of Default**" has the meaning given in Section 46.1(a) of the Project Agreement.

"**City Indemnified Parties**" means the City, IO, and any of their respective directors, officers, employees, agents or advisors, including the Consultant, the City's Representative and any delegate of the City's Representative.

"City Party" means any of the City's agents, contractors and subcontractors of any tier engaged with respect to the Project Scope, including the Consultant, its or their respective directors, officers and employees and IO and its directors, officers and employees, but excluding Project Co and any Project Co Party, and the "City Parties" shall be construed accordingly.

"**City Variation**" means a Variation initiated by the City under the Project Agreement.

"CLA" means the *Construction Lien Act* (Ontario).

"**Claim**" means any claim, demand, action, proceeding or liability.

"**Commencement Date**" means the dated notified under Article III above.

"**Completion**" means completion of the Subcontracted Works, in accordance with the terms of this Subcontract and readiness of the Subcontracted Works to be integrated into the System so that Revenue Service Commencement may be achieved. The criteria for achieving Completion are further defined in Clause 11 of this Subcontract.

"**Completion Certificate**" means a certificate issued under Clause 10 of this Subcontract.

"**Confidential Information**" means all confidential and proprietary information which is supplied by or on behalf of a Party, whether before or after Commercial Close.

"**Construction**" means the construction, testing, commissioning and completion of the Subcontracted Works as required by this Subcontract, including all labour, materials, construction equipment and the supply, installation, testing and commissioning of Equipment.

"**Construction Contract**" is defined in the recital of this Subcontract.

"**Construction Contractor Event**" means:

(a) a breach of any of the express provisions of this Subcontract (whether or not resulting in a Construction Contractor Event of Default) by Construction Contractor or any Person for whom Construction Contractor is responsible for (including its subcontractors), excluding any City Event, Project Co Event or Maintenance Contractor Event; or

(b) negligent acts or omissions, other tortious conduct, fraud or wilful misconduct of Construction Contractor or any Person for whom Construction Contractor is responsible for, excluding any City Event, Project Co Event or Maintenance Contractor Event

but, for greater certainty, not including any City Event, Project Co Event or Maintenance Contractor Event.

"**Construction Contract Price**" means the contract price payable to the Construction Contractor pursuant thereto.

"**Construction Contractor**" means Dragados Canada, Inc., SNC-Lavalin Constructors (Pacific) Inc. and EllisDon Corporation.

"**Construction Contractor's Documents**" means the documents in this Subcontract, the Prime Contract, the Project Agreement and all schedules, appendices and attachments thereto and other documents made by (or on behalf of) the Construction Contractor. Construction Contractor's Documents do not include Subcontractor documents identified as Subcontractor Confidential Information.

"**Construction Contractor's Equipment**" means the apparatus, machinery and vehicles (if any) made available by the Construction Contractor for the use of the Subcontractor in the execution of the Subcontracted Works.

"**Construction Contractor Events of Default**" means any of the events enumerated in Sub-Clause 16.2.1 of this Subcontract.

"**Construction Contractor Indemnified Parties**" means the Construction Contractor, the City, Project Co, the Lenders' Technical Advisor and the Independent Certifier, and the agents, officers, directors and employees of each of the foregoing.

"**Construction Contractor's Personnel**" means the Construction Contractor's Representative, the assistants referred to in Sub-Clause 3.2 of this Subcontract and all the other staff, labour and other employees of the Construction Contractor and any other personnel notified to the Subcontractor by the Construction Contractor or the Construction Contractor's Representative, as Construction Contractor's Personnel.

"**Construction Contractor's Representative**" means the person named by the Construction Contractor in the Subcontract or appointed from time to time by the

Construction Contractor under Sub-Clause 3.1 of this Subcontract, who acts on behalf of the Construction Contractor.

"**Construction Contractor Variation**" means a Variation to this Subcontract.

"Construction Equipment" means any equipment used by the Subcontractor or any of its Sub-subcontractors to perform Construction, but does not include Equipment, as defined below.

"**Contamination**" means the presence of any Hazardous Substance, chemical compound, mineral, gas, metal, carbon, radioactive isotope, organic material or other substance in the environment, including naturally occurring substances, where the presence of any of the foregoing substances in the environment is at concentrations which exceed applicable standards as set by Applicable Law or where monitoring, remediation or removal of such any of the foregoing substances is otherwise required pursuant to Applicable Law. If Contamination is present in soil, rock, surface water or groundwater, then the soil, rock, surface water or groundwater, as applicable, containing the Contamination shall also be deemed to be Contamination for the purposes of the Project Agreement.

"**Correction**" means correction of any error or Defect in any part of the Subcontract Works designed, supplied or constructed by the Subcontractor and is discovered and undertaken after the issue of the Performance Certificate.

"Default Interest Rate" means interest at [redacted]% per annum over the Interest prime rate.

"**Defect**" means any defect, deficiency, error or fault in the Design or Construction of the Subcontracted Works.

"**Defects Notification Period**" means the period for notifying Defects in the Subcontracted Works or a Section (as the case may be) under Sub-Clause 12.1 of this Subcontract.

"**Delay Liquidated Damages**" means, depending on the context, delay liquidated damages which the Subcontractor is obliged to pay to the Construction Contractor pursuant to Sub-Clause 7.6, Sub-Clause 8.3.6, Sub-Clause 8.6, Sub-Clause 13.2, and Sub-Clause 13.3 of this Subcontract.

"**Design**" means the entire process for the design of the System as required by the Project Agreement.

"Design and Specification Requirements" means the following documents:

1) Subcontractor Technical Exceptions and Deviations Rev03 2012-09-28 attached to this Subcontract as Appendix I;

2) Subcontractor Technical and Program Conditions attached to this Subcontract as Attachment B;

3) CBTC System Specification attached to this Subcontract as Schedule M;

4) Thales-Alstom Scope Split attached to this Subcontract as Schedule N; and

5) Output Specifications, but only to the extent that the Output Specifications are applicable to the Subcontracted Works.

It is understood that in the event of an error, omission, ambiguity, discrepancy or inconsistency in this Subcontract, the specific documents shall govern and take precedence as stipulated above. Any additions and modifications to such documents shall be processed in accordance with the provisions of the Subcontract.

"Design Data" means all drawings, reports, documents, plans, software, formulae, calculations, and other data prepared by Project Co or any Project Party relating to the design, construction or testing of the System, but excluding Intellectual Property Rights of third parties, such as CAD software, that is used only in the process of design and construction.

"**Direct Cost**" has the meaning given in the Project Agreement at Schedule 22 – Variation Procedure.

"**Direct Losses**" means, in respect of an event or omission, without duplication, all damages, losses (including for greater certainty, losses related to the Construction Contract Price or the Subcontract Price or losses related to the Construction Agreement which the Construction Contractor is obligated to pay to Project Co as a result of Project Co being required to pay to City), liabilities, penalties, fines, assessments, claims, actions, costs, expenses (including costs incurred in respect of fuel, OC Transpo labour costs, vehicle wear and tear and the cost of legal or professional services, legal costs being on a substantial indemnity basis), proceedings, demands, judgements and charges (subject to a duty to mitigate as specified in this Subcontract or otherwise at law), whether arising under statute, contract or at common law, which result directly from such event or omission but excluding any Indirect Losses.

"Discriminatory Change in Law" means any Change in Law the effect of which is to discriminate directly against or impose additional Taxes which apply specifically to:

(a) transit systems, including light rail transit systems whose design, construction, financing, operations, maintenance, rehabilitation, safety and security are procured by a contract similar to the Project Agreement in relation to other similar transit systems;

(b) the System in relation to other transit systems, including light rail transit systems;

(c) the Highway in relation to other public highways;

(d) Project Co in relation to other persons; or

(e) Persons undertaking projects for design, construction, financing, operations and maintenance that are procured by a contract similar to the Project Agreement in relation to other persons undertaking similar projects procured on a different basis,

except that such Change in Law shall not be a Discriminatory Change in Law:

(f) where it is in response to any act or omission on the part of Project Co which contravenes Applicable Law (other than an act or omission rendered illegal by virtue of the Discriminatory Change in Law itself);

(g) solely on the basis that its effect on Project Co is greater than its effect on other Persons;

(h) where such Change in Law is a change in Taxes that affects Persons generally; or

(i) in the case of a change to an OLRT Regulation that falls within the exception circumstances described in subparagraphs (a) and (b) of Section 38.4 of the Project Agreement.

"**Disputes**" means all disputes, controversies or claims arising out of or relating to any provision of this Subcontract, the alleged wrongful exercise or failure to exercise by a Party of a discretion or power given to that Party under this Subcontract or the interpretation, enforceability, performance, breach, termination or validity of this Subcontract including, without limitation, the dispute procedures identified within Schedule I attached to this Subcontract or any matter referred to for resolution pursuant said Schedule I (collectively and individually, a "**Dispute**") shall be resolved in accordance with the provisions of said Schedule I.

"**Dispute Resolution Procedure**" means the procedure set forth in Clause 20 of this Subcontract and set out in Schedule I attached to this Subcontract.

"Documentation" shall mean the information, manuals, documents, data, designs and drawings listed to be remitted by the Subcontractor to the Construction Contractor under this Subcontract concerning the design, installation, operation, maintenance and/or repair of the Equipment and Software, as the case may be.

"Encumbrance" means, with respect to the Lands and the System and the Highway Site and Highway, any mortgage, lien, pledge, judgment, execution, charge, security interest, restriction, claim or encumbrance of any nature whatsoever including claims of the Workplace Safety and Insurance Board, Canada Revenue Agency and other Governmental Authorities.

"**Equipment**" means all equipment designed, constructed or supplied by the Subcontractor to be integrated into, and to form part of, the permanent Subcontracted Works.

"Final Completion" with respect to the Subcontracted Works means the completion of the Subcontracted Works in accordance with this Subcontract, including rectification of all Minor Deficiencies.

"**Final Statement**" has the meaning set out in Schedule B attached to this Subcontract.

"**Force Majeure**" means:

(a) war, civil war, armed conflict or terrorism;

(b) nuclear or radioactive contamination of the Site, unless the source or cause of the contamination is the result of the action of the Subcontractor;

(c) chemical or biological contamination of the Site from an event described in item (a);

(d) pressure waves caused by devices traveling at supersonic speeds; or

(e) the discovery of any Species-at-Risk, fossils, artifacts and other objects having artistic, historic, archaeological or monetary value, including human remains and burial sites, which, as a result of Applicable Law, requires the Design and Construction Works or the Highway Work to be abandoned.

"**General Warranty Period**" has the meaning set out in Sub-Clause 12.1.

"**Goods**" means Construction Equipment, Materials, Equipment and Temporary Works, or any of them as appropriate.

"Good Industry Practice (Works)" means using standards, practices, methods and procedures to a good commercial standard, conforming to Applicable Law and exercising that degree of skill and care, diligence, prudence and foresight which would reasonably and ordinarily be expected from a qualified, skilled and experienced person engaged in a similar type of undertaking under the same or similar circumstances, provided that this definition applies throughout the Project Scope excluding the Highway and the Highway Work.

"**Governmental Activities**" means the provision of all governmental services and the conduct of all activities provided in connection or otherwise associated with the Lands and the System by any Governmental Authority or Emergency Service Provider, and includes the City Activities.

"**Has Knowledge**" or "**Have Knowledge**" means:

(1) With respect to all persons except the City,

(a) a natural person knows or has knowledge when information is acquired by the person under the circumstances in which a reasonable person would take cognizance of it; and

(b) a corporation knows or has knowledge when information has come to the attention of:

i. a director or officer of the corporation; or

ii. a senior employee of the corporation with responsibility for matters to which the information relates,

under circumstances in which a reasonable person would take cognizance of it.

(2) With respect to the City,

(a) the City knows or has knowledge when information has been received or has come to the attention of:

i. the Director, Rail Implementation Office;

ii. the Deputy City Manager – Infrastructure Services and Community Sustainability; or

iii. the City Manager of the City,

under circumstances in which a reasonable person would take cognizance of it and, in the case of Project Co, shall include matters referred to in subparagraph (a) or (b) above with respect to the Contractors, and "**Knowledge**" has a corresponding meaning.

"Hazardous Substance" means any contaminant, pollutant, dangerous substance, toxic substance, liquid waste, industrial waste, gaseous waste, hauled liquid waste, hazardous material, or hazardous substance as defined or identified pursuant to any Applicable Law.

"**Holdback**" means the accumulated retention monies which the Construction Contractor retains under the *Construction Lien Act* (Ontario) and pays under the provisions of Schedule B.

"HST" means the value-added tax imposed pursuant to Part IX of the *Excise Tax Act* (Canada) and any successor legislation thereto.

"Income Tax" means any tax imposed on the income of a Person by any Canadian Relevant Authority.

"Indirect Losses" means loss of profits, loss of use, loss of revenue, loss of contract, loss of goodwill, loss of production, loss of business opportunity, exemplary or punitive damages or any consequential loss or indirect loss of any nature, other than the following:

(a) losses (including loss of profits) related to the Contract Price or Subcontract Price; and/or

(b) losses related to the Construction Agreement which the Construction Contractor is obligated to pay to Project Co as a result of Project Co being required to pay the City pursuant to the terms of the Project Agreement.

"**Independent Certifier**" means the person appointed as the Independent Certifier pursuant to the Independent Certifier Agreement and as may be permitted pursuant to the Project Agreement.

"**Insolvency Legislation**" has the meaning set out in Sub-Clause 16.1.1(h)(iv) of this Subcontract.

"**Insurance Proceeds**" means the amount of any insurance proceeds received by a Person in respect of a claim made under any policy of insurance required to be maintained by the City, Project Co or by either Party under this Subcontract.

"**Insurance Receivables**" means the amount of any insurance proceeds which a Person is entitled to receive pursuant to policies of insurance required to be maintained by the City, Project Co or by either Party, but which have not been received.

"**Intellectual Property**" means discoveries, research, developments, designs, industrial designs, improvements, innovations, inventions, software, computer programs and code of all types, layouts, interfaces, applications, tools, databases, hardware, methods, concepts, processes, know-how, formulae, mask works, works subject to copyright and other technologies, works and creations now existing or developed in the future, whether or not registered or registrable, patentable or non-patentable or confidential or non-confidential.

"Interest" means interest payable by a Party to the other under this Subcontract, at the following rate, that is, the annual prime rate of interest announced by TD Bank (or its successors) plus [redacted]%, or other Canadian chartered bank agreed by the Parties from time to time as its reference rate then in effect for determining interest rates on Canadian dollar commercial loans made in Canada.

"Lands" means Real Property Interests, including Real Property Interests in Crown Lands described in the Real Property Schedule, provided that the After-Acquired Lands shall not constitute part of the Lands until the City acquires possession of any Real Property Interests in the After-Acquired Lands specified in the Real Property Schedule and Notice of possession of such Real Property Interest has been delivered to Project Co.

"**Lands Interests**" means all titles, leases, licences, rights-of-way, undersurface rights, easements and other interests in land acquired by City for purposes of providing access to the Site. Sub-Clause 1.13 of this Subcontract deals with the matter.

"**Latent Defect**" has the meaning set out in Sub-Clause 12.3 of this Subcontract..

"**Latent Defect Warranty**" and "**Latent Defect Warranty Period**" have the meaning set out in Sub-Clause 12.3 of this Subcontract.

"**Lenders**" means the financial institutions providing Project financing to Project Co.

"Liens" has the meaning ascribed thereto in the *Construction Lien Act* (Ontario).

"**Liquidated Damages**" means liquidated damages payable pursuant to Sub-Clause 8.6 of this Subcontract or as the case may be, pursuant to Sub-Clause 7.6 of this Subcontract.

"**Maintenance Contractor**" means Rideau Transit Maintenance General Partnership, a general partnership formed under the law of Ontario or its assignee.

"**Maintenance Services**" means maintenance of the System.

"**Materials**" means things of all kinds (other than Equipment) intended to form or forming part of the Permanent Works, including the supply-only materials (if any) to be supplied by the Subcontractor under the Subcontract.

"**Mediation Rules**" has the meaning given in Section 1.7(d) of Schedule I (Dispute Resolution Procedure) attached to this Subcontract.

"**Milestone**" has the meaning given in Schedule H attached to this Subcontract.

"**Milestone Dates**" has the meaning given in Schedule H attached to this Subcontract.

"Minor Deficiencies" means any defects, deficiencies and items of outstanding work (including in relation to seasonal work) arising from or related to the Subcontracted Works required to achieve Final Completion or milestone acceptance in the case of any Milestone, and which would not materially impair:

-the public's or the City's use and enjoyment of the System;
-the performance of the Governmental Activities;
-the performance of the Maintenance Services by Project Co; or
-safety or traffic flow on the System in any relevant respect.

"Monthly Service Payments" means payments required to be made by the City on account of Maintenance pursuant to the Project Agreement at Schedule 20 – Payment Mechanism.

"**Non-Fixed Assets**" means all tangible and intangible personal property designed, manufactured, acquired or otherwise supplied by or on behalf of the Subcontractor, for the Subcontracted Works including all Equipment and all Intellectual Property.

"**Output Specifications**" means Project Agreement Schedule 15 – Output Specifications, and includes Schedule 15-1 – Technical Definitions and Reference Documents and Schedule 15-2 – Design, Construction Requirements to the extent of the portions of these schedules that are applicable to Automatic Train Control Systems and as per the agreed Thales-Alstom Scope Split within Schedule N attached to this Subcontract.

"**Parent**" means the ultimate corporate parent of a Subcontractor.

"**Party**" means the Construction Contractor or the Subcontractor, as the context requires, and "**Parties"** means both of them.

"**Passenger**" means a natural person using any segment of the System.

"Payment Milestone" has the meaning given in Schedule B attached to this Subcontract.

"Payment Milestone Date" has the meaning given in Schedule B attached to this Subcontract.

"**Performance Certificate**" means the certificate issued under Sub-Clause 12.12 of this Subcontract.

"**Performance Security**" means the security to be provided by the Sub-Contractor under Sub-Clause 4.2 of this Subcontract.

"**Permits**" means all permissions, consents, approvals, certificates, permits, licences, statutory agreements and authorizations required from any Relevant Authority, Regulated Utilities, Non-Regulated Utilities and all necessary consents and agreements from any third parties or otherwise to Construct the System and the Highway Work, to effect the Revenue Service Availability and Substantial Completion of the Highway Work and to otherwise carry out the Project in accordance with this Agreement, but excludes Excluded Permits.

"**Permits, Licences and Approvals**" means the City Permits, Licences and Approvals and Project Co Permits, Licences and Approvals.

"Person" means an individual, legal personal representative, corporation, body corporate, firm, partnership, trust, trustee, syndicate, joint venture, unincorporated organization, other Business Entity or Relevant Authority.

"Preliminary Variation Instruction" has the meaning given in Sub-Clause 14.4 of this Subcontract.

"**Prime Contract**" is defined in the preamble.

"**Progress Report**" has the meaning given in Sub-Clause 4.22 of this Subcontract.

"**Prohibited Act**" means:

(i) offering, giving or agreeing to give to the City or any public body (or anyone employed by or acting on their behalf) or to any family member of such person, any gift or consideration of any kind as an inducement or reward:

(A) for doing or not doing, or for having done or not having done, any act in relation to the obtaining or performance of this Subcontract, the Prime Contract, the Project Agreement or any other agreement with the City or any public body in connection with the Project; or

(B) for showing or not showing favour or disfavour to any person in relation to this Agreement, the Project Agreement or any other agreement with the City or any public body in connection with the Project,

provided that the provisions of Clause 12 of this Subcontract shall not apply to the Subcontractor (or anyone employed by or acting on their behalf) providing consideration to the City or any public body in the ordinary course, or as reasonably necessary, to fulfill or comply with the obligations and liabilities of the Subcontractor under this Subcontract or, as they relate to the Subcontracted Works, of the Construction Contractor under the Prime Contract or of Project Co under the Project Agreement or any other agreement with the City or any public body in connection with the Project;

(ii) entering into the Project Agreement or any other agreement with the City or any public body in connection with the Project if a commission or a fee has been paid or has been agreed to be paid by the Subcontractor, or on its behalf or to its knowledge, to the City or any public body (or anyone employed by or acting on their behalf), or to any family member of such person unless, before the relevant agreement is entered into, particulars of any such commission or fee have been disclosed in writing to the City, provided that Clause 12 of this Subcontract shall not apply to a fee or commission paid by the Subcontractor (or anyone employed by or acting on their behalf) to the City or any public body pursuant to an agreement where such fee or commission is paid in the ordinary course, or as reasonably necessary, to fulfill or comply with the obligations and liabilities of Project Co under the Project Agreement or any other agreement with the City or any public body in connection with the Project without contravening the intent of Clause 12 of this Subcontract;

(iii) breaching or committing any offence under Applicable Law in respect of corrupt or fraudulent acts in relation to this Subcontract, the Prime Contract, the Project Agreement or any other agreement with the City or any public body in connection with the Project; or

(iv) defrauding or attempting to defraud or conspiring to defraud the City or any other public body.

"**Project**" means the Ottawa Light Rail Transit Project.

"**Project Agreement**" means the Amended and Restated Project Agreement, dated February 12, 2013 between the City and Project Co (including all schedules forming part thereof), as amended, restated or supplemented from time to time.

"**Project Co**" means the entity identified in the preamble of this Subcontract.

"**Project Co Event**" means:

(a) a breach of any of the express provisions of the Prime Contract (whether or not resulting in a Project Co Event of Default) by Project Co or any Person for whom Project Co is responsible under Section 4.3 of the Project Agreement, an extract of which is set out in Schedule N, excluding any City Event or Maintenance Contractor Event; or

(b) a variation or amendment to any of the Project Documents instigated by Project Co (other than as a result of a City Event or a Maintenance Contractor Event or any other act or omission for which the Construction Contractor is responsible), which has a material and adverse effect on:

i. the rights, obligations or remedies of the Construction Contractor under the Prime Contract; or
ii. the ability of the Construction Contractor to perform its obligations under the Prime Contract without incurring material additional expenditure; and

which, as a consequence, has a material and adverse effect on:

iii. the rights, obligations or remedies of the Subcontractor under this Subcontract; or
iv. the ability of the Subcontractor to perform its obligations under this Subcontract without incurring material additional expenditures.

"**Project Co Events of Default**" means any of the following events or circumstances:

(a) if Project Co fails to perform or observe any material term, condition, covenant or undertaking to the Construction Contractor contained in the Prime Contract and such failure materially and adversely affects the performance of the Subcontracted Work;

(b) if any of the following events occurs in respect of Project Co:

(i) any arrangement or composition with or for the benefit of creditors is entered into by or in relation to Project Co pursuant to any insolvency law;

(ii) a trustee, receiver, receiver and manager, interim receiver, liquidator, administrator or other custodian or other encumbrance holder takes possession of or is appointed over, or any distress, attachment, execution or other process is levied or enforced upon, the whole or any material part of the assets of Project Co;

(iii) Project Co ceases to carry on business;

(iv) Project Co makes an assignment for the benefit of its creditors, is declared bankrupt or commits an act of bankruptcy, becomes insolvent, makes a proposal or otherwise takes advantage of provisions for relief under any Insolvency Legislation or any other type of insolvency proceedings are commenced by or against Project Co under any Insolvency Legislation and, if commenced against Project Co, not stayed, dismissed or otherwise remedied within thirty (30) days of its commencement;

(v) a petition being filed (and not being contested in good faith using all reasonable efforts), or a resolution being passed or an order being made for the winding-up, liquidation, administration, dissolution or other similar proceeding of Project Co; or

(vi) any legal proceedings are taken by any Person (and not stayed within thirty (30) days of commencement) with a view to proposing (under any enactment or otherwise) any kind of composition, scheme of arrangement, compromise or arrangement involving Project Co and its creditors generally (or any class of them).

"**Project Co Permits, Licences and Approvals**" means all permissions, consents, approvals, certificates, permits, licences, agreements and authorizations required to perform the Project Scope in accordance with the Project Agreement and as required by Applicable Law and all necessary consents, approvals, certificates, permits, licences, agreements and authorizations from and with any third parties (including, to the extent applicable, all Development Approvals, Railway Approvals and Utility Agreements and the approval of the Fire Marshal of Ontario) needed to perform the activities within the Project Scope in accordance with the Project Agreement and as required by Applicable Law, but other than the City Permits, Licences and Approvals.

"**Project Co Variation**" means a Variation initiated by Project Co under the Project Agreement or the Prime Contract.

"Project Data", as applicable to the Subcontracted Works subject to the exclusionary items in c), means:

(a) all Design Data;

(b) all drawings, reports, documents, plans, software, formulae, calculations and other data relating to the performance of the Maintenance Services;

(c) any other materials, documents and or data acquired, brought into existence or used in relation to the Project Scope or the Project Agreement, with the exclusion of the Jointly Developed Materials and Background Information and other than Intellectual Property Rights of third parties, such as CAD software, that is used only in the process of design and construction; and

(d) any other drawings, reports, documents, plans, software, formulae, calculations and all other materials, data, or information relating to the Project, prepared by or on behalf of Project Co or any of the Contractors and Subcontractors.

"**Project Intellectual Property**" means Intellectual Property that is created or developed, or Ownership of which is acquired, by Project Co, any Subcontractor or any Project Co Personnel or Subcontractor Personnel, whether alone or together with each other or any other person, during the Project Term and within the Project Scope, and which is created, developed or acquired for the purposes of the Project or the Systems, but excluding Software, Embedded Software, Escrow Materials, Project Data and Drawings, Developed Intellectual Property and Technical Information.

"**Punch List Items**" means those items defined in Sub-Clauses 11.1(a) and 11.4 of this Subcontract.

"Quality Plans" means the Quality Manual, Quality Management Plans and Quality Audit Plans (all as defined in Schedule 11 – Quality Management) to be prepared, submitted and implemented by Project Co in accordance with Schedule 11 – Quality Management of the Project Agreement attached to this Subcontract.

"Real Property Interest" or **"Real Property Interests"** means any fee simple interest, lease, licence, right of way, under surface right, easement, including Construction Easements and Permanent Easements, or other interest in real property.

"**Relevant Authority**" means, with respect to any circumstance or matter, any domestic or foreign government, including any federal, provincial, state, territorial or municipal government, and any government agency, tribunal, commission or other authority exercising executive, legislative, judicial, regulatory or administrative functions of, or pertaining to, government, in each case having jurisdiction over such circumstance or matter.

"Relevant Change in Law" means a Discriminatory Change in Law or a System Specific Change in Law or a Highway Specific Change in Law.

"Required Revenue Service Availability Date" means May 24, 2018, the date in which Revenue Service Availability is achieved as such date may be extended pursuant to Section 40 of the Project Agreement.

"Revenue Service Commencement" means the commencement of Passenger service to the public on the System by the City on the Revenue Service Commencement Date.

"Revenue Service Availability Payment Date" means the date that is the later of:

(a) five (5) Business Days following the date Revenue Service Availability has been certified by the Independent Certifier; and

(b) five (5) days following the receipt of the invoice in respect of the Revenue Service Availability.

"SCTA" means WS Atkins International Ltd.

"Sensitive Information" means financial or commercial information which would, if disclosed to a competitor of the Subcontractor, give that competitor a competitive advantage over the Subcontractor and thereby prejudice the business of the Subcontractor; for greater certainty, "Sensitive Information" does not extend to Intellectual Property.

"Site" means, at any time and from time to time, that portion of the Lands on which Project Co or any Project Co Party or Subcontractor is engaged in any construction or demolition activities or is otherwise engaged in completing the Works or Subcontracted Works or on which any of the Works or Subcontracted Works have been commenced but not completed in their entirety or that is otherwise within the active construction footprint of the Works or Subcontracted Works.

"Software" means all or any part of the specific collection of computer programs and/or machine-readable instructions bundled with or embedded in the Equipment delivered under this Subcontract, whether as a stand-alone product or pre-installed on Equipment. Software does not include any source code.

"Station" means a Passenger station on the System.

"Subcontract" means the present instrument and its attached Schedules.

"**Subcontract Price**" means the agreed amount stated in Schedule B attached to this Subcontract for the design, execution and completion of the Subcontracted Works and the remedying of any defects, and includes adjustments (if any), in accordance with the Subcontract.

"**Subcontracted Works**" means the design, engineering, manufacturing, testing, delivery, installation (and installation training), commissioning and warranty of the Communication Based Train Control System for the System as set out in this Subcontract, the Design and Specification Requirements, the CBTC System Specification attached to this Subcontract as Schedule M and as per the Thales-Alstom Scope Split attached to this Subcontract as Schedule N.

"**Subcontractor Event of Default**" means any of the events enumerated in Sub-Clause 16.1.1.

"**Subcontractor Indemnified Parties**" means the Subcontractor and its agents, officers, directors and employees.

"**Subcontractor's Design Data**" means all drawings, reports, documents, plans, software, formulae, calculations, and other data prepared by the Subcontractor or any Subcontractor's Personnel relating to the design, construction or testing of the Subcontracted Works, but excluding Intellectual Property Rights of third parties, such as CAD software, that is used only in the process of design and construction.

"**Subcontractor's Personnel**" means the Subcontractor's Representative and all the personnel the Subcontractor utilizes in connection with the performance of the Subcontracted Works, which may include Sub-subcontractors and the staff, labour and other employees of the Subcontractor and of each Sub-subcontractor; and of any other personnel assisting the Subcontractor in the execution of the Subcontracted Works.

"**Subcontractor's Representative**" means the Person appointed from time to time by the Subcontractor under Sub-Clause 4.3, who acts on behalf of the Subcontractor.

"**Sub-subcontractor**" means any Person acting as a subcontractor to the Subcontractor of any tier, for a part of the Subcontracted Works and the legal successors in title to each such person.

"**Substantial Completion of Subcontracted Works**" has the meaning attributed to it in Clause 11.0.

"System" means the light rail rapid transit system to be Designed, Constructed, supplied, tested, commissioned and Maintained by Project Co in accordance with the Project Agreement, being the Fixed Facilities, the Vehicles and the E&M but, for greater certainty, includes, without limitation:

(a) all Infrastructure;

(b) all site services, utilities, roadways and parking areas required to support such Infrastructure;

(c) all supporting systems and improvements; and

(d) all other works, improvements, and demolitions to occur on the Lands or the Site,

in each case required to meet the Output Specifications and the requirements under the Permits Licences and Approvals and whether or not in the course of construction, installation or completion.

"System Specific Change in Law" means any Change in Law which principally affects or principally relates only to the design, construction, operation, maintenance, safety and security of rail transit systems or the Vehicles.

"**Taking-Over Certificate**" means a certificate issued under Clause 10 of this Subcontract.

"**Tax**" or "**Taxes**" means any and all taxes, levies, imposts, duties, fees, withholdings, assessments, deductions or charges whatsoever, imposed, assessed, levied or collected by any Governmental Authority, together with interest thereon and penalties with respect thereto, and includes all HST except where stated to the contrary provided, however, that "**Taxes**" shall not include the City Taxes.

"**Temporary Works**" means all temporary works of every kind (other than Construction Equipment) required on Site for the execution and completion of the Subcontracted Works and the remedying of any defects.

"**Tests after Completion**" means the tests (if any) which are specified in the Subcontract or required by the City, acting reasonably in accordance with the PA, and which are carried out under Clause 13 of this Subcontract after the Subcontracted Works or a Section (as the case may be) are taken over by the Construction Contractor.

"**Tests on Completion**" means the tests which are specified in the Subcontract or required by the City, acting reasonably in accordance with the PA, or agreed by both Parties in writing or instructed as a Variation, and which are carried out under Clause 10 of this Subcontract before the Subcontracted Works or a Section (as the case may be) are taken over by the Construction Contractor.

"**Third Party**" means any Person that is not (i) a party to this Subcontract; (ii) and/or suppliers, or subcontractors which are Affiliates of a Party to this Subcontract, participating, directly or indirectly, in the design, construction, testing, operation and/or maintenance of the Project or any supply or other activities relating to the Project or a component of the Project including, without limitation, the Construction Constructor, the Maintenance Contractor, Project Co, the City and their respective agents, suppliers, or subcontractors.

"**Time for Completion**" means the time for achieving Completion of the Subcontracted Works or a Section (as the case may be) under Sub-Clause 8.2 of this Subcontract, as stated in Schedule H attached to this Subcontract (with any extension under Sub-Clause 8.4 of this Subcontract).

"**Utilities**" means energy/power supplies and waste recovery, including electricity, natural gas/fuel oil, water, sanitary waste and storm water.

"**Variation**" means a variation, addition, reduction, substitution, omission, modification, deletion, removal or other change to the whole or any part of the scope of the

Subcontracted Works, including in relation to the whole or any part of the Subcontracted Works or the Maintenance Services, as well as any change pertaining to the Subcontracted Works required under the Prime Contract or the Subcontract.

"Variation Certificate" has the meaning set out in Sub-Clause 14.11 of this Subcontract.

"Variation Report" has the meaning given in Sub-Clause 14.7 of this Subcontract.

"**Vehicles**" means all rolling stock used to carry Passengers on the System.

"**Works**" means the whole of the engineering, procurement and construction of the System and the Highway pursuant to the Prime Contract.

1.2 Interpretation

In the Subcontract, except where the context requires otherwise:

(a) words indicating one gender include both genders;

(b) words indicating the singular also include the plural and words indicating the plural also include the singular;

(c) provisions including the word "agree", "agreed" or "agreement" require the agreement to be recorded in writing;

(d) "written" or "in writing" means hand-written, type-written, printed or electronically made, and resulting in a permanent record; and

(e) "day" means a calendar day.

Headings and sub-headings shall not be taken into consideration in the interpretation of these Subcontract provisions.

1.3 Communications

Wherever this Subcontract provides for the giving or issuing of approvals, certificates, consents, determinations, notices and requests, these communications (but excluding day-to-day communications) shall be:

(a) in writing and delivered by hand (against receipt), sent by electronic mail confirmed by registered mail or courier or sent by fax confirmed by registered mail or courier; and

(b) delivered, sent or transmitted to the address for the recipient's communications as stated in Sub Clause 21 of this Subcontract. However:

(i) if the recipient gives notice of another address, communications shall thereafter be delivered accordingly; and
(ii) if the recipient has not stated otherwise when requesting an approval or consent, it may be sent to the address from which the request was issued.

Approvals, certificates, consents and determinations shall not be unreasonably withheld or delayed.

1.4 Law and Language

The Subcontract shall be governed by the laws of Ontario, Canada.

The language for communications and Subcontractor's Design Data shall be English.

1.5 Priority of Documents

The documents forming the Subcontract are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence:

(a) the main body of the Subcontract;

(b) the applicable Schedules attached to this Subcontract;

(c) the Prime Contract, as incorporated by reference herein, but only to the extent applicable to the Subcontracted Works; and

(d) the Project Agreement, as incorporated by reference herein, but only to the extent applicable to the Subcontracted Works.

For the removal of doubt, the Parties agree that references to the Project Agreement will in no event create a direct contractual relationship between the Subcontractor, on the one hand, and the City, Project Co, or the Maintenance Contractor, on the other hand.

For the removal of doubt, the Parties agree that references to the Prime Contract will in no event create a direct contractual relationship between the Subcontractor, on the one hand, and Project Co or the Maintenance Contractor, on the other hand.

1.6 Schedules

With reference to Article IV – Back-to-Back Principle, the Schedules attached herein as Schedule A – List of Schedules are applicable to the Subcontract, to the extent they are applicable to the Subcontracted Works. It is understood that, in the event of a conflict,

error, omission, ambiguity, discrepancy or inconsistency between the Subcontract, the Construction Contract and the Project Agreement, the Subcontract shall take precedence.

1.7 Effectiveness of the Subcontract

The Subcontract shall come into full force and effect as set out above in Article III.

1.8 Assignment, Direct Agreement

The Subcontractor shall not assign the whole or any part of the Subcontract or any benefit or interest in or under the Subcontract without the consent of the Construction Contractor, which consent will not be unreasonably withheld. For clarity, it is not unreasonable when the Construction Contractor withholds consent as required under the Construction Contractor's Documents.

Upon the occurrence of any event which would entitle the Subcontractor to terminate this Subcontract, the Subcontractor shall serve notice (a "**Default Notice**") on the Construction Contractor, Project Co and the Collateral Agent of the occurrence, specifying details of such event and, if the relevant matter or circumstance has not been rectified or remedied by the Construction Contractor (or otherwise) within thirty (30) Business Days of delivery of the Default Notice (the "**Default Period**"), the Subcontractor may serve a further notice on the Construction Contractor terminating this subcontract with immediate effect, with a copy of such notice to Project Co and the Collateral Agent, provided that, at any time prior to the expiry of the Default Period, the Subcontractor acknowledges and agrees that either the Collateral Agent or Project Co may, but is not obligated to (i) assign the Construction Contractor's rights under this subcontract to a replacement contractor; and/or (ii) cure the event which gave rise to the Subcontractor's right to terminate this Subcontract provided that the Subcontractor shall not be obligated to perform its obligations under its Subcontract until such event which gave rise to the Subcontractor's right to terminate this Subcontract has been cured; provided further that, unless agreed by the parties otherwise, upon assignment, the replacement contractor shall be responsible for any obligations of the Construction Contractor (or the replacement contractor) arising from future performance of the Subcontract.

1.9 Not Used

1.10 Confidentiality

1.10.1 Use and Disclosure of Confidential Information

The Construction Contractor, through Project Co, shall ensure that neither the City nor Infrastructure Ontario will disclose portions of the Project Agreement or any terms thereof, including any contractual submissions or other records kept in accordance with this Subcontract, any information related to the performance of the Subcontractor or any information derived from this Subcontract or the information related to the performance

of the Subcontractor which would be exempt from disclosure under section 10(1) of MFIPPA or section 17(1) of FIPPA.

If the Subcontractor, acting in good faith, contends that any of the information constitutes information that falls within the scope of Section 52.1(b) of the Project Agreement and, accordingly, would be exempt from disclosure under, as applicable, MFIPPA or FIPPA, the dispute may be referred for resolution in accordance with Schedule 27 – Dispute Resolution Procedure, and the Construction Contractor and Project Co shall ensure that the City shall not (and the City shall cause Infrastructure Ontario to not) disclose any information in dispute until a determination is made. Any such determination shall be made with reference to the text and principles of MFIPPA or FIPPA.

The Construction Contractor and Project Co shall ensure that the City and Infrastructure Ontario respectively shall, within the time periods provided in MFIPPA and FIPPA for a party to exercise rights to prevent disclosure of information, advise the Subcontractor through Project Co and the Construction Contractor of any request for Confidential Information that relates to the Subcontractor or of the City's intention to voluntarily release any information or documents which contain Confidential Information that relates to the Subcontractor.

(a) Except as authorized hereunder, each Party shall hold in confidence, not disclose and not permit any person any manner of access to, whether directly or indirectly, any Confidential Information of the other Party, provided that this Sub-Clause 1.10 shall not restrict either Party from disclosing such Confidential Information to its professional advisors, to the extent necessary, to enable that Party to perform, to cause to be performed or to enforce its rights or obligations under this Agreement.

In consultation with the Construction Contractor, Project Co may disclose in confidence to prospective lenders or investors, such Subcontractor Confidential Information as is reasonably required by such lenders or investors in connection with the Project provided that such prospective lenders or investors execute and deliver a confidentiality agreement or agree to be bound by the confidentiality provisions in the Credit Agreement, and provided further that, in respect of any Thales Trade Secret Information to be disclosed to an Identified Thales Competitor, Project Co shall not disclose any such Thales Trade Secret Information without prior notification of the Thales Trade Secret Information proposed to be disclosed and rationale therefor and a confidentiality agreement in form and substance approved by the Construction Contractor and the Subcontractor.

"Thales Trade Secret Information" shall mean trade secrets identified as trade secrets by Thales and belonging to Thales of an industrial and technical nature within Thales' core business, which Thales has kept confidential to maintain an advantage over competitors.

"Thales Identified Competitor" means any of:
1. Alstom

2. Siemens
3. Bombardier
4. Ansaldo
5. Invensys
6. GE
7. Hitachi
8. Nippon Signal;

(b) Subject to the foregoing, it is acknowledged that:

(a) Project Co may disclose in confidence to the Lenders and prospective Lenders and their professional advisors such Confidential Information as is reasonably required by the Lenders in connection with the raising or syndication of the financing or any sub-participation in the financing of the Project Scope or which Project Co is obliged to supply by the terms of the Lending Agreements;

(b) Project Co may disclose in confidence to any Project Co Party and their professional advisors, such Confidential Information as is necessary for the performance by that Project Co Party of that Project Co Party's obligations under the Project Agreement or any other Project Document, and Project Co may disclose in confidence to the Maintenance Contractor or any MC Party and their professional advisors such Confidential Information as is necessary for the performance by same of the Maintenance Contract or any subcontract of any tier under the Maintenance Contract;

(c) the Construction Contractor may disclose in confidence to Project Co, the City and/or its nominee such Confidential Information as is necessary for the performance by the Construction Contractor of the Prime Contract or the performance by Project Co of the Project Scope under the Project Agreement;

(d) Project Co may disclose in confidence to the SCTA, the Lenders and their professional advisors such Confidential Information as is reasonably required by the Lenders or the SCTA in connection with the performance of the Prime Contract;

(e) Project Co may disclose Confidential Information in confidence to prospective lenders or investors;

(f) the Subcontractor may, subject to providing written notice to the Construction Contractor, disclose in confidence to any of its professional advisors or any Subcontractor Personnel, such Confidential Information as is necessary for the performance by the Subcontractor or the Subcontractor Personnel, of its and/or their obligations under this Subcontract or in connection with the Subcontracted Work; and

(g) the City and any City Party may use the Confidential Information of Project Co for Approved Purposes not specific to the Project, but for other general governmental purposes.

(c) Subject to the foregoing, neither Party shall use, or directly or indirectly cause, authorize or permit any other person to use, any Confidential Information of the other Party except for the purposes of this Subcontract, as permitted by this Agreement or as authorized by the disclosing Party in writing.

(d) Each Party shall protect all Confidential Information of the disclosing Party with the same degree of care as it uses to prevent the unauthorized use, disclosure, publication or dissemination of its own confidential information of a similar nature or character, but in no event with less than a reasonable degree of care.

(e) Without limiting the generality of this Sub-Clause 1.10, the Construction Contractor shall comply with the document control and security protocol submitted to the City by the Construction Contractor pursuant to Part 2 Section 20.11. of the Prime Contract and approved by Project Co and the City, which protocol shall prescribe limitations on the use, disclosure and storage of this Subcontract and any other Confidential Information of Project Co and of the City.

1.10.2 Exceptions

(a) Information of a Party (the "**Proprietor**"), other than Government Sensitive Information and other than Personal Information, will not be considered Confidential Information in the following circumstances:

(a) the Proprietor advises the other Party to whom the information has been disclosed (the "**Confidant**") that the information is not required to be treated as Confidential Information;

(b) the information, becomes at any time generally available to or accessible by the public through no fault or wrongdoing of the Confidant;

(c) the information is a matter of public record or in the public domain;

(d) the information was in the possession of the Confidant prior to its disclosure and the Confidant came into possession of such information without being in breach of this Agreement;

(e) the information is received by the Confidant on a non-confidential basis from a source other than the Proprietor, provided that to the best of the Confidant's knowledge, such source is not bound by a confidentiality agreement with the Proprietor or otherwise prohibited from disclosing the information to the Confidant by a contractual, legal or fiduciary obligation;

(f) the information was independently developed by the Confidant without access to the Confidential Information, as evidenced by the Confidant's written records;

(g) the information is required to be disclosed pursuant to Applicable Law, provided that the Confidant provides the Proprietor with reasonable notification and an opportunity to contest such requirement prior to disclosure or to procure a protective order;

(h) subject to the obligation set forth in Attachment 41 – CC Intellectual Property, the information is disclosed to Project Co and/or the City upon a termination of this Subcontract, pursuant to Clause 16 or is otherwise required by Project Co or the City for the purposes of performing (or having performed) the Project Scope, including the design or construction of the System, the maintenance or improvement of the System for Approved Purposes specific to the Project Scope, or

(i) Subject to the Subcontractor's rights to prevent or seek the prevention of the disclosure of information , the determination by a competent authority that the information would not be exempt from disclosure under FIPPA or MFIPPA.

1.10.3 Survival of Confidentiality

(a) The obligations in Sub-Clause 1.10 of this Subcontract will cease on the date that is fifteen (15) years after the Revenue Service Availability Date and, accordingly, shall survive the termination of this Agreement.

1.11 Intellectual Property

1.11.1 Terms used in this Sub-Clause 1.11 and not defined herein have the meaning given in Attachment 41 – Intellectual Property. The term "**CBTC Intellectual Property**" means the CC Subcontractor Intellectual Property of the Subcontractor and all Sub-subcontractors.

1.11.2 The Subcontractor will comply with (or ensure that its Sub-subcontractors comply with) all obligations of a CC Subcontractor under Attachment 41, including those of an Escrow Provider or a Licensor. The Subcontractor will do or not do (or ensure that its Sub-subcontractors do or not do) anything that the Construction Contractor is required to ensure a CC Subcontractor do or not do in accordance with Attachment 41 in respect of the CBTC Intellectual Property. The specific provisions of this Sub-Clause 1.11 are not intended to limit the generality of this Sub-Clause 1.11.1.

1.11.3 The Subcontractor or its Sub-subcontractors, as applicable, shall be and remain the sole and exclusive Owner of the CBTC Intellectual Property, provided that nothing in this Subcontract shall transfer to the Subcontractor or any Sub-subcontractor any Ownership of, or grant to, the Subcontractor or its Sub-subcontractors any right in respect of CC Intellectual Property, City Intellectual Property or Project Co Intellectual Property used in the creation or development of, or that is embodied, incorporated, embedded, otherwise

included or illustrated in any, CBTC Intellectual Property, except for the Licence granted under Sub-Clause 1.11.6.

1.11.4 The Construction Contractor shall be and remain the sole and exclusive Owner of the CC Intellectual Property, provided that nothing in this Agreement shall transfer to the Construction Contractor any Ownership of, or grant to Construction Contractor any right in respect of, the CBTC Intellectual Property used in the creation or development of or that is embodied, incorporated, embedded, otherwise included or illustrated in any CC Intellectual Property, except for the Licence granted under Sub-Clause 1.11.5.

1.11.5 The Subcontractor acknowledges and agrees that Project Co shall be and remain the sole and exclusive Owner of the Project Co Intellectual Property and that the City shall be and remain the sole and exclusive Owner of the City Intellectual Property.

1.11.6 The provision of Section 3.4 of Attachment 41 shall apply *mutatis mutandis* to give effect to the agreement as to Ownership of Intellectual Property pursuant to Sub-Clauses 1.11.3, 1.11.4 and 1.11.5.

1.11.7 The Subcontractor will include in its subcontracts such provisions as Project Co is required to include in its CC Subcontracts (as defined in the Construction Contract), including such terms and conditions as may be necessary for the Construction Contractor to grant or obtain for Project Co, the Ownership, Licences, rights and benefits provided for in Attachment 41 and, where required in accordance with Attachment 41, to deposit or have deposited Escrow Materials for Deliverables supplied by its CC Subcontractors in accordance with section 4.5 of Attachment 41.

1.11.8 The Subcontractor shall and shall ensure that Subcontractor Personnel:

(a) by duly executed written agreement or by operation of law, irrevocably and unconditionally sell, assign and transfer to that party all right, title and interest, including all Intellectual Property Rights, that its Subcontractor Personnel may have in or to any and all Intellectual Property referred to in Attachment 41 and all Modifications thereto, such that agreements as to Ownership of Intellectual Property pursuant to Sub-Clauses 1.11.3, 1.11.4 and 1.11.5 and the assignment by that party pursuant to Sub-Clause 1.11.6 include all right, title and interest, including all Intellectual Property Rights, of the Subcontractor Personnel; and

(b) by duly executed written agreement, irrevocably waive all non-transferable rights, including moral rights, that they have or may have in any Intellectual Property referred to in Schedule 41 of the Project Agreement and all Modifications thereto in favour of Project Co, the City, the Subcontractor and all of their respective successors, assigns and licensees.

1.11.9 The Subcontractor hereby grants to the Construction Contractor the right to grant the Licence under section 4.2 of Attachment 41 in respect of the CBTC Intellectual Property.

1.11.10 The Subcontractor hereby grants to the Construction Contractor a Licence in respect of the CBTC Intellectual Property this is equivalent to the Licence under Section 4.2 of Attachment 41 and sufficient for the Construction Contractor to perform its obligations under the Construction Contract. The Construction Contractor agrees not to use the licenses granted herein except as are required for the Construction Contractor to perform its obligations under the Construction Contract. Without prejudice to the licenses granted in 1.11.9, the Construction Contractor agrees not to transfer, further license, or disclose the licenses granted by Subcontractor or CBTC Intellectual Property to any other person without Subcontractor's express prior written consent, not to be unreasonably withheld.

1.11.11 The Construction Contractor hereby grants the Subcontractor the right to Use and Modify City Intellectual Property, Project Co Intellectual Property and CC Intellectual Property to the extent necessary for the Subcontractor to perform its obligations under this Subcontract, on such terms as are not in breach of or conflict with the Construction Contract.

1.11.12 The Subcontractor agrees not to assert, and to require its Sub-subcontractors not to assert, any Intellectual Property Right against the Construction Contractor, Project Co, the City or any Licencee that would have the effect of diminishing the rights granted to those parties hereunder. Without limiting the generality of the foregoing, the Subcontractor will not sue, and will require its Sub-subcontractors not to sue, the Construction Contractor, Project Co, the City or any Licencee on the basis that any Equivalent Activity or the Ownership or Use of the System, any CC Deliverable or any part of the Work within the scope of the Permitted Purposes infringes any Intellectual Property Right of the Subcontractor or any of its Sub-subcontractors.

1.12 Subcontractor's Use of Construction Contractor's Documents

As between the Parties, the Construction Contractor shall own the copyright and other intellectual property rights in the Construction Contractor's Documents in this Subcontract, the Prime Contract, the Project Agreement and all schedules, appendices and attachments thereto and other documents made by (or on behalf of) the Construction Contractor. The Subcontractor may, at its cost, copy, use and obtain communication of these documents strictly and solely for the purposes of the Subcontract.

The Construction Contractor's Documents shall not, without the Construction Contractor's prior written consent, be copied, used or communicated to a third party by the Subcontractor, except as necessary for the purposes of performing the Subcontracted Works.

1.13 Not Used

1.14 Compliance with Laws

The Subcontractor shall, in performing the Subcontracted Works, comply with Applicable Law. Unless otherwise stated in the Subcontract:

(a) the Construction Contractor or Project Co or the City, as the case may be, shall have obtained (or shall obtain) the planning, zoning or similar permission for the Subcontracted Works;

(b) except as provided in sub-paragraph (a) above, the Subcontractor shall give all notices, pay all Taxes and obtain all Permits, as required by the Applicable Law in relation to the design, execution and completion of the Subcontracted Works and the remedying of any defects;

(c) the Construction Contractor shall provide reasonable administrative assistance to the Subcontractor to facilitate the issuance of necessary Permits that could not otherwise be obtained without such assistance; and

(d) the Subcontractor shall comply with all Permits Licences and Approvals related to the performance of its obligations in accordance with their terms.

1.15 Joint and Several Liability

If the Subcontractor constitutes (under Applicable Law) a joint venture, consortium or other unincorporated grouping of two or more Persons these persons shall be deemed to be jointly and severally liable to the Construction Contractor for the performance of the Subcontracted Works.

If the Construction Contractor constitutes (under Applicable Law) a joint venture, consortium or other unincorporated grouping of two or more Persons these persons shall be deemed to be jointly and severally liable to the Subcontractor for its obligations under the Subcontract.

1.16 Representations and Warranties

1.16.1 Subcontractor's Representations and Warranties

The Subcontractor represents and warrants to the Construction Contractor:

(a) The Subcontractor is a duly incorporated and validly existing company under the laws of Canada, and has all the requisite power and authority to own its properties and assets, to carry on its business as it is currently being conducted and to enter into this Subcontract and to duly observe and perform its obligations hereunder;

(b) The Subcontractor and the Subcontractor's Personnel, collectively, have extensive experience and are knowledgeable in the Subcontracted Works and other work similar to the Subcontracted Works in scale, scope, type and complexity and have the required ability, experience, skill and capacity to perform the activities within the scope of this Subcontract in a timely and professional manner as set out in this Subcontract;

(c) The Subcontractor has the requisite power, authority and capacity to execute, deliver and perform this Subcontract, and to do all acts and things and execute, deliver and perform all other agreements, instruments, undertakings and documents as are required by this Subcontract to be done, executed, delivered or performed;

(d) No steps or proceedings have been taken or are pending to supersede or amend the constating documents, articles or by-laws of the Subcontractor in a manner that would impair or limit its ability to perform the obligations of the Subcontractor under this Subcontract;

(e) This Subcontract has been duly authorized, executed, and delivered on behalf of the Subcontractor and constitutes a legal, valid, and binding obligation of the Subcontractor, enforceable against the Subcontractor in accordance with its terms, subject only to:

i. limitations with respect to the enforcement of remedies by bankruptcy, insolvency, moratorium, winding-up, arrangement, reorganization, fraudulent preference and conveyance and other laws of general application affecting the enforcement of creditors' rights generally; and

ii. general equitable principles and the fact that the availability of equitable remedies is in the discretion of a court and that a court may stay proceedings or the execution of judgments;

(f) The execution, delivery, and performance by the Subcontractor of this Subcontract does not and will not violate or conflict with, or constitute a default under:

i. its constating, formation or organizational documents, including any by-laws;

ii. any Applicable Law; or

iii. any covenant, contract, agreement, or understanding to which it is a party or by which any of its properties or assets are bound or affected;

(g) No Subcontractor Event of Default has occurred and is continuing;

(h) There are no actions, suits, proceedings or investigations pending or threatened against the Subcontractor or, to the Subcontractor's knowledge, any Subcontractor Personnel at law or in equity before any Governmental Authority or arbitral body (whether or not covered by insurance) that individually or in the aggregate could result in any material adverse effect on the business, properties, or assets, or the condition, financial or otherwise, of the Subcontractor or in any impairment of the Subcontractor's ability to perform its obligations under this Subcontract, and the

Subcontractor has no knowledge of any violation or default with respect to any order, writ, injunction, or decree of any Governmental Authority or arbitral body that could result in any such material adverse effect or impairment;

(i) The Subcontractor has carefully reviewed the whole of this Subcontract, the Prime Contract and the Project Agreement and all other documents made available to the Subcontractor by or on behalf of the Construction Contractor, and, to the Subcontractor's knowledge, nothing contained herein or therein inhibits or prevents the Subcontractor from completing the Subcontracted Works or performing the activities within the scope of this Subcontract in accordance with this Subcontract in a good and safe manner so as to achieve and satisfy the requirements of this Subcontract;

(j) The Subcontractor is not an insolvent person within the meaning of the *Bankruptcy and Insolvency Act* (Canada);

(k) The Subcontractor is registered under Division V of Part IX of the *Excise Tax Act* (Canada) and its registration number is GST#897981403RT0D07**;**

(l) The Time for Completion is a realistic date and is achievable by the Subcontractor performing the Subcontracted Works in accordance with this Subcontract;

(m) The Subcontractor is a Canadian Resident for purposes of the *Income Tax Act* (Canada).

The copy of the constating documents of the Subcontractor certified by an appropriate officers of the Subcontractor and delivered to the Construction Contractor prior to entering into this Subcontract is true and accurate and there are no outstanding proposals to amend such documents;

(n) The Subcontractor has satisfied itself as to the purposes of the Project and the nature and extent of the risks assumed by it in relation to the Subcontracted Works;

(o) The Subcontractor is and shall be the sole and exclusive owner of the CBTC Intellectual Property that is Owned, created, developed or acquired by the Subcontractor or any Subcontractor Personnel;

(p) The Subcontractor has and shall have the right to provide the Licences granted to the Construction Contractor, Project Co and the City herein;

(q) None of the CBTC Intellectual Property that is Owned, created, developed or acquired by the Subcontractor or any Subcontractor Personnel infringes, or is a misappropriation of, any third Person's Intellectual Property Rights, and as of the date of this Subcontract, to the extent that the Subcontractor Has Knowledge, no allegations of infringement or notices of misappropriation have been issued by

any Person regarding any of Project Co Intellectual Property that is Owned, created, developed or acquired by the Subcontractor or any Subcontractor Personnel;

(r) Not used;

(s) There has been no material change to any of the information including the financial information provided by the Subcontractor to the Construction Contractor as provided in the relation to the Response and there is no Change in Control with respect to the Subcontractor;

(t) There is no misrepresentation or material omission of any nature or kind whatsoever contained in the information provided by the Subcontractor in relation to the Response;

(u) This Subcontract shall be sufficient to perform and complete the Subcontracted Works;

(v) All insurance required to be maintained by the Subcontractor under this Agreement has been placed and is in full force and effect, all premiums in respect thereof that are due and payable have been paid or will be paid within the time permitted for payment under the relevant insurance agreement or policy and the Subcontractor has not received any notices of cancellation or any notice that policies are not in full force and effect or that liability has been reduced or avoided or, save as disclosed by the Subcontractor to the Construction Contractor, any notice of pending cancellation;

(w) All Permits which are required to be obtained by or on behalf of the Subcontractor pursuant to this Agreement have been obtained on or before the date that they are required in order to implement the Subcontracted Works and are in full force and effect and the Subcontractor is in compliance with all such Permits except to the extent such failure to obtain, revocation, or cancellation or non-compliance would not have a material adverse effect on the ability of the Subcontractor to perform its obligations under this Subcontract, and to the knowledge of the Subcontractor, no steps have been taken to revoke or cancel any such Permit;

(x) All Applicable Law applicable to the Subcontracted Works have been complied with by the Subcontractor, except to the extent non-compliance would not have a material adverse effect on the ability of the Subcontractor to perform its obligations under this Subcontract;

(y) The Subcontractor and, to the Subcontractor's knowledge, its directors, officers, employees, agents, representatives and subcontractors have not offered, given or agreed to give any improper or dishonest gift, commission or consideration which would be a "Prohibited Act" under the Project Agreement; and

(z) The Subcontractor has available to it or will have available to it prior to the date on which such property is required for the Subcontracted Works, rights in all CBTC Intellectual Property (whether licensed or owned) necessary and required for the implementation, in all material respects, of the Subcontracted Works at such time, except where the absence thereof would not reasonable be expected to have a material adverse effect on the ability of the Subcontractor to perform its obligations under this Subcontract.

The representations and warranties contained in Clauses 1.16.1(a) to (f) and (i), (l), (m), (s), (u) and (v) shall survive the execution of this Subcontract and shall not be deemed to be merged thereon. The remaining representations and warranties contained in Clauses 1.16.1 shall be deemed to have merged on the Commencement Date, except to the extent that they are required to be repeated pursuant to the below paragraph.

The representations set out in paragraphs (g), (h), (p), (q), (v) through (z) of Sub-Clause 1.16.1 shall be deemed to be repeated by the Subcontractor by reference to the facts and circumstances then existing on the date of Financial Close and of the first Business Day of each month thereafter until the date two (2) years after actual Revenue Service Availability. If at any other time the Subcontractor becomes aware of any information that would make any of those representations untrue, it shall notify the Construction Contractor of such information as soon as reasonably practicable.

1.16.2 Construction Contractor's Representations and Warranties

The Construction Contractor represents and warrants to the Subcontractor:

(b) the Construction Contractor is an unincorporated joint venture comprised of DRAGADOS CANADA, INC. ("**Dragados**"), ELLISDON CORPORATION ("**EllisDon**"), and SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC. ("**SNC**") (each, a "**Construction Contractor Member**"), and:

i. Dragados is a duly incorporated and validly existing company under the laws of Canada, and has all the requisite power and authority to own its properties and assets, to carry on its business as it is currently being conducted and to enter into this Agreement and to duly observe and perform its obligations hereunder;

ii. SNC is a duly incorporated and validly existing company under the laws of Canada, and has all the requisite power and authority to own its properties and assets, to carry on its business as it is currently being conducted and to enter into this Agreement and to duly observe and perform its obligations hereunder;

iii. EllisDon is a duly incorporated and validly existing company under the laws of Ontario, and has all the requisite power and authority to own its properties and assets, to carry on its business as it is currently being

conducted and to enter into this Agreement and to duly observe and perform its obligations hereunder;

(c) The Construction Contractor has the requisite power, authority and capacity to execute, deliver and perform this Subcontract, and to do all acts and things, and execute, deliver and perform all other agreements, instruments, undertakings and documents as are required by this Subcontract to be done, executed, delivered or performed;

(d) No Construction Contractor Event of Default has occurred and is continuing;

(e) There are no actions, suits, proceedings, or investigations pending or threatened against the Construction Contractor, the Construction Contractor Members or, to the Construction Contractor's knowledge, any Subcontractor Personnel at law or in equity before any Governmental Authority or arbitral body (whether or not covered by insurance) that individually or in the aggregate could result in any material adverse effect on the business, properties, or assets, or the condition, financial or otherwise, of the Construction Contractor or any Construction Contractor Members or in any impairment of the Construction Contractor's ability to perform its obligations under this Subcontract, and the Subcontractor has no knowledge of any violation or default with respect to any order, writ, injunction, or decree of any Governmental Authority or arbitral body that could result in any such material adverse effect or impairment; and

(f) The Construction Contractor and each of the Construction Contractor Members is able to meet its obligations as they generally become due.

The representations and warranties contained in Clauses 1.16.2(a) and (b) shall survive the execution of this Subcontract and shall not be deemed to be merged thereon. The remaining representations and warranties contained in Clauses 1.16.2 shall be deemed to have merged on the Commencement Date.

2.0 SITE ACCESS AND USE

2.1 Right of Access to the Site

The Construction Contractor shall prepare the Site and perform all necessary / civil, energy, and environmental / work as set out in the Responsibility Matrix to prepare the Site prior to Installation in accordance with the Approved Contract Schedule. The Subcontractor will send its representative to the Site following preparation thereof by the Construction Contractor in order to ensure that the Construction Contractor has carried out all relevant matters set out in the Responsibility Matrix so as to permit the Installation. Should the Site not be ready, the Subcontractor will notify the Construction Contractor of any modification required and the Construction Contractor shall effect such modification immediately. If the Installation is prevented from beginning on time, then

the Approved Contract Schedule shall be extended accordingly and for a period which shall in no case be inferior to the delay resulting from the fact that the Site(s) is (are) not ready, and the Subcontractor shall be reimbursed (in accordance with the claims procedures of Clause 9 of this Subcontract) in respect of any expenses and extra costs resulting from the same or due to the recalling of installation personnel.

At all times during the performance of any services at a Site, the Construction Contractor shall:

i. ensure, at the Construction Contractor's expense, for the Subcontractor's benefit (and the benefit of its subcontractors, as the case may be) all rights of access to the Site (including, as the case may be, rights of passage on third party property) and all building and other permits as may be necessary according to local regulations for performance of this Subcontract;

ii. ensure that the Site is safe and free from actual or potential hazards and is equipped with reasonable heat, light, plumbing, electricity and ventilation;

iii. provide sufficient on Site storage space for the Subcontractor's equipment and materials;

iv. ensure that the Subcontractor's personnel have access to the applicable Equipment during the times necessary to perform the services; and

v. comply in good time with any reasonable requests made by the Subcontractor to permit the Subcontractor properly to perform the Services.

The Construction Contractor shall give the Subcontractor a non-exclusive licence, rights of use and access to those parts of the Site within those times stated within the in Approved Subcontract Schedule. The Subcontractor's licence to the Site is not exclusive to the Subcontractor and is subject to any reservations of the City from the licence granted to Project Co under the Project Agreement. Furthermore, the Construction Contractor will have no obligation to provide the Subcontractor with a licence to the Site that is broader than the licence that it is entitled to receive from Project Co under the Construction Contract, and the presence and interference of Protesters and Trespassers on or around the Site will not be considered a breach the Construction Contractor of this Subcontract, provided that this shall not limit the Subcontractor's right to claim relief for a City Event. The Subcontractor's rights of use and access to the Site are subject to the other terms of this Subcontract including, without limitation, the Design and Specification Requirements. If, under the Subcontract, the Construction Contractor is required to give to the Subcontractor possession of any foundation, structure, plant or means of access, the Construction Contractor shall do so in a timely manner, without interference from other parties and in a manner consistent with the Construction

Contractor's safety and security restrictions, that will allow the Subcontractor to perform its obligations in accordance with the Subcontract and Approved Subcontract Schedule.

When entering the Site or the Lands or accessing the System, the Subcontractor will act in a manner consistent with the obligations of the Construction Contractor under the Prime Contract. The Subcontractor agrees to provide access to the Site and any workshop where materials or equipment are being manufactured, prepared or stored, to the City or any third party in order to allow the Prime Contractor to comply with its obligations under the Prime Contract, and in particular under sections 21.1 and 21.5 thereof.

If the Subcontractor suffers delay or incurs Direct Loss as a result of a failure by the Construction Contractor to give any such right or possession within such time, the Subcontractor shall give written notice to the Construction Contractor of any Claim by the Subcontractor for:

(a) an extension of time for any such delay, if Completion is or will be delayed, under Sub-Clause 8.4 of this Subcontract; and

(b) payment of any such Direct Loss,

provided that in the case of a City Event or a Project Co Event, the Subcontractor shall be entitled to an extension of time and additional payment to the extent applicable under Clause 9 of this Subcontract.

After receiving this notice, the Construction Contractor shall proceed in accordance with Sub-Clause 3.5 of this Subcontract to agree or determine these matters.

2.2 Mitigation

The Subcontractor shall use all reasonable efforts to mitigate the time and cost effect of delayed access to the Site.

If and to the extent that the Construction Contractor's failure to provide access to the Site was caused by any error or delay by the Subcontractor, or if and to the extent that the Subcontractor fails to use reasonable efforts to mitigate the delay or Direct Losses it suffers as a result of not being given timely access to Site, the Subcontractor shall not be entitled to an extension of time or to its Direct Loss.

2.3 Construction Contractor's Personnel and other subcontractors

The Construction Contractor shall cause the Construction Contractor's Personnel and require the Construction Contractor's other subcontractors on the Site to:

(a) co-operate with the Subcontractor's efforts under Sub-Clause 4.7 of this Subcontract; and

(b) take actions similar to those which the Subcontractor is required to take under sub-paragraphs (a), (b) and (c) of Sub-Clause 4.9 and under Sub-Clause 4.19 of this Subcontract.

3.0 THE CONSTRUCTION CONTRACTOR'S ADMINISTRATION

3.1 The Construction Contractor's Representative

Within ten (10) days after the Commencement Date, the Construction Contractor shall appoint a Construction Contractor's Representative to act on its behalf under the Subcontract and it shall give written notice to the Subcontractor of the name, address, duties and authority of the Construction Contractor's Representative.

The Construction Contractor's Representative shall carry out the duties assigned to him or her, and shall exercise the authority delegated to him or her, by the Construction Contractor. Unless and until the Construction Contractor notifies the Subcontractor otherwise, the Construction Contractor's Representative shall be deemed to have the full authority of the Construction Contractor under the Subcontract, but not to amend the Subcontract.

If the Construction Contractor wishes to replace any Person appointed as Construction Contractor's Representative, the Construction Contractor shall give the Subcontractor not less than fourteen (14) days' notice of the replacement's name, address, duties and authority and of the date of appointment.

3.2 Other Construction Contractor's Personnel

The Construction Contractor or the Construction Contractor's Representative may from time to time assign duties and delegate authority to assistants, and may also revoke such assignment or delegation. These assistants may include a resident engineer, or independent inspectors appointed to inspect or test items of Equipment or Materials. The assignment, delegation or revocation shall not take effect until a copy of it has been given in writing to the Subcontractor.

Assistants shall be suitably qualified Persons, who are competent to carry out these duties and exercise this authority.

3.3 Delegated Persons

All Persons, including the Construction Contractor's Representative and assistants, to whom duties have been assigned or authority has been delegated, shall only be authorized to issue instructions to the Subcontractor to the extent defined by the written delegation. Any approval, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test, or similar act by a delegated person, in accordance with the

delegation, shall have the same effect as though the act had been an act of the Construction Contractor. However:

(a) it shall not relieve the Subcontractor from any responsibility it has under the Subcontract, including its responsibility for errors, omissions, discrepancies and non-compliances. The Subcontractor shall not be responsible for errors, omissions, discrepancies and non-compliances which are the responsibility of the Construction Contractor, Project Co, the City and any Third Party under this Subcontract;

(b) any failure to disapprove any work, Equipment or Materials shall not constitute approval, and shall therefore not prejudice the right of the Construction Contractor to reject the work, Equipment or Materials; and

(c) if the Subcontractor questions any determination or instruction of a delegated Person, the Subcontractor may refer the matter to the Construction Contractor, which shall promptly confirm, reverse or vary the determination or instruction.

3.4 Instructions

The Construction Contractor may issue to the Subcontractor instructions in a timely manner which may be necessary for the Subcontractor to perform its obligations under the Subcontract. Each instruction shall be given in writing in a timely manner in order to allow the Subcontractor to perform its obligations in accordance with this Subcontractor, and each instruction shall state the obligations to which it relates and the Sub-Clause (or other term of the Subcontract) in which the obligations are specified. If any such instruction constitutes a Construction Contractor Variation, the Construction Contractor shall clearly so indicate in the instruction and Clause 14 of this Subcontract shall apply.

When written instructions are issued in accordance with the provisions of this Subcontract, the Subcontractor shall take written instructions from the Construction Contractor, or from the Construction Contractor's Representative or an assistant to whom the appropriate authority has been delegated under this Clause.

3.5 Determinations

Whenever this Subcontract provides that the Construction Contractor or the Parties shall proceed in accordance with this Sub-Clause 3.5 to agree or determine any matter, the Construction Contractor shall consult in good faith with the Subcontractor in an endeavour to reach mutual agreement. If mutual agreement is not achieved within ten (10) days, the Construction Contractor shall, within thirty (30) days, in good faith make a fair determination in accordance with the Subcontract, having due regard to all relevant circumstances.

The Construction Contractor shall give notice to the Subcontractor of each agreement or determination, with supporting particulars. Each Party shall give effect to each

agreement or determination, subject to the Subcontractor's right to give notice to the Construction Contractor, of its disagreement with a determination, which notice of disagreement shall be given as soon as reasonably possible given the nature of the matter and in any case within fourteen (14) days of the Subcontractor receiving the determination from the Construction Contractor. Either Party may then refer the dispute to the Dispute Resolution Procedure pursuant to Clause 20 of this Subcontract. For the removal of doubt, the Subcontractor shall comply with the Construction Contractor's determination pending resolution of the dispute and if the dispute is resolved in favour of the Subcontractor, the Subcontractor will be entitled to an extension of time and any Direct Losses incurred.

4.0 THE SUBCONTRACTOR

4.1 Subcontractor's General Obligations

4.1.1 The Subcontractor shall design, execute and complete the Subcontracted Works in accordance with the Subcontract, and shall remedy any Defects in the Subcontracted Works in accordance with the warranty provisions at Clause 12 of this Subcontract. When completed, the Subcontracted Works shall be fit for the purposes for which the Subcontracted Works are intended.

4.1.2 In accordance with the timelines specified within the Subcontract and applicable schedules the Subcontractor shall prepare and provide the Subcontractor's Design Data specified in the Subcontract, assign to the performance of the Subcontracted Works all Subcontractor's Personnel, and deliver Goods, consumables and other things and services, whether of a temporary or permanent nature, required in and for this design, execution, completion and remedying of Defects.

4.1.3 The Subcontracted Works shall include any work which is necessary to satisfy the Design and Specification Requirements, or which is otherwise an obligation of the Subcontractor under the Subcontract and the Subcontractor shall ensure that all Subcontracted Works necessary for the stability or for the completion, or safe and proper operation of the Subcontracted Works portion of the System have been performed.

4.1.4 The Subcontractor shall ensure the adequacy, stability and safety for all of its operations and Subcontracted Works at the Site, and for of all methods of its construction for all the Subcontracted Works.

4.1.5 The Subcontractor shall, whenever reasonably required by the Construction Contractor, submit details of the arrangements and methods which the Subcontractor proposes to adopt for the execution of the Subcontracted Works. No significant alteration to these arrangements and methods shall be made without this having previously been notified to and accepted by the Construction Contractor.

4.1.6 **Commissioning Activities**

The Subcontractor shall perform all commissioning activities specified in the Design and Specification Requirements, which must meet the requirements of the Project Agreement in particular Schedule 14 – Commissioning thereto) that are applicable to Subcontracted Works and, in accordance with the Thales-Alstom Scope Split as identified attached to this Subcontract as Schedule N, shall support and facilitate the performance of all required commissioning by the City, Project Co, any Project Co Party or the Construction Contractor, including the commissioning as set forth in Schedule 14 – Commissioning to the Project Agreement, as applicable to the Subcontracted Works but in accordance with Thales-Alstom Scope Split as identified within Schedule N to this Subcontract.

4.2 **Performance Security**

The Subcontractor shall (at its cost) provide the Construction Contractor with the Performance Security for proper performance of its obligations under the Subcontract in the form set out in Schedule D for [redacted]%) of the Subcontract Price which

Performance Security is limited to 5.1 years from the Subcontractor's Notice To Proceed date or upon Revenue Service date, whichever occurs first.

The Performance Security shall be issued by a first class Canadian bank approved by the Construction Contractor. In the case where the rating of the issuer's senior unsecured debt has been downgraded by S&P below an A- rating, the Construction Contractor may on ten (10) Business Days' notice demand that the Subcontractor provide replacement Performance Security which meets the requirements of this Clause 4.2 of this Subcontract.

The Subcontractor shall ensure that the Performance Security is valid and enforceable until the Subcontractor has executed and completed the Subcontracted Works and remedied any defects. If the terms of the Performance Security specify its expiry date, and the Subcontractor has not become entitled to receive the Performance Certificate by the date 28 days prior to the expiry date, the Subcontractor shall extend the validity of the Performance Security until the Subcontracted Works have been completed and any defects have been remedied, failing which the Construction Contractor may immediately demand payment.

The Construction Contractor shall not make a claim under the Performance Security, except for amounts to which the Construction Contractor is entitled under the Subcontract in the event of:

(a) failure by the Subcontractor to extend the validity of the Performance Security as described in the preceding paragraph or failure by the Subcontractor to Provide replacement Performance Security as required by this Clause in the event of a downgrade of the issuer, in which event the Construction Contractor may claim the full amount of the Performance Security,

(b) failure by the Subcontractor to pay the Construction Contractor Delay Liquidated Damages as required by Sub-clause 8.6 of this Subcontract when due, within ten (10) days after receiving the Construction Contractor's notice requiring the amount to be paid;

(c) failure by the Subcontractor to remedy a default within ten (10) Business days, or such extended time period as agreed to between the Subcontractor and Construction Contractor, after receiving the Construction Contractor's notice requiring the default to be remedied, or

(d) circumstances which entitle the Construction Contractor to termination under Sub-Clause 16.1 of this Subcontract, irrespective of whether notice of termination has been given,

4.2A Warranty Performance Security

The Subcontractor shall provide the Construction Contractor with a performance security ("**Warranty Performance Security**") in a form substantially similar to that attached as Schedule D for proper performance of its obligations under the Subcontract for the General Warranty Period, equal in value to [redacted]%) of the Subcontract Price.

The Warranty Performance Security shall be issued to the Construction Contractor 30 days prior to the expiry of the Performance Security, so as to be in effect from the date of the issuance of the Taking-Over Certificate to the Subcontractor for the Subcontracted Works, or entry into Revenue Service Commencement by the City (whichever is earlier) and shall expire on the earlier of (a) the expiry of the General Warranty Period or (b) October 31, 2020. For greater certainty, the Warranty Performance shall only take effect upon the expiry of the Performance Security.

The Construction Contractor shall return the Performance Security to the Subcontractor upon the date in which the Taking-Over Certificate is issue, or entry into Revenue Service Commencement by the City (whichever is earlier).The Warranty Performance Security shall be issued by a first class Canadian bank approved by the Construction Contractor.

The exercise of the options available under the Option Agreement shall not have the effect of extending the expiry of the Warranty Performance Security applicable to the Subcontracted Works performed under the Subcontract. The Warranty Performance Security does not entitle the Construction Contractor to a General Warranty Period that would extend past May 24, 2020.

The Construction Subcontractor shall not make a claim under the Warranty Performance Security except for amounts to which the Construction Contractor is entitled in the event of a failure by the Subcontractor to remedy a default of its obligations under Clause 12 of the Agreement, within thirty (30) business days after receiving the Construction Contractor's notice requiring the default to be remedied.

4.3 Subcontractor's Representative

Within ten (10) days after the Commencement Date, the Subcontractor shall appoint the Subcontractor's Representative and shall give him or her all authority necessary to act on the Subcontractor's behalf under the Subcontract.

Unless the Subcontractor's Representative is named in the Subcontract, the Subcontractor shall, prior to the Commencement Date, submit to the Construction Contractor for consent the name and particulars of the person the Subcontractor proposes to appoint as Subcontractor's Representative. Consent will not be unreasonably delayed or withheld. If consent is withheld or subsequently revoked, or if the appointed person fails to act as Subcontractor's Representative, the Subcontractor shall similarly submit the name and particulars of another suitable person for such appointment.

The Subcontractor shall not, without the prior consent of the Construction Contractor, revoke the appointment of the Subcontractor's Representative or appoint a replacement.

The Subcontractor's Representative shall, on behalf of the Subcontractor, receive instructions under Sub-Clause 3.4 of this Subcontract.

The Subcontractor's Representative may delegate any powers, functions and authority to any competent Person with the consent of the Construction Contractor, and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Construction Contractor has received prior notice signed by the Subcontractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked.

If requested by Project Co or the Construction Contractor, the Subcontractor's Representative, or another representative of the Subcontractor mutually agreeable to the parties, shall serve as a representative of Project Co on the Works Committee (as defined in the Project Agreement) pertaining to the Subcontracted Works and shall fulfill his or her responsibilities in such capacity in a diligent manner and in accordance with any reasonable direction of Project Co or the Construction Contractor.

The Subcontractor's Representative and all these Persons shall be fluent in English.

4.4 Sub-subcontractors

The Subcontractor shall not sub-subcontract the whole of the Subcontracted Works. Nor will the Sub-subcontractor subcontract any part of the Subcontracted Works without the Construction Contractor's prior written consent, which shall not unreasonably be withheld. The Subcontractor's use of personnel (individuals to supplement the Subcontractor's workforce) from placement agencies shall not be deemed as Sub-subcontractors.

The Subcontractor shall be responsible for the acts or defaults of any Sub-subcontractor, its agents or employees, as if they were the acts or defaults of the Subcontractor. The Subcontractor shall give the Construction Contractor not less than twenty-eight (28) days' notice of:

(a) the intended appointment of any Sub-subcontractor, with detailed particulars which shall include its relevant experience;

(b) the intended scope of the Sub-subcontractor's work; and

(c) the intended commencement date of the Sub-subcontractor's work on the Site.

Any rejection by the Construction Contractor of a proposed Sub-subcontractor shall be notified in writing within ten (10) days of receipt of the Subcontractor's notice, stating

the reasons for rejection, failing which the Subcontractor's proposed Sub-subcontractor shall be deemed accepted by the Construction Contractor.

4.5 **Not Used**

4.6 **Algonquins of Pikwakanangan**

The Subcontractor acknowledges that the nature of the Design and Construction Works and the Maintenance Services has been discussed with the Algonquins of Pikwakanangan. This First Nation group has notified the City that personnel, equipment and resources are available to Project Co, if required. Project Co shall contact the Algonquins of Pikwakanangan in writing, copying the City, and invite them to a meeting to discuss the availability of personnel, equipment and materials for the Design and Construction Works and the Maintenance Services. The Subcontractor will participate in any such meeting if requested by Project Co or the Construction Contractor. For clarity, the foregoing shall not be interpreted as a binding commitment on the Subcontractor to obtain personnel, equipment and materials from the Algonquins of Pikwakanangan for the Subcontractor's Design and Construction Works and Maintenance Services.

4.7 **Co-operation**

The Subcontractor shall, as specified in the Subcontract or as reasonably instructed by the Construction Contractor allow reasonable opportunities for the Construction Contractor carrying out other Project Works on the Site to:

(a) the Construction Contractor's Personnel; and

(b) any other subcontractors employed by the Construction Contractor,

who may be employed in the execution on or near the Site of any work not included in the Subcontracted Works.

The Subcontractor shall be responsible for its construction activities on the Site and shall co-ordinate on a reasonable basis its own activities with those of the Construction Contractor and/or other subcontractors specified in this Subcontract or as otherwise identified in writing by the Construction Contractor and with those of the City and other third parties with which Project Co is obligated to co-ordinate its activities, as specified in the Project Agreement, including in section 19(a) thereof, or otherwise identified in writing by the Construction Contractor.

The Subcontractor shall comply with all obligations of Project Co with respect to the Additional Works/Additional Contractors and Third Party Works/Third Party Contractors, including those set out in section 9.7 of the Project Agreement, and shall comply with the instructions of the Construction Contractor in this regard.

To clarify the Subcontractor is not responsible for providing methods and manner of construction to Third Party Contractors. Nor is the Subcontractor responsible for the overall responsibility for Third Party Contractors compliance with all aspects of Applicable Law relating to health and safety at the Site and the Highway site (if applicable).

Where the Subcontractor's work is impacted by Additional Works and Third Party Works that result in any delay in the Subcontractors Works Schedule, or result in any additional costs incurred by the Subcontractor, the Subcontractor shall be entitled to claim an extension of time and compensation to the extent due to a City Event in accordance with Sub-Clause 9.3 of this Subcontract.

4.8 Not Used

4.9 Safety Procedures

The Subcontractor shall:

(a) comply with all applicable safety regulations required by Law and by Relevant Authority, applicable on the Site and to the Subcontracted Works, as may be determined by the Safety Auditor appointed by the City;

(b) take care for the safety of all persons entitled to be on the Site;

(c) inform the Construction Contractor of the presence of any Protester and Trespassers and cooperate with the efforts of the Construction Contractor or any other party to manage or remove Protesters and Trespassers;

(d) use reasonable efforts to keep the Site and the Subcontracted Works clear of unnecessary obstruction so as to avoid danger to these persons;

(e) provide any Temporary Works which may be necessary for the execution of the Subcontracted Works; and

(f) comply with any safety programs and procedures required under the Construction Contract, including the Safety Management Plan and the Safety Management System, or otherwise instituted by the Construction Contract, as the same may be amended from time to time.

4.10 Quality Assurance

The Subcontractor shall institute a quality assurance ("**QA**") system to demonstrate compliance with the requirements of the Subcontract. The system shall be in accordance with Schedule 11 – Quality Management of the Project Agreement as it applies to the Subcontracted Works, namely the relevant Clauses of Schedule 11 of the Quality Management of the Project Agreement: 2.3, 2.4 a) i, ii and iv, 2.5 c) and d) i E, Clause 4,

5.3, 5.4, 5.5, 5.6, 5.7, 6 and 7. The Construction Contractor shall be entitled to audit any aspect of such QA system.

Details of all procedures and compliance documents shall be submitted to the Construction Contractor for information before each design and execution stage is commenced. When any document of a technical nature is issued to the Construction Contractor, evidence of the prior approval by the Subcontractor itself shall be apparent on the document itself.

Compliance with the QA system shall not relieve the Subcontractor of any of its duties, obligations or responsibilities under the Subcontract.

4.11 **Not Used**

4.12 **Sufficiency of the Subcontract Price**

The Subcontractor shall be deemed to have satisfied itself as to the correctness and sufficiency of the Subcontract Price.

Unless otherwise stated in the Subcontract, the Subcontract Price covers all the Subcontractor's obligations under the Subcontract and all things necessary for the proper design, execution and completion of the Subcontracted Works and the remedying of any Defects in accordance with this Subcontract.

4.13 **Not Used**

4.14 **Rights of Way and Facilities**

The Subcontractor shall bear all costs and charges for special and/or temporary rights-of-way which it may require, including those for access to the Site. The Subcontractor shall also obtain, at its risk and cost, any additional facilities outside the Site which it may require for the purposes of the Subcontracted Works.

4.15 **Avoidance of Interference**

The Subcontractor shall not interfere unnecessarily or improperly with:

(a) the convenience of the public; or

(b) the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Construction Contractor or of others.

The Subcontractor shall comply with Project Co's obligations with respect to avoiding interference with the activities of the City and third parties and avoid impairment of public use and enjoyment, including those specified in section 19(b) of the Project

Agreement, and shall comply with the instructions of the Construction Contractor in this regard.

4.16 Access Route

The Subcontractor shall be deemed to have satisfied itself as to the suitability and availability of all means of access to the Site. The Subcontractor shall use reasonable efforts to prevent any road, bridge and other property from being damaged, and shall indemnify the Construction Contractor Indemnified Parties from any damage caused by the Subcontractor's traffic or by the Subcontractor's Personnel. These efforts shall include the proper use of appropriate vehicles and routes.

Except as otherwise stated in this Subcontract:

(a) the Subcontractor shall (as between the Parties) be responsible for any maintenance which may be required for its use of access routes and other means of access to the Site;

(b) the Subcontractor shall provide all necessary signs or directions along access routes, and shall obtain any permission which may be required from the Relevant Authority for its use of routes, signs and directions;

(c) the Construction Contractor shall not be responsible for any Claims which may arise from the use of any access route, with the exception of use of an access route in which access route was unsafe or the Subcontractor's use of access route was impeded by the Construction Contractor or a third party; and

(d) the Construction Contractor does not warrant or guarantee the suitability or availability of particular access routes.

4.17 Transport of Goods

Unless otherwise expressly stated in this Subcontract:

(a) the Subcontractor shall give the Construction Contractor notice of the date on which any Goods will be delivered to the Site;

(b) the Subcontractor shall be responsible for packing, loading, transporting, receiving, unloading, storing and protecting all Goods and other things to the Site required for the Subcontracted Works; and

(c) the Subcontractor shall indemnify and hold the Construction Contractor Indemnified Parties harmless against and from all Direct Loss resulting from the transport of Goods, and shall negotiate and pay all claims arising from their transport.

4.18 Construction Equipment

The Subcontractor shall be responsible for all Construction Equipment. When brought on to the Site, Construction Equipment shall be deemed to be exclusively intended for the execution of the Subcontracted Works.

4.19 Protection of the Environment and Energy Requirements

The Subcontractor shall take all necessary steps to protect the environment (both on and off the Site), to avoid damage and nuisance to Persons and property resulting from pollution, noise and other results of its operations and to comply with the obligations of Project Co under Schedule 17 – Environmental Obligations of the Project Agreement wherever and as applicable to the scope of this Subcontract or prescribed by this Subcontract.

The Subcontractor shall be responsible for removing or remediating, in accordance with Section 5.5(b) of Schedule 17 – Environmental Obligations of the Project Agreement:

(a) any Contamination which the Subcontractor or any Subcontractor Personnel causes or permits to be Released in a manner which does not comply with Applicable Law or which causes a Risk to Human Health or the Environment; or

(b) any Contamination which was harmless or stored, contained or otherwise dealt with in accordance with Applicable Law which the Subcontractor or any Subcontractor Personnel causes or permits to be Released in a manner which does not comply with Applicable Law or which causes a Risk to Human Health or the Environment.

Upon the discovery of any Contamination, the Subcontractor shall immediately inform the Construction Contractor's Representative and shall comply, and ensure compliance by all Subcontractor Personnel, with all Applicable Law and any direction of the Construction Contractor's Representative.

Upon the discovery of any Species-at-Risk, the Subcontractor shall:

(c) immediately inform the Construction Contractor's Representative of such discovery; and

(d) comply, and ensure compliance by all Subcontractor Personnel, with all Applicable Law and any direction of the Construction Contractor's Representative.

The Subcontractor will be responsible for the inputs that the Subcontractor has provided to the Construction Contractor and Project Co for the purposes of Schedule 8 – Energy Matters and Schedule 39 – Operations Matters of the Project Agreement but only with respect to provisions of Schedule 8 and Schedule 39 of the Project Agreement which are applicable to the Subcontractor's scope of work.

4.20 Electricity, Water and Gas

The Subcontractor shall be entitled to use for the purposes of the Subcontracted Works such supplies of electricity, water, gas and other services as may be available on the Site. The Subcontractor shall, at its risk and cost, provide any apparatus necessary for its use of these services and for measuring the quantities consumed.

4.21 Not Used

4.22 Progress Reports

Unless otherwise stated in this Subcontract, monthly Progress Reports shall be prepared by the Subcontractor and submitted to the Construction Contractor in three (3) hard copies and in Microsoft Word electronic version. The first Progress Report shall cover the period up to the end of the first calendar month following the Commencement Date. Progress Reports shall be submitted monthly thereafter, each within five (5) days after the last day of the period to which it relates.

Reporting shall continue until the Subcontractor has completed all work which is known to be outstanding at the completion date stated in the Completion Certificate for the Subcontracted Works.

Each Progress Report shall comply with Schedule 33 to the Project Agreement (as applicable to the Subcontracted Works and shall include:

(a) an executive summary describing the general status of the Subcontracted Works and progress made over the relevant month;

(b) an updated Approved Subcontract Schedule, printed in both summary and detailed formats (PDF), and in native P6 format (XER);

(c) a narrative description of any delays and disputes related to the Subcontracted Works, including any action that has taken place over the relevant month to resolve such delays and disputes;

(d) an update on those matters set out in Schedule 33 to the Project Agreement that are applicable to the Subcontracted Works; and

(e) such other reports and information regarding the Subcontracted Works that the Construction Contractor may reasonably [request from time to time (for greater certainty, it would be reasonable to request information if so required by the City pursuant to the Project Agreement),

all in form and substance satisfactory to the Construction Contractor, acting reasonably. For greater certainty, for all updates and revisions to the Approved Subcontract Schedule, the Subcontractor must provide a revised critical path reflecting the updated/revised

Approved Subcontract Schedule. Notwithstanding the foregoing, the Subcontractor will not be required to provide internal costs/man hours information.

(b) The Subcontractor shall use, and shall ensure that the Subcontractor's Personnel use, the project management software system specified by the City.

The Subcontractor shall, in performing all activities within the scope of the Subcontracted Works, cooperate with the Construction Contractor by, amongst other things, participating in meetings, committees and subcommittees related to the Project in respect of which the Construction Contractor requires the Subcontractor shall participate and, in the event that such participation is determined by Construction Contractor and the City to constitute a significant expense to the Subcontractor, the Subcontractor's participation shall, subject to and in accordance with Clauses 9 and 14 of this Subcontract, result in a Variation.

The Subcontractor will provide assistance to the Construction Contractor in the Design Review Meetings when reasonably required by the Construction Contractor for issues related to the Subcontracted Works.

4.23 **Not Used**

4.24 **Subcontractor's Operations on Site**

The Subcontractor shall confine its operations to the Site and to any additional areas which may be obtained by the Subcontractor at its own cost and agreed in writing by the Construction Contractor as working areas. The Subcontractor shall take all necessary precautions to keep its Construction Equipment and Subcontractor's Personnel within the Site and these additional areas and to keep them off adjacent land.

During the execution of the Subcontracted Works, the Subcontractor shall keep the Site free from all unnecessary obstruction, and shall store or dispose of any Construction Equipment or surplus materials of which it brought to the Site. The Subcontractor shall clear away and remove from the Site any wreckage, rubbish and Temporary Works which are no longer required.

Prior to the issue of the Taking-Over Certificate for the Subcontracted Works, the Subcontractor shall clear away and remove all Construction Equipment, surplus materials, wreckage, rubbish and Temporary Works. The Subcontractor shall leave the Site and the Subcontracted Works in a clean and safe condition.

To clarify the Subcontractor is not responsible to clear away and remove all Construction Equipment, surplus materials, wreckage, rubbish and Temporary Works that was brought to site or left on Site by other subcontractors or third parties.

4.25 **Items of Geological, Historical or Archaeological Interest or Value**

4.25.1 As between the Parties, all fossils, artifacts and other objects having artistic, historic, archaeological or monetary value, including human remains and burial sites, which may be found on or at the Lands or Highway Site are or shall be the sole and absolute property of the Construction Contractor.

4.25.2 Upon the discovery of any item referred to in Sub-Clause 4.25.1 of this Subcontract during the performance of the Subcontract, the Subcontractor shall:

(a) immediately inform the Construction Contractor Representative of such discovery;

(b) take all steps not to disturb the item and, if necessary, cease any activities within the Subcontracted Works in so far as performing such Subcontracted Works would endanger the item or prevent or impede its excavation;

(c) take all necessary steps to preserve and ensure the preservation of the item in the same position and condition in which it was found; and

(d) comply, and ensure compliance by all Subcontractor Personnel, with Applicable Law and all requirements of Governmental Authorities with respect to such discovery, including Schedule 17 – Environmental Obligations, Part 7 of the Project Agreement.

4.25.3 In the event that the Construction Contractor wishes the Subcontractor to perform actions which are in addition to any required pursuant to Sub-Clause 4.25.2 of this Subcontract, then the Construction Contractor shall issue an instruction to the Subcontractor specifying what action the Construction Contractor requires the Subcontractor to take and the Subcontractor shall promptly and diligently comply with all such instructions.

4.25.4 If Sub-Clauses 4.25.2 and 4.25.3 of this Subcontract require the Subcontractor to perform any alteration, addition, demolition, extension or variation in the activities within the Subcontracted Works as a result of any such discovery and which would not otherwise be required under this Subcontract, then any such alteration, addition, demolition, extension or variation (but only to the extent it directly results in the interruption of the performance of the Subcontracted Works with respect to each such discovery) shall be a Construction Contractor Variation, unless it is a City Event or a Project Co Event.

4.25.5 In the event that the Construction Contractor and the Subcontractor do not agree as to the nature or extent of the actions required to be performed by the Subcontractor pursuant to Sub-Clauses 4.25.2(b), 4.25.2(c) or 4.25.2(d), of this Subcontract such disagreement shall be referred for determination to an independent and suitably qualified and experienced person, acceptable to the Subcontractor and the Construction Contractor, each acting reasonably (and the costs and expenses of retaining such person shall be borne by the unsuccessful Party). Such person's decision shall be final and binding on the Parties except to the extent that either Party alleges that such decision would result in non-compliance with Applicable Law or this Subcontract, in which event either Party

may refer the disagreement for resolution in accordance with the Dispute Resolution Procedure.

4.26 **Encumbrances**

4.26.1 The Subcontractor shall not create, incur, permit or suffer to exist any Encumbrance to be filed, issued or registered upon or against the Lands or any part thereof or any interest therein due to an act or omission of the Subcontractor or any Subcontractor Personnel.

4.26.2 The Subcontractor shall promptly notify the Construction Contractor of any Encumbrance which is not a Title Encumbrance as soon as it becomes aware thereof.

4.26.3 In the event that the Lands or any part thereof or any interest therein becomes subject to any Encumbrance due to an act or omission of the Subcontractor or any Subcontractor Personnel which has not been consented to in writing by the Construction Contractor, the Subcontractor shall immediately take all steps necessary to remove, vacate or discharge such Encumbrance. If such Encumbrance is not removed, vacated or discharged within three (3) Business Days of the filing, issuance or registration of such Encumbrance then, without prejudice to any other rights or remedies it may have, the Construction Contractor will be at liberty to take whatever steps it deems necessary and appropriate to remove, vacate or discharge the Encumbrance, including payment of any amount owing or claimed thereunder, and seek immediate recovery from the Subcontractor of the amount of any such payment and any associated costs, including legal costs (on a full indemnity basis), all of which shall be payable on demand.

4.27 ***Construction Lien Act*** **(Ontario)**

4.27.1 The Parties acknowledge that the foregoing provisions of Sub-Clauses 4.26.1 and 4.26.2 of this Subcontract shall apply to claims for lien made upon or against the Lands pursuant to the CLA and shall also apply to claims made against the City, Project Co, the Construction Contractor or the holdback held by any of them under the CLA as though such a claim were an Encumbrance against the Lands as referred to therein.

4.27.2 Subcontractor shall withhold from each of its subcontractor the holdbacks required under the CLA and shall deal with such holdbacks in accordance with the CLA.

4.27.3 The parties acknowledge and agree that Section 20(2) of the CLA applies and that all liens shall arise and expire on a lot-by-lot basis, which, in the context of the Project Agreement, shall mean on the System and Highway basis.

4.27.4 The Subcontractor shall promptly provide the Construction Contractor with a copy of any materials which the Construction Contractor may reasonably request to evidence compliance with the CLA, including statutory declarations from the Subcontractor and its Sub-subcontractors in forms acceptable to the Construction Contractor.

4.27.5 If the Construction Contractor performs a subsearch of title on the Lands or any part thereof, the Subcontractor shall pay the reasonable costs of any such search if (i) a search that reveals Encumbrances that are not permitted by this Subcontract, (ii) a search requested based on a reasonable suspicion that an Encumbrance that is not permitted by this Subcontract has been registered on title to the Lands, or (iii) a search requested for the purpose of confirming that an Encumbrance that is not permitted by this Subcontract has been discharged from the Lands.

4.28 Remedial Rights and Emergencies

The Subcontractor acknowledges that the City and Project Co have certain remedial rights which they can exercise pursuant to Section 32 of the Project Agreement and Part 2 Section 32 of the Prime Contract. The Subcontractor will indemnify the Construction Contractor where the City or Project Co exercises such rights due to a breach of this Subcontract by the Subcontractor or any act or omission of the Subcontractor or any Subcontractor Personnel.

4.29 Emergency

Upon the occurrence of an Emergency, the Subcontractor will comply with any emergency response plan under the Project Agreement.

4.30 Energy Matters and Operations Matters

The Subcontractor will be responsible for the inputs that it has provided to the Construction Contractor and Project Co for the purposes of Schedule 8 – Energy Matters and Schedule 39 – Operations Matters of the Project Agreement as applicable to the Subcontractor's scope of work.

4.31 Development of Regulatory Standards

For clarity, with respect to the 8,000 hours threshold cumulative aggregate hours of Project Co. staff resource time established under s. 3.(a)(viii) Schedule 15 -4 refers to all Project Co Parties (as defined under the PA) and not exclusively to the Subcontractor. The Subcontractor will be obliged to support the City in respect of this requirement to the extent the City's request relates to the development of regulatory standards in relation to the scope of the Subcontracted Works

5.0 DESIGN

5.1 General Design Obligations

The Subcontractor shall be deemed to have scrutinized, prior to the execution of this Subcontract, the Design and Specification Requirements (including design criteria and calculations, if any).

The Subcontractor shall be responsible for the design of the Subcontracted Works, which design shall be in accordance with:

1) Subcontractor Technical Exceptions and Deviations Rev03 2012-09-28 attached to this Subcontract as Appendix I;

2) Subcontractor Technical and Program Conditions attached to this Subcontract as Attachment B;

3) CBTC System Specification attached to this Subcontract as Schedule M;

4) Thales-Alstom Scope Split attached to this Subcontract as Schedule N; and

5) Output Specifications, but only to the extent that the Output Specifications are applicable to the Subcontracted Works.

The design of the Subcontracted Works, which for clarity shall include the responsibility for meeting all obligations of Project Co under the Project Agreement regarding the development of design of the Subcontracted Works as it is applicable to the Subcontracted Works, including the obligations as it is applicable to the Subcontracted Works within Sections 20.3, 20.4, 20.5, 20.7, 20.8 and 20.11 of the Project Agreement and Schedule 10 – Review Procedure to the Project Agreement, as applicable, and participating as a member of the Design Team if so requested by the Construction Contractor, and for the accuracy of such Design and Specification Requirements (including design criteria and calculations), except as stated below.

Any data or information received by the Subcontractor, from the Construction Contractor or otherwise, shall not relieve the Subcontractor from its responsibility for the design and execution of the Subcontracted Works.

5.2 Subcontract Design Data

In addition to those documents required to meet the design requirements of the Project Agreement, as applicable to the Subcontracted Work, the Subcontractor's Design Data shall include documents specified in the Design and Specification Requirement (having due regard to the responsibilities of the Subcontractor under Schedule N - Thales-Alstom Scope Split), such being the responsibility of the Subcontractor and documents required to satisfy all Relevant Authority approvals.

The Subcontractor shall prepare all Subcontractor's Design Data, and shall also prepare other documents necessary to instruct the Subcontractor's Personnel or necessary to satisfy the Subcontractor's obligation to cooperate with the rolling stock provider or for which the Subcontractor is responsible under the Thales-Alstom Scope Split as attached to this Subcontract as Schedule N.

Subject to the Subcontractor complying with its obligations under Schedule N - Thales-Alstom Scope Split, the Construction Contractor shall ensure that the rolling stock provider prepares all of its Design Data, and shall also prepare other documents necessary to instruct the rolling stock provider Personnel or necessary to satisfy the rolling stock

provider's obligation to cooperate with the Subcontractor or for which the rolling stock provider is responsible under the Thales-Alstom Scope Split as attached to this Subcontract as Schedule N. The Subcontractor shall reasonably co-operate with the Construction Contractor and rolling stock provider in respect of the exchange of information and other activities to permit each of Subcontractor and rolling stock provider to perform their respective obligations.

The Subcontractor will submit the Subcontractor's Design Data to the Construction Contractor for review, together with a notice as described below. In the following provisions of this Sub-Clause (i) "review period" means the period required by the Construction Contractor for review; and (ii) "Subcontractor's Design Data" exclude any documents which are not required to be submitted for review.

Each review period shall not exceed thirty (30) days, calculated from the date on which the Construction Contractor receives a submittal of the Subcontractor's Design Data and the Subcontractor's notice. This notice shall state that the submittal of Subcontractor's Design Data is considered ready, both for review in accordance with this Sub-Clause and for use. The notice shall also state that the submittal of Subcontractor's Design Data complies with the Subcontract, or the extent to which it does not comply.

The Construction Contractor may within the review period which shall not exceed thirty (30) days. The Construction Contractor shall give notice to the Subcontractor within the thirty (30) days review period as to how the submittal of Subcontractor's Design Data fails (to the extent stated) to comply with the Design and Specification Requirements, or that the submittal of Subcontractor's Design Data complies with the Design and Specification Requirements.

If a submittal of Subcontractor's Design Data so fails to comply with the Design and Specification Requirements, the notice shall be appropriately substantiated with reference to how the Subcontractor's Design Data is non-compliant with the Design and Specification Requirements. The Subcontractor's Design Data shall then be rectified, resubmitted and reviewed in accordance with this Sub-Clause, at the Subcontractor's cost.

For each part of the Subcontracted Works, and except to the extent that the Parties otherwise agree in writing;

(a) execution of such part of the Subcontracted Works shall not commence prior to the expiry of the review periods for all the submittals of Subcontractor's Design Data which are relevant to its design and execution;

(b) execution of such part of the Subcontracted Works shall be in accordance with these submittals of Subcontractor's Design Data, as submitted for review; and

(c) if the Subcontractor wishes to modify any design or document which has previously been submitted for review, the Subcontractor shall immediately give

notice to the Construction Contractor. Thereafter, the Subcontractor shall submit revised documents to the Construction Contractor in accordance with the above procedure.

Any such agreement (under the preceding paragraph) or any review (under this Sub-Clause or otherwise) shall not relieve the Subcontractor from any obligation or responsibility that is has under this Subcontract.

5.3 Subcontractor's Undertaking

The Subcontractor undertakes that the design, the Subcontractor's Design Data, the execution and the completed Subcontracted Works will be in accordance with:

(a) the Laws of Ontario,

(b) the documents forming the Subcontract, as altered or modified by Variations, including the Design and Specification Requirements; and

(c) technical standards which are applicable to the Subcontracted Works under the Project Agreement and the Design and Specification Requirements.

5.4 Technical Standards

Where this Subcontract requires the Subcontractor to comply with a technical standard under the Project Agreement or the Design and Specification Requirements in respect of the design and construction aspects of the Subcontracted Works, and that standard has changed between the date of the signing of the Project Agreement and the date that such compliance is required, then the Subcontractor shall give notice to the Construction Contractor of such change. If, after such notice, the Construction Contractor requires compliance with the changed standard (rather than the standard applicable as of the date of the Effective Agreement of the Subcontract Agreement), then, to the extent such change impacts the design and construction aspects of the Subcontracted Works and would not have otherwise been taken into account by compliance with Good Industry Practice (Works), such changed standard shall, subject to and in accordance with Clause 14 of this Subcontract, result in a Variation. If the Construction Contractor does not require compliance with the changed standard, then the Subcontractor shall continue to comply with the standard applicable as of the date of the signing of the Project Agreement, without a Variation therefor. This section shall not apply where a change in a technical standard is also a Change in Law.

5.5 Training

The Subcontractor shall carry out the training of Construction Contractor's Personnel and/or Project Co's or Maintenance Contractor's or the City's personnel in the operation and maintenance of the Subcontracted Works as specified in the Design and Specification Requirements and Subcontract. If the Subcontract specifies training which is to be

carried out before taking-over, the Subcontracted Works shall not be considered to be completed for the purposes of taking-over under Sub-Clause 11.1 of this Subcontract until this training has been completed.

5.6 Records

5.6.1 Record Provisions

(a) The Subcontractor shall comply with Attachment 26 – CC Record Provisions to the Construction Contract, as applicable to the Subcontractor and the Subcontracted Works.

(b) The Subcontractor shall ensure the back up and storage in safe custody of the data, materials and documents referred to in this Sub-Clause 5.6 and all Project Data related to the Subcontracted Works in accordance with Good Industry Practice. The Subcontractor shall submit to the Construction Contractor's Representative the Subcontractor's proposals for the back up and storage in safe custody of such data, materials and documents and the Construction Contractor shall be entitled to object if the same is not in accordance with Good Industry Practice, and the Subcontractor shall comply, and shall cause all Subcontractor's Personnel to comply, with all procedures to which the Construction Contractor's Representative has not objected. The Subcontractor may vary its procedures for such back up and storage subject to submitting its proposals for change to the Construction Contractor's Representative, who shall be entitled to object on the basis set out above.

5.6.2 Information and General Audit Rights

(a) The Subcontractor shall provide and shall cause each Sub-subcontractor to provide to the Construction Contractor, and at the Construction Contractor's request, Project Co and the City, all information, reports, documents, records and the like, including as referred to in Attachment 26 – CC Record Provisions, as applicable to the Subcontractor and the Subcontracted Works, in the possession of, or available to, the Subcontractor as the Construction Contractor may reasonably require from time to time for any purpose in connection with this Subcontract, the Construction Contract or the Project Agreement, other than Sensitive Information. The Subcontractor shall use commercially reasonable efforts to ensure that, for such purpose, all such information, reports, documents, records and the like in the possession of, or available to its Sub-subcontractors shall be available to the Subcontractor, the Construction Contractor, and at the Construction Contractor's request, Project Co and the City, and the Subcontractor shall include relevant terms in all Sub-subcontracts to this effect.

(b) The Subcontractor shall also provide to the Construction Contractor, and shall require each Sub-subcontractor to provide to the Construction Contractor, all information, reports, documents, records and the like required to be provided pursuant to Sub-Clause 5.6.2(a) of this Subcontract which subsequently come into the possession of, or become available to, the Subcontractor or each Sub-subcontractor, as the Construction, Project Co or the City may reasonably require from time to time (at the reasonable cost of the party

imposing the requirement) to enable the Construction Contractor, Project Co or the City to provide reports, notices, returns and the like pursuant to Applicable Law, including information and documentation pertaining to the physical condition of the System, security, health and safety, fire safety, emergency preparedness, environmental matters, employees and human resources related matters, other than Sensitive Information.

(c) The Subcontractor shall promptly after receipt provide the Construction Contractor with a copy of any material notice, order, direction, requirement or other similar communication received by it or by any Sub-subcontractor from any Governmental Authority in relation to any of the Subcontracted Works or the System, and the Subcontractor shall include relevant terms in all Sub-subcontracts to this effect.

(d) The Subcontractor shall promptly notify Construction Contractor of any actions, suits, proceedings, or investigations commenced, pending or threatened against the Subcontractor or, to the Subcontractor's knowledge, any Sub-subcontractor at law or in equity before any Governmental Authority or arbitral body (whether or not covered by insurance) that individually or in the aggregate could result in any material adverse effect on the business, properties, or assets or the condition, financial or otherwise, of the Subcontractor or in any impairment of its ability to perform its obligations under this Subcontract.

(e) All information, reports, documents and records in the possession of, or available to, the Subcontractor, including as referred to in Attachment 26 – CC Record Provisions, as applicable to the Subcontractor and the Subcontracted Works, which are required to be provided to or available to the Construction Contractor, the City or Project Co hereunder, shall be subject and open to inspection and audit by the Construction Contractor, Project Co and the City at any time and from time to time, which inspection and audit shall take place during normal business hours and at the Construction Contractor's normal places of business unless the Construction Contractor and the Subcontractor otherwise agree. The Construction Contractor, the City and Project Co shall also have the right to monitor and audit the performance of any and all Subcontracted Works wherever located, and the Subcontractor shall cooperate with, and shall require each Sub-subcontractor to cooperate with, and provide access to the representatives of the Construction Contractor, Project Co or the City, monitoring and auditing the Subcontracted Works, including providing them with access and copies (at the reasonable cost of the party requesting them) of all relevant information, reports, documents and records pertaining to the performance of the Subcontracted Works.

(f) In conducting an audit of the Subcontractor under Sub-Clause 5.6.2(e) of this Subcontract or as otherwise provided under this Subcontract, the Construction Contract or the Project Agreement, the Construction Contractor, Project Co and the City shall have all rights necessary or incidental to conducting an audit, including the right to have access to and inspect and take copies (at the reasonable cost of the party requesting them) of all books and records of the Subcontractor required to be provided to or available to the Construction Contract, Project Co or the City hereunder or under the Construction Contract or the Project Agreement, upon reasonable notice and at reasonable times. The

Subcontractor shall fully cooperate with the Construction Contractor, Project Co and the City and its auditors in the conduct of any audits, including by making available all such records and accounts (other than Sensitive Information) in existence at that time as they may require to perform a full and detailed audit, and the Subcontractor further agrees to promptly review and settle with the Construction Contractor, or at the Construction Contractor's request, Project Co or the City, in accordance with the requirements of the Project Agreement, all matters arising from such audits, including the refunding of monies to the Construction Contractor in accordance with the requirements of the Project Agreement where applicable. At the reasonable request of the Construction Contractor's, Project Co's or the City's auditors, the Construction Contractor shall provide such information, reports, documents and records as such auditors may reasonably require, other than Sensitive Information, provided that any of the same to be provided to the City's auditors shall be so provided by the Subcontractor in consultation with the Construction Contractor.

(g) The Subcontractor acknowledges that the rights of the Construction Contractor, Project Co and the City pursuant to this Sub-Clause 5.6.2 of this Subcontract shall be in addition to, and shall not limit, any other information, inspection or similar rights under this Subcontract, the Construction Contract or the Project Agreement.

(h) The Subcontractor acknowledges that the rights of the Construction Contractor, Project Co and the City pursuant to this Sub-Clause 5.6.2 of this Subcontract shall not limit or restrict any Governmental Authority's right of review, audit, information or inspection under Applicable Law. Upon notice to the Subcontractor, the City's right pursuant to section 37.2 of the Project Agreement may also be exercised by HMQ, the Auditor General of Ontario, Her Majesty the Queen in Right of Canada, the Auditor General of Canada and anyone acting on their behalf without the requirement for further action on the part of the City or the Construction Contractor.

(i) With the exception of any Sensitive Information, the Subcontractor shall provide the Construction Contractor with a copy of any information that is provided to the City pursuant to this Sub-Clause 5.6.2.

5.7 Operations and Maintenance Services Manuals

Prior to commencement of the Tests on Completion or as otherwise required by the City, acting reasonably in accordance with the Project Agreement, the Subcontractor shall supply to the Construction Contractor provisional operation and maintenance manuals in sufficient detail for the user to operate, maintain, dismantle, reassemble, adjust and repair the Subcontracted Works as required by the City, acting reasonably in accordance with the Project Agreement.

The Subcontracted Works shall not be considered to be completed for the purposes of taking-over under Sub-Clause 11.1 of this Subcontract until the Construction Contractor has received final operation and maintenance manuals in such detail, and any other

manuals applicable to the Subcontracted Works as specified in the Subcontract for these purposes.

5.8 **Design Error**

If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Subcontractor's Design Data, they and the Subcontracted Works shall be corrected at the Subcontractor's cost, notwithstanding any consent or approval under this Clause.

6.0 STAFF AND LABOUR

6.1 **Engagement of Staff and Labour**

The Subcontractor shall make arrangements for the engagement and payment of all of its staff and labour.

6.2 **Persons in the Service of Others**

The Subcontractor shall not recruit, or attempt to recruit, staff and labour from amongst the Construction Contractor's Personnel. The Construction Contractor shall not recruit, or attempt to recruit, staff and labour from amongst the Subcontractor's Personnel.

6.3 **Labour Laws**

The Subcontractor shall comply, and shall cause its Sub-subcontractors to comply, with all the relevant labour Laws applicable to the Subcontractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights. The Subcontractor shall require its employees to obey all Applicable Law, including those concerning safety at work.

6.4 **Not Used**

6.5 **Facilities for Staff and Labour**

The Subcontractor shall provide and maintain all necessary facilities for the Subcontractor's Personnel.

The Subcontractor shall not permit any of the Subcontractor's Personnel to maintain any temporary or permanent living quarters within the Site and/or within the structures forming part of the Permanent Works.

6.6 **Health and Safety, Workplace Safety and Insurance Board, Compliance**

6.6.1 For the purposes of Applicable Law, the Construction Contractor will be, as of the date of commencement of any construction of the System, the "constructor" as defined in the *Occupational Health and Safety Act* (Ontario) and an "employer" under the Federal

Canada Labour Code and accordingly will comply, or will cause to be complied, with all resulting requirements and obligations including:

(a) ensuring continuing coordination of the occupational health and safety activities of all employers on the Site, including the Subcontractor, Sub-subcontractors, any other subcontractors and everyone engaged by or through any of them;

(b) delivering notices of the Project as required by Applicable Law; and

(c) complying with the obligation of a constructor for a multi-employer workplace as prescribed by Applicable Law.

6.6.2 The Subcontractor shall at all times take all reasonable precautions to maintain the health and safety of the Subcontractor's Personnel. In collaboration with local health relevant authority and with the Construction Contractor's health and safety personnel or consultant, the Subcontractor shall ensure that first aid equipment is available at all times at the Site, and that medical staff/ambulance service will be called to the Site when the occasion requires their presence. The Construction Contractor shall be responsible for providing access for any emergency vehicles. The Construction Contractor shall ensure that suitable arrangements are made for all necessary welfare and hygiene requirements for Subcontractor's Personnel on Site.

6.6.3 The Subcontractor shall cooperate with the Construction Contractor's health and safety Personnel in maintaining safety and protection against accidents and shall have the authority to issue instructions and take protective measures to prevent accidents. throughout the execution of the Subcontracted Works.

6.6.4 The Subcontractor shall notify the Construction Contractor of any accident as soon as practicable after its occurrence. The Subcontractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Construction Contractor may reasonably require.

6.6.5 Upon request of the Construction Contractor's Representative acting reasonably the Subcontractor will provide evidence, satisfactory to the Construction Contractor's Representative, of compliance by the Subcontractor with the requirements of the *Occupational Health and Safety Act* (Ontario) and the Federal *Canada Labour Code*, each as amended, and all regulations and successor legislation thereto, including payments due thereunder at the following times:

(a) prior to commencing any Subcontracted Works on Site;

(b) as a condition to the issue of any Taking-Over Certificate; and

(c) at any time during Subcontracted Works on Site, upon request of the Construction Contractor's Representative acting reasonably.

If the Subcontractor or any Person employed by or through the Subcontractor in the performance of any Subcontracted Works on Site does not comply with the requirement of the *Occupational Health and Safety Act* (Ontario) and the Federal *Canada Labour Code*, each as amended, and all regulations and successor legislation thereto, including payment and deduction and remittance of any and all contributions, fees, assessments and charges required to be made pursuant to the above, the Subcontractor shall indemnify the Construction Contractor from any Direct Losses, liability or obligation which the Construction Contractor may incur as a result.

6.7 Subcontractor's Superintendence

Throughout the design and execution of the Subcontracted Works, and as long thereafter as is necessary to fulfill the Subcontractor's obligations as stipulated within the Subcontract, the Subcontractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect and test the Subcontracted Works.

Superintendence shall be given by a sufficient number of persons having adequate knowledge of the English language and of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Subcontracted Works.

6.8 Subcontractor's Personnel

The Subcontractor's Personnel shall be appropriately qualified, skilled and experienced in their respective trades or occupations. The Construction Contractor may require by written notice that the Subcontractor to remove (or cause to be removed) any person employed on the Site or the Subcontracted Works, including the Subcontractor's Representative if applicable, who:

(a) persists in any misconduct or lack of care;

(b) carries out duties incompetently or negligently;

(c) fails to conform with any material provisions of the Subcontract;

(d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment; or

(e) the City or Project Co instructs the Construction Contractor to remove or (cause to be removed) from the Site or the Subcontracted Works in accordance with Section 28.2 of the Project Agreement or Part 2, Section 28.2 of Construction Contract.

If appropriate, the Subcontractor shall then appoint (or cause to be appointed) a suitable replacement person.

6.9 Records of Subcontractor's Personnel and Equipment

The Subcontractor shall submit to the Construction Contractor details showing the number of each class of Subcontractor's Personnel and of each type of Construction Equipment (if applicable) on the Site. Details shall be submitted each calendar month, in the Subcontractor' standard form as approved by the Construction Contractor, until the Subcontractor has completed all work which is known to be outstanding at the completion date stated in the Taking-Over Certificate for the Subcontracted Works.

6.10 Disorderly Conduct

The Subcontractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst the Subcontractor's Personnel, and to preserve peace and protection of persons and property on and near the Site.

6.11 Restricted Persons

The Subcontractor shall not subcontract any interest in this Subcontract, and shall not permit the Sub-subcontractors to subcontract any interest in the applicable Sub-subcontract to a Restricted Person, or any Affiliate thereof, or a person whose standing or activities: (i) are inconsistent with the City's role (in the City's reasonable opinion); (ii) may compromise the reputation or integrity of the City and/or any City Party; or (iii) are inconsistent with the nature of the City or the Project, so as to negatively affect public perception of the City or the Project.

6.12 Prohibited Acts

"Prohibited Act" has the meaning given in Clause 1.1 of this Subcontract.

The Subcontractor shall notify the City of the occurrence and details of any Prohibited Act promptly on the Subcontractor becoming aware of its occurrence.

If the Subcontractor or any Subcontractor Personnel (or anyone employed by or acting on their behalf) commits any Prohibited Act, then the Construction Contractor shall be entitled to act in accordance with the following:

(a) if the Prohibited Act is committed by the Subcontractor or by an employee acting under the direction of a director or officer of the Subcontractor, then it shall be a Subcontractor Event of Default;

(b) if the Prohibited Act is committed by an employee of the Subcontractor acting independently of a direction of a director or officer of the Subcontractor, then the Construction Contractor may give written notice to the Subcontractor and it shall be a Subcontractor Event of Default, unless, within twenty (20) days of receipt of such notice, the Subcontractor terminates the employee's employment

and ensures that the relevant part of the Subcontracted Works shall be performed by another person;

(c) if a Prohibited Act is committed by any Sub-subcontractor or by an employee of the Sub-subcontractor not acting independently of a direction of a director or officer of that Sub-subcontractor, then the Construction Contractor may give written notice to the Subcontractor and it shall be a Subcontractor Event of Default, unless, within twenty (20) days of receipt of such notice, the Subcontractor terminates the relevant Sub-subcontract and ensures that the relevant part of the Subcontracted Works shall be performed by another person;

(d) if a Prohibited Act is committed by any Sub-subcontractor or by an employee of the Sub-subcontractor acting independently of a direction of a director or officer of that Sub-subcontractor, then the Construction Contractor may give written notice to the Subcontractor and it shall be a Subcontractor Event of Default, unless, within twenty (20) days of receipt of such notice, the Subcontractor causes the termination of the employee's employment and ensures that the relevant part of the Subcontracted Works shall be performed by another person; and

(e) if the Prohibited Act is committed on behalf of the Subcontractor or a Sub-subcontractor by a person not specified in paragraphs (a) to (d) above, then the City may give notice to the Subcontractor and it shall be a Subcontractor Event of Default, unless, within twenty (20) days of receipt of such notice, the Subcontractor causes the termination of such person's employment or the appointment of their employer and, if necessary, ensures that the relevant part of the Subcontracted Works shall be performed by another person.

6.12A Corporate Responsibility

The Subcontractor shall, while performing its obligations under this Subcontract, ensure compliance by itself, its directors, officers, employees, and agents with:

a. the provisions of guidelines and conventions issued by the Organisation for Economic Co-operation and Development (including the Convention Against Bribery of Foreign Public Officials in International Business Transactions ("OECD Guidelines"); and

b. the Subcontractor's Code of Ethics (which is available from Thales website, at http://www.thalesgroup.com/Group/Corporate_Responsibility/Documents/code_of_ethics/), as it may be amended, supplemented, superseded or replaced, by Subcontractor from time to time

7.0 EQUIPMENT, MATERIALS AND WORKMANSHIP

7.1 Manner of Execution

The Subcontractor will ensure that the Subcontracted Works and all consumables and materials used or supplied by it in connection with the Subcontractor Works to be of good quality, fit for their intended purpose and maintained in a safe, serviceable and clean condition in accordance with the:

(a) Subcontractor Technical Exceptions and Deviations Rev03 2012-09-28 attached to this Subcontract as Appendix I;

(b) Subcontractor Technical and Program Conditions attached to this Subcontract as Attachment B;

(c) CBTC System Specification attached to this Subcontract as Schedule M;

(d) Thales-Alstom Scope Split attached to this Subcontract as Schedule N;

(e) Output Specifications but only to the extent of the portions of Output Specifications that are applicable to the Subcontracted Work, and of the type specified in the Output Specifications, if applicable to the Subcontracted Work;

(f) Good Industry Practice (Works); and

(g) in compliance with all Applicable Law,

and shall, as soon as practicable after receiving a request from the Construction Contractor's Representative, supply to the Construction Contractor's Representative evidence to demonstrate its compliance with this Clause.

The Subcontractor shall provide the equipment and materials, including those required in connection with the testing and commissioning of the Subcontracted Work, required to comply with its obligations under this Subcontract.

7.2 Samples

The Subcontractor shall submit samples of Subcontractor's Documents to the Construction Contractor, for review in accordance with the procedures for Subcontractor's Documents described in Sub-Clause 5.2 of this Subcontract, as specified in the Subcontract and at the Subcontractor's cost. Each sample shall be labelled as to origin and intended use in the Subcontracted Works.

7.3 Inspection

Without limiting the access rights prescribed in Clause 2.1 of this Subcontract, the Construction Contractor's Personnel shall at all reasonable times:

(a) have full access to all parts of the Site and to all places from which natural Materials are being obtained; and

(b) during production, manufacture and Construction (at the Site and elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship (in accordance with the Inspection and Test Plan ("**ITP**") to be developed by the Subcontractor and approved by the Construction Contractor in accordance with the provisions of the Subcontract), and upon reasonable notice provided by the Construction Contractor to the Subcontractor to check the progress of manufacture of Equipment.

The Inspection and Test Plan ("**ITP**") shall, at a minimum, include:
(i) a description of the inspection, testing and monitoring activity;
(ii) frequency of inspections, tests and monitoring;
(iii) reference to standards, codes, specifications, and acceptance criteria;
(iv) reports and checklists required;
(v) personnel responsible for inspection, testing and monitoring activity;
(vi) quality assurance review, witness and hold points; and
(vii) description and frequency of geotechnical instrumentation monitoring and adherence to acceptance criteria.

The Subcontractor shall give the Construction Contractor's Personnel full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Subcontractor from any obligation or responsibility.

If the Construction Contractor, Project Co or the City increases its level of monitoring of the Subcontracted Works over what is specified in this Subcontract, the Prime Contract or the Project Agreement, as applicable, or over what it would be typically because the Subcontracted Works has been demonstrated to contain defects or fails to comply in a material respect with the requirements of this Subcontract, the Subcontractor shall pay the Construction Contractor the reasonable costs of such increased monitoring.

7.4 Testing

This Sub-Clause shall apply to all tests requirements under this Subcontract including those specified in the ITP developed by the Subcontractor and approved by the Construction Contractor.

The Subcontractor shall provide all apparatus, assistance, documents and other information, equipment, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Subcontractor and Construction Contractor shall mutually agree upon the time and place for the specified testing of any Equipment, materials and other parts of the Subcontracted Works.

The Construction Contractor may, under Clause 14 of this Subcontract, vary the location or details of specific tests, or instruct the Subcontractor to carry out additional tests. If these additional tests show that the tested Equipment, Materials or workmanship is not in compliance with the Subcontract, the cost of carrying out this Construction Contractor Variation shall be borne by the Subcontractor, notwithstanding other provisions of the Subcontract.

If these varied or additional tests show that the tested Equipment, Materials or workmanship was in compliance with the Subcontract, the cost of carrying out this Construction Contractor Variation shall be borne by the Construction Contractor.

The Construction Contractor shall give the Subcontractor not less than 48 hours' notice of the Construction Contractor's intention to attend the tests.

The Subcontractor shall promptly forward to the Construction Contractor duly certified reports of the tests. When the specified tests have been passed, the Construction Contractor shall endorse the Subcontractor's test certificate, or issue a certificate to that effect. If without cause or notice the Construction Contractor has not attended the tests, it shall be deemed to have accepted the readings as accurate and the Subcontractor's test certificate shall be deemed to have be endorsed and issued by the Construction Contractor. The Construction Contractor may require the Subcontractor to postpone or delay one or more tests, subject to an equitable extension of the Time for Completion, if any, and to reimbursement of Direct Costs actually incurred by the Subcontractor as a result of such postponement or delay.

7.5 Independent Certifier's and Others' Attendance

The Construction Contractor may invite the Independent Certifier, as well as representatives of Project Co, and/or the Lenders and/or of City, to attend, witness and participate in inspections and testing under Sub-Clauses 7.3 and 7.4 of this Subcontract.

7.6 Rejection

If, as a result of an examination, inspection, measurement or testing, any Equipment, Materials, design or workmanship is found to be defective or otherwise not in accordance with the Subcontract, the Construction Contractor may reject the Equipment, Materials, design or workmanship by giving written notice to the Subcontractor, with reasons as to how the Equipment, Materials, design or workmanship was non-compliant with the Subcontract. The Subcontractor shall then promptly make good the defect and ensure that the rejected item complies with the Subcontract.

If the Construction Contractor requires the rejected Equipment, Materials, design or workmanship to be retested, because of the Subcontractor's non-compliance to the Subcontract, then the tests shall be repeated under the same terms and conditions. If the rejection and retesting cause the Construction Contractor to incur Direct Losses or entitle

the Construction Contractor to claim Liquidated Damages, the Subcontractor shall, subject to Sub-Clause 2.5 of this Subcontract, pay such Direct Losses or Liquidated Damages to the Construction Contractor.

7.7 Remedial Work

Notwithstanding any previous test or certification, the Construction Contractor may instruct the Subcontractor to:

(a) remove from the Site and replace any Equipment or Materials which is not in compliance with the Subcontract;

(b) remove and re-execute any other work which is not in compliance with the Subcontract; and

(c) execute any work which is urgently required for the safety of the Subcontracted Works, whether because of an accident, unforeseeable event or otherwise. If the safety issue did not arise due to a breach by the Subcontractor of this Subcontract or any act or omission of the Subcontractor or the Subcontractor's Personnel, the Subcontractor shall be entitled to an equitable, make claims for Direct Damages, pursuant to the provisions of Clause 9, and other relief as available under this Agreement.

If the Subcontractor fails to comply with any such instruction, which complies with Sub-Clause 3.4 of the Subcontract, the Construction Contractor shall be entitled to employ and pay other Persons to carry out the work and to obtain reimbursement of Direct Loss and/or Liquidated Damages arising therefore from the Subcontractor.

7.8 Ownership of Equipment and Materials

Title to each item and part of the Subcontractor's Work, including any materials, supplies, equipment, facilities, parts and any other deliverable or component items shall pass to the Construction Contractor (or as the Construction Contractor may direct pursuant to the Project Agreement) upon the receipt of such item on the site, provided however that title to items of tangible personal property (personal property that can be seen, weighed, measured, felt or touched or that is in any way perceptible to the senses and includes computer programs, natural gas and manufactured gas) that comprise the System or are to be affixed or attached to either Component of the System prior to Revenue Service Availability shall pass to the City (or as the City may direct) at the time that such items are included in the System or affixed or attached to the System.

The Subcontractor agrees that title to each item and part of the Subcontracted Works, including Equipment and Materials, will pass to the Construction Contract so as to enable it to comply with Section 55.1 of the Prime Contract.

Without limiting the generality of the foregoing, each item of Equipment and Materials shall become the property of the Construction Contractor free from liens and other encumbrances when the Subcontractor has received payment of the value of any Equipment and Materials or Sections thereof under Clause 15 of this Subcontract and Schedule B.

7.9 Installation

Installation Supervision shall mean the supervision by the Subcontractor of the installation work and testing of the Equipment to be performed by the Construction Contractor.

The Construction Contractor shall perform installation of the Equipment in accordance with Annex N – Thales-Alstom Scope Split and Ottawa Light Rail Transit Project Communications Based Train Control System Specification Document No. 507528-0000-48EG-0001, Rev. 02 (hereinafter, "**Installation**").

The Construction Contractor shall delegate to the Site in order to perform Installation, a sufficient number of employees who are of the requisite technical level and duly qualified. For the first three months of Installation, the Subcontractor shall appoint one (1) of its employees as its representative on Site to act on its behalf for the purpose of this Subcontract and to handle all communications with the Construction Contractor and with third parties. The Construction Contractor shall appoint one (1) of its employees as its representative on Site to act on its behalf for the purpose of this Subcontract and to handle all communications with the Subcontractor and with third parties.

The Construction Contractor shall perform Installation of the Equipment in accordance with the Subcontractor's Installation and test procedures and with the Approved Subcontract Schedule.

During the course of Installation, the Construction Contractor shall:

i. notify the Subcontractor of any circumstance likely to affect the performance of Installation or Installation Supervision;

ii. maintain with the Subcontractor a log book to be signed by both Parties; and

iii. provide the supervisors with suitable access to the Site.

For the first three months of Installation, the Subcontractor shall assign to the Site a sufficient number of qualified and experienced supervisors to give written instructions and verbal advice to the Construction Contractor's employees in charge of Installation.

The Subcontractor's supervisors may be replaced:

i. upon the Construction Contractor's request, in case of obvious unfitness for duty, misconduct or gross negligence or disrespect of local regulations; or

ii. at the Subcontractor's discretion, particularly in case of expiry of the contractual term, change in the internal organization of the Subcontractor's company or in its program of assignment.

In both cases the Subcontractor shall replace the supervisor as quickly as possible by another supervisor of the same level of qualification, no further cost or liability being thus incurred by either Party to the other.

The Subcontractor shall replace or repair any Equipment damaged in the course of Installation. However, the Construction Contractor shall bear the cost of such repair or replacement including, inter alia, freight and insurance when caused by the Construction Contractor.

Should the Approved Subcontract Schedule have to be extended in respect of Installation for any reason beyond the Subcontractor's control, the Subcontractor's supervisors may remain on the Site at the Construction Contractor's sole expense and subject to terms and conditions to be mutually agreed.

Application of the Subcontractor's instructions and advice and Installation of the Equipment shall be the entire responsibility of the Construction Contractor.

The correct positioning of Equipment to the designed location (as defined by the Subcontractor) is the responsibility of the Construction Contractor installers. The Construction Contractor shall rectify any error in the positioning or alignment of Equipment that is not in accordance with the design of locations. Should Equipment be required to be moved from the original design position due to new information made available to the Subcontractor, or changes to the approved design of locations then the moving of the Equipment shall be the responsibility of the Construction Contractor.

Changes to Approved Design of Locations

Any additional information received after the approved design of locations, or any changes to the approved design of locations, shall be considered a Variation which shall be processed in accordance with Clause 14 of this Subcontract.

8.0 COMMENCEMENT, DELAYS AND SUSPENSION

8.1 Commencement of Subcontracted Works

Subject to Clauses 8.1.1 and 8.1.2 of this Subcontract, the Subcontractor shall commence the design and execution of the Subcontracted Works immediately upon the

Commencement Date as defined at Article III – Coming into Force, and shall then proceed with the Subcontracted Works with due expedition and without delay.

8.2 Time for Completion

The Subcontractor shall complete the whole of the Subcontracted Works within the Time for Completion as stated within Schedule H for the Subcontracted Works, including:

(a) achieving the passing of the Tests on Completion;
(b) achieving acceptance of the Subcontracted Works by the City as part of achievement of Revenue Service Availability;
(c) completing all Subcontractor Works which is stated in the Subcontract as being required for Completion; and
(d) delivering all documentation as required by the Subcontract.

8.3 Schedule and Scheduling

8.3.1 The Subcontractor's preliminary schedule for the performance of the Subcontracted Works is appended to Schedule H. Within thirty (30) days after the date of this Subcontract the Subcontractor shall deliver to the Construction Contractor's Representative, in both paper copy and in computer readable form in a format compatible with the Primavera Project Planner software, a proposed detailed Project schedule for review and approval by the Construction Contractor that conforms to the initial schedule appended to Schedule H attached to this Subcontract, and that shows at a minimum the following additional information:

(a) a detailed breakdown of the Subcontracted Works into details of Design and Construction activities, for each Section and for the Subcontracted Works as a whole, indicating:

i. the sequence of activities, including the schedule for public consultation where required by this Subcontract or any Relevant Authority;

ii. a breakdown of the Design schedule into the main components of the Subcontracted Works including those identified as such in Schedule H attached to this Subcontract;

iii. a breakdown of the construction schedule into the main components of the Subcontracted Works including those identified as such in Schedule H attached to this Subcontract;

iv. the early and late start and completion date for each activity;

v. the proposed durations in working days for each activity; and

vi. such additional information as is specified in Schedule H attached to this Subcontract to be included in the Approved Subcontract Schedule.

8.3.2 Within fifteen (15) Business Days of the Construction Contractor's receipt of the Subcontractor's proposed detailed schedule pursuant to Sub-Clause 8.3.1 of this Subcontract, the Construction Contractor's Representative will review the schedule and as reasonably necessary, (having regard for the requirements of this Subcontract) return it to the Subcontractor requesting in writing if applicable that the Subcontractor make adjustments to the schedule or provide further detail based on the criteria in Sub-Clause 8.3.2 of this Subcontract . If the Construction Contractor's Representative responds and requests adjustments or further details, the Subcontractor will, within five (5) Business Days of receipt of the request from the Construction Contractor's Representative, incorporate all adjustments acceptable to the Subcontractor, acting reasonably, and provide the additional details requested by the Construction Contractor's Representative and re-submit the proposed detailed schedule to the Construction Contractor's Representative. The process referred to above in this Sub-Clause 8.3.2 will be repeated until the Construction Contractor's Representative notifies the Subcontractor that no further changes to the Schedule are required. At that time, the schedule will become the approved schedule (the "**Approved Subcontract Schedule**") for performance of the Subcontracted Works.

The Parties agree to establish procedures which will enable that the necessary inputs, information, responses and documents to be provided by one Party are effectively provided by the date it is reasonably necessary by the other Party to the extent that the same is relevant to the discharge of its obligations under this Subcontract, the Prime Contract and the Project Agreement. The Parties agree to identify and document each Party's responsibility in ensuring the necessary inputs, responses, documents and other such dependencies (such responsibilities referred to as "**Additional Obligations**"), and such Additional Obligations, when agreed and documented, will constitute a covenant of the relevant Party to perform or cause such Additional Obligations to be performed under this Agreement.

8.3.3 Delivery to the Construction Contractor's Representative of a schedule pursuant to Sub-Clause 8.3.1 of this Subcontract, or updates as required under the Sub-Clause 8.3.8 of this Subcontract, will be for purposes of establishing the Approved Subcontract Schedule only and will not constitute compliance with any notice requirements under this Subcontract, including any notice of Claim or notice of circumstances giving rise to an event of Force Majeure, Variation or any other Claim under this Subcontract, nor will delivery of a schedule be construed as an agreement by the Construction Contractor to any extension of any Milestone Date.

The Parties agree that the Approved Subcontract Schedule will be the basis for and constitute so as to achieve Completion and the other Milestone Dates by the dates indicated on the Approved Subcontract Schedule. Compliance with any notice requirements under this Subcontract, including any notice of Claim or notice of circumstances giving rise to an event of Force Majeure, Variation or any other Claim

under this Subcontract. Accordingly the Approved Subcontract Schedule shall apply and the Parties acknowledge that time is of the essence in performing their obligations under this Agreement.

8.3.4 The Subcontractor will undertake the Design and Construction of the Subcontracted Works in compliance with the Approved Subcontract Schedule, as may be amended by the Subcontractor in accordance with Sub-Clause 8.3.8 of this Subcontract, so as to achieve Completion and the other Milestone Dates by the dates indicated on the Approved Subcontract Schedule. The Subcontractor will monitor the progress of the Subcontracted Works relative to the Approved Subcontract Schedule and will promptly advise the Construction Contractor's Representative upon becoming aware of any material delays to the progress of the Subcontracted Works, howsoever caused, as well as the remedial steps the Subcontractor is taking to ensure that the Subcontracted Works progress according to the Approved Subcontract Schedule. The Subcontractor shall also notify the Construction Contractor Representative if, at any time, the actual progress of the Design and Construction of the Subcontracted Works is significantly ahead of the Approved Subcontract Schedule.

8.3.5 If the Construction Contractor reasonably determines, based on a critical path analysis, that the progress of any relevant aspect of the Subcontracted Works is not sufficient to meet the corresponding Milestone Date and that missing such Milestone Date would likely result in failure to meet Revenue Service, then at the direction of the Construction Contractor's Representative:

(a) the Subcontractor will within five (5) Business Days of such direction prepare and submit to the Construction Contractor's Representative for review and approval a recovery plan, for such aspect of the Subcontracted Works. The recovery plan may include working overtime or extra shifts or providing additional labour, equipment, materials or other items; and

(b) within five (5) Business Days of such submittal the Subcontractor and the Construction Contractor's Representative will meet to review and, as necessary modify, the recovery plan.

Upon approval of the recovery plan by the Construction Contractor's Representative and the Subcontractor, the Subcontractor will immediately implement the recovery plan. If elements of the recovery plan as submitted by the Subcontractor are not approved by the Construction Contractor's Representative, acting reasonably, then:

(c) the Subcontractor will immediately implement those elements with which the Construction Contractor's Representative and the Subcontractor agree; and

(d) the Construction Contractor's Representative may give the Subcontractor written direction to implement other acceleration measures as specified by the Construction Contractor's Representative, without prejudice to the

Subcontractor's rights to submit the reasonableness of such directions to the Dispute Resolution Procedure.

Any measures taken by the Subcontractor under this Sub-Clause 8.3.5 of this Subcontract where the Subcontracted Works is deemed not sufficient to meet the corresponding Milestone Date due to the Subcontractor's responsibility it will be at the Subcontractor's expense unless the direction given under Sub-Clause 8.3.5(d) of this Subcontract is determined to have been unreasonable by the Subcontractor, in which case the measures taken in accordance with such direction will be at the Construction Contractor's expense.

8.3.6 Furthermore, the Subcontractor acknowledges that under Sections 22.3 of the Project Agreement and Part 2 Articles 22.3 of the Construction Contract, the City and Project Co have the right to require the delivery of a report identifying the reasons for delay and a recovery plan identifying steps to eliminate or reduce delay and to require the Design and Construction Works to be brought back on schedule in accordance with the approved recovery plan. To the extent that the Subcontracted Works are implicated, the Subcontractor will cooperate with and provide all necessary assistance to the Construction Contractor in fulfilling its obligations under the Construction Contract, including the delivery of a report, a recovery plan or other information requested by the Construction Contractor no later than two (2) Business Days prior to the Construction Contractor being required to deliver the same under the Construction Contract, and will conduct the Subcontracted Works in accordance with the approved recovery plan.

Any measures taken by the Subcontractor under this Sub-Clause 8.3.5 of this Subcontract will be at the Subcontractor's sole expense. unless the direction given under Sub-Clause 8.3.5(d) of this Subcontract is determined to have been unreasonable, in which case then the measures taken in accordance with such direction will be at the Construction Contractor's expense.

The Subcontractor agrees that it shall comply, and shall cause all relevant Subcontractor Personnel to comply with all directions issued by the City from time to time in respect of the 2017 Readiness Work, to the extent the Subcontracted Works are implicated, requiring acceleration and/or execution of a mitigation strategy approved by the City at the Subcontractor's expense.

8.3.7 In accordance with Clause 14 of this Subcontract, but without limiting Sub-Clauses 8.3.5 and 8.3.6 of this Subcontract, if at any time the Construction Contractor determines that it requires the Subcontracted Works to proceed in advance of the Approved Subcontract Schedule then the Construction Contractor may give written notice to the Sub-Contractor to provide the Construction Contractor with a written proposal to accelerate the Subcontracted Works, including cost estimates and an estimate of the time saved. If the Construction Contractor's Representative accepts said proposal, then the Subcontractor will on written direction from the Construction Contractor's Representative implement the directed acceleration at the Construction Contractor's cost pursuant to the provisions of Clause 14 of this Agreement.

8.3.8 The Subcontractor will, as required from time to time until Completion, but no less than once per calendar month or more frequently if required under the Prime Contract, update and deliver to the Construction Contractor's Representative an updated Approved Subcontract Schedule which complies with the requirements of this Subcontract, and which includes the following:

(a) progress of the Subcontracted Works;

(b) excusable delays, if any, as permitted by this Subcontract;

(c) as the Design progresses, best estimates of the start date for Construction; and

(d) the planned start and completion dates of the major activities of Construction, the scheduled date for Completion and for total performance of the entire Subcontracted Works.

If the updates to the schedule include changes to any Milestone Date, Payment Milestone Date or critical path item then the approval procedure in Sub-Clause 8.3.2 of this Subcontract will apply to updates to the Approved Subcontract Schedule. The updated schedule will then be the Approved Subcontract Schedule under this Subcontract:

(a) if the updates do not include changes to any Milestone Date, Payment Milestone Date or critical path item then upon submission to the Construction Contractor's Representative; or

(b) if the updates do include changes to any Milestone Date, Payment Milestone Date or critical path item, then upon approval by the Construction Contractor's Representative, acting reasonably.

The Approved Subcontract Schedule will at all times be an accurate, reasonable and realistic representation of the Subcontractor's plans for the completion of the Design and Construction of the Subcontracted Works in accordance with the requirements of this Subcontract. Any permitted or agreed to adjustment to the Milestone Dates or Payment Milestone Dates will be included in the updated Approved Subcontract Schedule.

8.3.9 If the Subcontractor fails or refuses to provide the schedule as required under Sub-Clause 8.3.1 of this Subcontract, or to update the Approved Subcontract Schedule as required under Sub-Clause 8.3.8 or the Prime Contract of this Subcontract, and if the Subcontractor fails or refuses to provide such schedule or update within five (5) days of a written notice from the Construction Contractor, then the failure or refusal to provide the schedule or update within the five (5) day period will be deemed to be a material breach of the Subcontractor's obligations to which the termination provisions of Sub-Clause 16.1 of this Subcontract will apply.

8.3.10 **Not Used**

8.3.11 The Progress Report submitted under Sub-Clause 4.22 of this Subcontract will identify any known deviation from the Approved Subcontract Schedule and outline the justification for such deviation and the remedial measures that the Subcontractor is taking to ensure that the Subcontracted Works progress according to the Approved Subcontract Schedule.

8.4 **Extension of Time for Completion**

The Subcontractor shall be entitled, subject to the applicable provisions of the Subcontract and subject to Clause 20 of this Subcontract, to an extension of the Time for Completion if and to the extent that completion for the purposes of Sub-Clause 11.1 of this Subcontract is or will be delayed by any of the following causes, provided always that the Subcontractor shall use all reasonable efforts to mitigate the effect of such causes:

(a) a Variation;

(b) a cause of delay giving an entitlement to extension of time under a Sub-Clause of this Subcontract;

(c) a Construction Contractor Event;

(d) a Project Co Event; or

(e) a City Event.

If the Subcontractor considers itself to be entitled to an extension of the Time for Completion, the Subcontractor shall give notice to the Construction Contractor in accordance with Clause 21 of this Subcontract. When determining each extension of time under Sub-Clause 3.5 of this Subcontract, the Construction Contractor shall review previous determinations and may increase, but shall not decrease, the total extension of time. If the Subcontractor's claim for an extension of time is due to one of the causes mentioned in subparagraph (a) or (b) as applicable), the provisions of Clause 14 will apply. If the Subcontractor's claim for an extension of time is due to one of the causes mentioned in subparagraphs (b as applicable), or (c) or (d) or (e), the provisions of Clause 9 will apply.

8.5 **Not used**

8.6 **Delay Liquidated Damages**

Subject to the provisions of sub-clause 8.4 and any other remedies available to the Subcontractor under this Subcontract, if the Subcontractor fails to comply with Sub-Clause 8.2, the Subcontractor shall pay delay Liquidated Damages to the Construction

Contractor for this default. These delay Liquidated Damages shall be paid for every day which shall elapse between the relevant Time for Completion and the date stated in the Taking-Over Certificate and shall be in the sum stated below:

(a) In respect of the milestone Delivery of 20th VOBC on December 7th, 2016 at a rate of $[redacted] per day of delay.

(b) In respect of the milestone Revenue Service (handover of CBTC safety certificate) on May 24th, 2018 at a rate of $[redacted] per day of delay. Liquidated Damages under sub-clause 8.6(b) shall only become payable by the Subcontractor to the Construction Contractor, if and when, the Construction Contractor demonstrates that it has been assessed and paid liquidated damages to Project Co.

However, the total aggregate amount due under this Sub-Clause shall not exceed the maximum amount of [redacted]% of the base Subcontract Price.

Payments of such Liquidated Damages are genuine pre-estimates of the Direct Losses which would be incurred by the Construction Contractor for any period of delay for the period of such delay and shall be deemed liquidated damages and shall be paid in lieu of any other indemnity, liability or damages, consequential or otherwise, and shall be the Construction Contractor's sole remedy and in final satisfaction for such delay provided.

Payment of Liquidated Damages pursuant to this Sub-clause 8.6 shall form part of the total liability of the Subcontractor.

8.7 Suspension of Subcontracted Works

The Construction Contractor may at any time instruct the Subcontractor to suspend progress of part or all of the Subcontracted Works. During such suspension, the Subcontractor shall protect, store and secure such part or the Subcontracted Works against any deterioration, loss or damage.

The Construction Contractor may also notify the cause for the suspension, if and to the extent that the cause is notified and the cause for suspension is responsibility of the Subcontractor, the following Sub-Clauses 8.8, 8.9 and 8.10 of this Subcontract shall not apply.

8.8 Consequences of Suspension

If the Subcontractor suffers delay and/or incurs Direct Losses from complying with the Construction Contractor's instructions under Sub-Clause 8.7 and/or from resuming the work, the Subcontractor shall give notice to the Construction Contractor and shall be entitled, subject to Sub-Clauses 9.3 and 9.5 of this Subcontract, to:

(a) an extension of time for such delay, if Completion is or will be delayed, under Sub-Clause 8.4 of this Subcontract; and

(b) payment of any such Direct Losses, which shall be added to the Subcontract Price.

After receiving this notice, the Construction Contractor shall proceed in accordance with Sub-Clause 3.5 of this Subcontract to agree or determine these matters.

The Subcontractor shall not be entitled to an extension of time for, or to payment of Direct Losses incurred in making good the consequences of the Subcontractor's faulty Design, workmanship or Materials, or incurred because of the Subcontractor's failure to protect, store or secure in accordance with Sub-Clause 8.7 of this Subcontract.

8.9 **Not used**

8.10 **Resumption of Subcontracted Works**

After the permission or instruction to proceed is given, the Parties shall jointly examine the Subcontracted Works and the Equipment and Materials affected by the suspension. The Subcontractor shall make good any deterioration or defect in or loss of the Subcontracted Works or Equipment or Materials, which has occurred during the suspension. For clarity, the Subcontractor's right to receive compensation for suspension of such work is dealt with under Sub-Clause 8.8.

9.0 SUBCONTRACTOR'S COMPENSATION AND RELIEF CLAIMS

9.1 **Basis of Claim**

Where the Subcontractor intends to claim any payment in addition to the Subcontract Price or other amounts payable, any reduction in any financial or other obligation hereunder or any extension of time (whether, in each case, pursuant to any term of this Subcontract (and in particular as a result of any of the events referred to in Clause 9.2), on the basis of breach of contract, or any other ground related in any way to the Subcontracted Works) then this Clause 9 shall apply.

9.2 **Scope of Claim**

The Subcontractor shall not have, and hereby waives, any right to seek, an increase in, or any payment in addition to, the Subcontract Price, any reduction in or relief from any financial or other obligation or any extension of time in connection with the Subcontracted Works, unless the Subcontractor has suffered a delay or an increase in the cost of performing the Subcontracted Works or Direct Losses or is prevented from performing any of its obligations, as a result of:

(a) a City Event;

(b) Maintenance Contractor;

(c) a Project Co Event;

(d) a Construction Contractor Event;

(e) any circumstance giving rise to an indemnity in favour of the Subcontractor under Clause 17.2 of this Subcontract;

(f) a Construction Contractor Variation or a Subcontractor's Variation (as set forth in a Variation Certificate); or

(g) any other remedy expressly available to the Subcontractor under this Subcontract.

Furthermore, in respect of any City Event or Project Co Event, the Subcontractor's rights against the Construction Contractor will be limited to the Subcontractor's rights under Sub-Clause 9.3 or 9.5, of this Subcontract as applicable, or Sub-Clause 14.1 of this Subcontract, in the case of a City Variation or a Project Co Variation. The Subcontractor shall have no right to make any claim against the Construction Contractor, whether under this Subcontractor, in tort or under any theory of liability, for any breach of contract, act or omission of the Maintenance Contractor or an MC Party.

9.3 **Claims Pursuant to a City Event**

Where the Subcontractor seeks an increase in, or any payment in addition to, the Subcontract Price, a reduction in or relief from any financial or other obligation hereunder or an extension of time as a result of a City Event (other than a City Variation), the following shall apply.

(a) After the occurrence of a City Event, the Subcontractor shall:

i. as soon as practicable, and in any event within five (5) days after the Subcontractor Has Knowledge that a City Event has occurred, give to the Construction Contractor a notice summarizing, to the extent the Subcontractor Has Knowledge, the City Event and consequences, and the nature and amount of relief or claim requested;

ii. within ten (10) Days of receipt by the Construction Contractor of a notice pursuant to Sub-Clause 9.3(a)(i), to the Extent the Subcontractor Has Knowledge, give to Project Co:

A additional details, including available supporting documentation, in support of the requested amount or period; and

B a detailed breakdown of all Direct Losses or delay incurred, or relief claimed, by the Subcontractor as a result of the City Event;

iii. notify the Construction Contractor if at any time it Has Knowledge of any further information relating to the City Event, giving details of that information to the extent that such information is new or renders information previously submitted materially inaccurate or misleading;

iv. demonstrate to the reasonable satisfaction of the Construction Contractor that:

A the Subcontractor could not have avoided such occurrence or consequences by steps which it might reasonably be expected to have taken;

B the City Event caused the Subcontractor to incur a Direct Loss or a delay or entitles the Subcontractor to relief from its obligations (financial or otherwise) under the Subcontract;

C the claimed Direct Losses, delay or relief from obligations (financial or otherwise) under this Subcontract could not reasonably be expected to be mitigated or recovered by the Subcontractor without incurring material expenditure which the Construction Contractor had not agreed to pay; and

D the Subcontractor is using commercially reasonable efforts to perform its obligations under this Subcontract without incurring any material expenditure which the Construction Contractor had not agreed to pay;

(b) If the Subcontractor has complied with Sub-Clause 9.3(a) of this Subcontract, the Construction Contractor will in a diligent and timely manner, seek such remedies on behalf of the Subcontractor pursuant to the provisions of the Prime Agreement. The Construction Contractor shall pursue any recovery and advance any defence of which the Subcontractor provides it Notice within a reasonable period of time and shall not compromise any claim or defence for which the Subcontractor shall ultimately be liable, in whole or in part, without the prior written consent of Subcontract. The Construction Contractor may at any time elect not to pursue any remedy on behalf of the Subcontractor, in which case the Construction Contractor will compensate the Subcontractor for any Direct Losses, grant an extension of time, make an additional payment or grant relief from any obligations (financial or otherwise) as to the extent it would have been liable to do if it had pursued such remedy; and

(c) The Construction Contractor shall not be liable to compensate the Subcontractor for any Direct Losses, grant an extension of time, make an additional payment or grant relief from any obligations (financial or otherwise) under this Sub-Clause 9.3 to any greater extent than the Construction Contractor actually receives under

the provisions of the Prime Contract and then only in such proportion as is equitable in the circumstances.

9.4 Claims related to the Maintenance Contractor

The Parties acknowledge that the Maintenance Contractor has agreed not to interfere with, obstruct, impede or delay Construction Contractor in the performance of its obligations under the Construction Contract, provided that the Maintenance Contractor shall not be required to act in breach of the Maintenance Contract.

Where the Subcontractor has been interfered with, obstructed, impeded or delayed by the Maintenance Contractor, it may seek compensation for its Direct Losses and provision of Sub-Clause 9.5 of this Subcontract shall apply *mutatis mutandis* to any such claim.

The Construction Contractor shall not be liable to compensate the Subcontractor for any Direct Losses under this Sub-Clause 9.4 to any greater extent than the Construction Contractor actually receives from the Maintenance Contractor, and then only in such proportion as is equitable in the circumstances.

9.5 Claims Pursuant to a Project Co Event

Where the Subcontractor seeks an increase in, or any payment in addition to, the Subcontract Price, a reduction in or relief from any financial or other obligation hereunder or an extension of time as a result of a Project Co Event (other than a Project Co Variation), the following shall apply.

(a) After the occurrence of a Project Co Event, the Subcontractor shall:

i. as soon as practicable, and in any event within five (5) days after it Has Knowledge that a Project Co Event has caused or is likely to cause any delay or any increase in the cost of performing the Subcontracted Works, give to the Construction Contractor a notice summarizing, to the extent the Subcontractor Has Knowledge, Project Co Event and consequences, and the amount or period requested;

ii. within ten (10) days of receipt by the Construction Contractor of a notice pursuant to Sub-Clause 9.5(a)(i), to the Extent the Subcontractor Has Knowledge, give to the Construction Contractor:

A additional details, including available supporting documentation, in support of the requested amount or period; and

B a detailed breakdown of all Direct Losses or delay incurred, or relief claimed, by the Subcontractor as a result of Project Co Event;

iii. notify the Construction Contractor if at any time it Has Knowledge of any further information relating to Project Co Event, giving details of that information to the extent that such information is new or renders information previously submitted materially inaccurate or misleading;

iv. demonstrate that:

A the Subcontractor could not have avoided such occurrence or consequences by steps which it might reasonably be expected to have taken;

B Project Co Event caused the Subcontractor to incur a Direct Loss or a delay in Completion or entitles the Subcontractor to relief from its obligations under this Subcontract;

C the claimed Direct Losses, reduction in any financial or other obligation or delay under this Subcontract could not reasonably be expected to be mitigated or recovered by the Subcontractor without incurring material expenditure which the Construction Contractor had not agreed to pay; and

D the Subcontractor is using commercially reasonable efforts to perform its obligations under this Subcontract without incurring any material expenditure which the Construction Contractor had not agreed to pay;

(b) If the Subcontractor has complied with Sub-Clause 9.5(a), the Construction Contractor will, in a diligent and timely manner, seek such remedies on behalf of the Subcontractor;

(c) provided however that the Construction Contractor may at any time elect not to pursue any remedy on behalf of the Subcontractor, in which case the Construction Contractor will compensate the Subcontractor for any Direct Losses, grant an extension of time, make an additional payment or grant relief from any obligations (financial or otherwise) as to the extent it would have been liable to do if it had pursued such remedy; and

(d) The Construction Contractor shall not be liable to compensate the Subcontractor for any Direct Loss, or to grant an extension of time, or to make additional payment or grant relief from any obligation (financial or otherwise) under this Sub-Clause 9.5 to any greater extent than the Construction Contractor actually receives under the provisions of the Prime Contract, and then only in such proportion as is equitable in the circumstances.

9.6 Claims Pursuant to a Construction Contractor Event

Where the Subcontractor seeks an increase in, or any payment in addition to, the Subcontract Price, a reduction in or relief from any financial or other obligation hereunder or an extension of time as a result of a Construction Contractor, the same procedure as set out above in Sub-Clause 9.5(a) of this Subcontract shall be followed,

except that each "Project Co Event" shall be read to mean "Construction Contractor Event".

(a) If the Subcontractor has complied with procedure in Sub-Clause 9.5(a) of this Subcontract:

i. the Construction Contractor will pay to the Subcontractor an amount equal to the amount of Direct Losses incurred by the Subcontractor as a direct result of, or reduce or relieve the Subcontractor from its financial or other obligations hereunder to the extent attributable to, the Construction Contractor Event;

ii. the Subcontractor shall be granted relief from its obligation to pay Delay Liquidated Damages, as the case may be, for such period as is reasonable in the circumstances to take account of the likely effect of the delay which will be caused by the Construction Contractor Event; and

iii. the Subcontractor shall not be considered to be in default of its obligations under this Subcontract to the extent such default is caused by a Construction Contractor Event.

9.7 Payment Dates

Any amounts payable to the Subcontractor:

(a) pursuant to Sub-Clause 9.3, 9.4 or 9.5 of this Subcontract, the Subcontractor shall be paid by the Construction Contractor within ten (10) Business Days of the receipt of payment by the Construction Contractor from Project Co; or of agreement or determination of such amount when the Construction Contractor elected not to pursue the claim and compensate; and

(b) pursuant to Sub-Clause 9.6 of this Subcontract shall be paid by the Construction Contractor to the Subcontractor within ten (10) Business Days of agreement or determination of such amount.

9.8 Delay in Notification or Failure to Mitigate

If any notice or any required information is provided by the Subcontractor to the Construction Contractor after the dates referred to in Sub-Clause 9.3, 9.4, 9.5 or 9.6 of this Subcontract, as the case may be, or if the Subcontractor failed or refused to use commercially reasonable efforts to mitigate the effects of the event as required under Sub-Clause 9.3, 9.4, 9.5 or 9.6 of this Subcontract, as the case may be, then the Subcontractor will not be entitled to any additional payment, reduction in financial obligation or extension of time to the extent that such additional payment, reduction in financial obligation or extension of time was increased as a result of such delay in providing such information, or the failure to mitigate, or to the extent the Construction

Contractor has lost the opportunity to make any claim under the Prime Contract or implement measures to reduce costs, provided that if mitigation measures require material expenditure, the Subcontractor will so advise the Construction Contractor and will not be obliged to carry out such measures unless the Construction Contractor confirms in writing that the Construction Contractor will pay such expenditures.

In a case where the Subcontractor is in disagreement with the Construction Contractor in that the Construction Contractor states that the Subcontractor failed to provide timely notice of an event/required information, and/or that the Subcontractor refused to use commercially reasonable efforts to mitigate the effects of the event, and if the matter is not settled to the satisfaction to the Subcontractor, then the Subcontractor may dispute the issue (s) in accordance with the Dispute Resolution Procedure of this Subcontract. If the dispute is then settled in favour of the Subcontractor then the Construction Contractor shall be liable for the Subcontractor's for any additional payment, any reduction in financial obligation or extension of time, and any Direct Losses.

9.9 Procedural Requirements

The Construction Contractor shall keep the Subcontractor informed at all times as to the Construction Contractor's efforts and actions and of any matter relevant to the pursuit of remedies or claims on behalf of the Subcontractor.

If the Subcontractor has complied with Sub-Clause 9.3(a) in respect of a City Event or Sub-Clause 9.5(a) of this Subcontract in respect of a Project Co Event, then, subject always to the provisions of Sub-Clause 9.10 of this Subcontract:

(a) unless the Construction Contractor elects to inform the Subcontractor under paragraph (c)1.1.1(iii) below, the Construction Contractor shall, promptly (having regard to the timeframe required for the determination under paragraph (c)1.1.1(iii) following receipt of such notice, submit to the Project Co a claim (an "**Equivalent Claim**") reflecting the Subcontractor's notice of claim;

(b) the Subcontractor shall provide such additional details and/or information as may be reasonably requested by the Construction Contractor or by the Project Co through the Construction Contractor in relation to the Equivalent Claim;

(c) the Construction Contractor shall, at its option, either:

(i) subject always to Sub-Clause 9.10.4 of this Subcontract, use its best efforts to pursue the Equivalent Claim with Project Co, provided that (i) the Subcontractor shall be obliged to provide all assistance which the Construction Contractor, acting reasonably, considers necessary to substantiate any Equivalent Claim, including the collection of information and details relating to the relevant Equivalent Claim and the making available of personnel to assist the Construction

Contractor in the pursuit of the Equivalent Claim and (ii) the Subcontractor shall keep the Construction Contractor informed at all times of any matter relevant to the pursuit of the Equivalent Claim of which the Subcontractor becomes aware; or

(ii) elect not to pursue the relevant Equivalent Claim with Project Co, in which case the Construction Contractor shall, within five (5) Business Days of receipt of the Subcontractor's claim notice (or such other reasonable period as mutually agreed to between the Subcontractor and Construction Contractor, notify the Subcontractor in writing that it has elected not to pursue such Equivalent Claim, and the Subcontractor shall be authorized to pursue the Equivalent Claim with Project Co in the name of the Construction Contractor, provided that the Subcontractor shall: (i) bear all costs and expenses relating to the pursuit of such Equivalent Claim; (ii) keep the Construction Contractor informed at all times (including providing copies of any relevant documentation) of the progress and outcome of such Equivalent Claim; and (iii) comply with all applicable provisions of the Prime Contract; or

(iii) within ten (10) Business Days of receipt of an Subcontractor's claim notice (or, if the Construction Contractor reasonably requests further information with respect to the Equivalent Claim, within ten (10) Business Days of receipt by the Construction Contractor of such further information) (or, in each case, such other reasonable period as mutually agreed to between the Subcontractor and Construction Contractor having regard to any time limit for submission of such Equivalent Claim by the Construction Contractor to Project Co under the Prime Contract) inform the Subcontractor that, in its view, acting reasonably, it does not consider that the event(s) or circumstance(s) referred to in the Subcontractor's claim notice gives or give rise to any entitlement on the part of the Subcontractor to claim in respect of a City Event, a Project Event or interference by the Maintenance Contractor (in accordance with Sub-Clause 9.4 of the Subcontract), provided that, if the Subcontractor does not agree with the Construction Contractor, such matter shall be referred to the Dispute Resolution Procedure and if it is determined pursuant to the Dispute Resolution Procedure that the event(s) or circumstance(s) give or gave rise to any such entitlement, then the Construction Contractor shall proceed with the Equivalent Claim failing which the provisions of Sub-Clause 9.9.10 of this Subcontract shall apply; and the Construction Contractor shall bear all of the subcontractor's Costs and expenses relating to the pursuit of such Equivalent Claim;

(iv) inform the Subcontractor that the Construction Contractor does not wish to pursue such Equivalent Claim, but that the Subcontractor shall

be entitled to recover from the Construction Contractor the full benefit of the relief to which the Subcontractor would otherwise have been entitled pursuant to the provisions of Sub-Clause 9.9.9 of this Subcontract.

(d) if the Construction Contractor elects to pursue the Equivalent Claim pursuant to Sub-Clause 9.9.1(c)(i):

(i) the Subcontractor and relevant CC Parties shall be entitled (if and to the extent permitted by Project Co, and may be required by the Construction Contractor, to attend any meetings between Project Co and the Construction Contractor at which the Equivalent Claim is to be discussed and the Subcontractor may, at its sole cost and expense, appoint counsel for the purpose;

(ii) the Construction Contractor shall consult with and use reasonable efforts to agree with the Subcontractor with respect to the appointment of counsel (other than counsel appointed by the Subcontractor pursuant to Sub-Clause (i)) and other third party advisors, provided that the Construction Contractor shall have sole discretion in such appointments after reasonable consultation and reasonable efforts to agree with the Subcontractor; and

(iii) the Construction Contractor shall not be entitled to settle any Equivalent Claim, or waive any contractual right to an Equivalent Claim if such settlement or waiver would adversely affect any right of the Subcontractor, without the prior written consent of the Subcontractor, such consent not to be unreasonably withheld or delayed by the Subcontractor; and if the Subcontractor withholds its consent to settlement of an Equivalent Claim or waiver of a contractual right to an Equivalent Claim, so that the Construction Contractor is required to continue to pursue such Equivalent Claim, then, in addition to the Subcontractor's obligations under Sub-Clause 9.10 of this Subcontract, the Subcontractor shall be liable for and shall indemnify and hold harmless the Construction Contractor from and against the value to the Construction Contractor of any lost settlement or agreement previously available to the Construction Contractor should the pursuit of such Equivalent Claim prove unsuccessful, provided always that the Construction Contractor shall not be entitled to double recovery;

(e) if the Construction Contractor authorizes the Subcontractor to pursue the Equivalent Claim pursuant to Sub-Clause 9.9.1(c)(ii) of this Subcontract:

(i) the Construction Contractor shall be entitled, to attend any meetings between the Project Co and the Subcontractor at which the Equivalent

Claim is to be discussed and the Construction Contractor may, at its sole cost and expense, appoint counsel for the purpose; and

(ii) the Subcontractor shall not be entitled to settle any Equivalent Claim, or waive any contractual right under the Project Agreement if such settlement or waiver would adversely affect any right of the Construction Contractor, without the prior written consent of the Construction Contractor such consent not to be unreasonably withheld or delayed; and if the Construction Contractor withholds its consent to settlement of an Equivalent Claim or waiver of a contractual right to an Equivalent Claim, so that the Subcontractor is required to continue to pursue such Equivalent Claim, the Construction Contractor shall be liable for and shall indemnify and hold harmless the Subcontractor from and against the value to the Subcontractor of any lost settlement or agreement previously available to the Subcontractor should the pursuit of such Equivalent Claim prove unsuccessful, provided always that the Subcontractor shall not be entitled to double recovery;

(f) the Construction Contractor shall, on receipt of any reasonable request to do so from the Subcontractor, invoke the CC Dispute Resolution Procedure under the Prime Contract in respect of matters relating to the Subcontracted Works which request shall be dealt with as an Equivalent Claim subject to and in accordance with this Sub-Clause 9.9.

9.9.2 The Subcontractor shall be entitled to the benefit of any relief in respect of a City Event, a Project Co Event to the extent that the Construction Contractor is or becomes entitled under the Prime Contract as provided in Sub-Clause 9.9.3 of this Subcontract, but in any event to no greater extent than the Construction Contractor's entitlement under the Prime Contract determined pursuant to either:

(a) an agreement between the Construction Contractor and Project Co effected in accordance with Sub-Clause 9.9.2(d)(iii) of this Subcontract and subject to the provisions of Sub-Clause 9.9.3 of this Subcontract; or

(b) a determination made pursuant to the Dispute Resolution Procedure under the Project Agreement or the CC Dispute Resolution Procedure under the Prime Contract which is binding upon the Construction Contractor and the Project Co.

9.9.3 Subject to Sub-Clause 9.10, the Subcontractor shall not be entitled to receive any entitlement or benefit in respect of a City Event or Project Co Event (including without limitation any payment or other compensation) until the Construction Contractor has received such entitlement or benefit from the Project Co. In addition, the Subcontractor's entitlement to the benefit of a City Event or Project Co Event shall:

(a) where the agreement or determination referred to in Sub-Clause 9.9.2 of this Subcontract expressly separately identifies the amount, nature or extent of the

Construction Contractor's entitlement attributable to the Subcontractor or the Subcontracted Works, be the amount, nature or extent so identified; or

(b) where the agreement or determination referred to in Sub-Clause 9.9.2 of this Subcontract does not separately identify the amount, nature or extent of the Construction Contractor's entitlement attributable to the Subcontractor or the Subcontracted Works, be a fair and reasonable proportion of the Construction Contractor's entitlement, it being acknowledged between the Construction Contractor and the Subcontractor that the party(ies) bearing the risks and costs associated with an entitlement shall be entitled to a proportionate amount of the benefit arising therefrom.

9.9.4 If the parties are unable to agree, pursuant to Sub-Clause 9.9.3(b) of this Subcontract on what is a fair and reasonable proportion of such entitlement within twenty-one (21) days of a written request by either party to agree on the same, either party may refer the matter to Dispute Resolution Procedure attached to this Subcontract as Schedule I.

9.9.5 Following agreement or determination of the entitlement of the Subcontractor under Sub-Clause 9.9.3 or 9.9.4 of this Subcontract, as the case may be:

(a) where such entitlement consists of relief from performance of obligations, the Subcontractor shall be relieved from the performance of its obligations under this Subcontract to the extent of such entitlement;

(b) where such entitlement consists of an extension of time, the Subcontractor shall be entitled to a corresponding extension of time under this Subcontract; and

(c) where such entitlement consists of a positive adjustment to payments due to the Construction Contractor under the Prime Contract or the payment of a lump sum by the Project Co to the Construction Contractor, as the case may be, the Construction Contractor shall pay to the Subcontractor the amount of such entitlement promptly, and in any event no later than five (5) Business Days, after receipt of the corresponding payment from the Project Co (and in accordance with the provisions of Sub-Clause 9.9.3 of this Subcontract). The Construction Contractor shall not be entitled to pay the Subcontractor for such entitlement other than on a lump sum or progress basis as the work is performed, without the prior consent of the Subcontractor, such consent not to be unreasonably withheld or delayed.

9.9.6 Pending the determination, agreement or resolution of the Subcontractor's entitlement to any benefit in respect of a City Event or Project Co Event, the Subcontractor shall continue to perform its obligations under this Subcontract and shall take no steps to enforce any right under this Subcontract whether by set-off against sums otherwise payable to the Construction Contractor, by commencing proceedings of any kind, by counterclaiming in any proceedings or otherwise howsoever, to the extent that, pursuant to the terms of this Subcontract, such right depends upon or is related to the

relevant agreement or determination of Equivalent Project Relief. Notwithstanding the foregoing, the parties agree that nothing contained in this Sub-Clause 9.9.6 of this Subcontract will preclude the Subcontractor from commencing legal proceedings in the Courts of Ontario if such proceedings are necessary to preserve any rights or applicable limitation period.

9.9.7 Following the determination, agreement or resolution of the Subcontractor's entitlement to the benefit in respect of a City Event or Project Co Event, the Subcontractor shall be conclusively deemed to have waived any rights under or in connection with this Subcontract in excess of those arising from such determination, agreement or resolution, except insofar as such rights arise from or as a result of any failure on the part of the Construction Contractor to comply with its obligations to the Subcontractor under this Subcontract. Accordingly, except as provided in the preceding sentence, the Subcontractor shall not take any steps, under the Dispute Resolution Procedure or otherwise, to argue that any entitlement of the Subcontractor in respect of a City Event or Project Co Event should be resolved other than by reference to the resolution of the Subcontractor's entitlement in accordance with this Sub-Clause 9.9 of this Subcontract and the Subcontractor hereby waives any right to do so.

9.9.8 If, in relation to any entitlement or benefit in respect of a City Event or Project Co Event, the Construction Contractor fails to comply with its obligations under this Subcontract, including, without limitation, failure to comply with this Sub-Clause 9.9.8, and as a consequence of such failure the entitlement of the Subcontractor is likely to be reduced or lost, then, unless such failure was caused by any act or omission by the Subcontractor or any Subcontractor Personnel, the Subcontractor may give notice to the Construction Contractor specifying the failure and the likely reduction in or loss of the entitlement of the Subcontractor and requiring the Construction Contractor to remedy the relevant failure.

9.9.9 If the Construction Contractor fails:

(a) to remedy such failure within fifteen (15) Business Days of the date of receipt of notice pursuant to Sub-Clause 9.9.8;

(b) to provide the Subcontractor with proposals for remedying such failure which are acceptable to the Subcontractor, acting reasonably, within five (5) Business Days of the date of receipt of notice pursuant to Sub-Clause 9.9.8; or

(c) to fulfil the terms of an acceptable proposal provided to the Subcontractor in accordance with Sub-Clause (b)

the Subcontractor may serve a further notice upon the Construction Contractor that the Subcontractor is no longer bound by the provisions of Sub-Clauses 9.9.1 to 9.9.7 in relation to the entitlement concerned.

If

(a) the provisions of Sub-Clauses 9.9.1 to 9.9.7 are disapplied in accordance with Sub-Clause 9.9.9;

(b) the Construction Contractor has elected not to proceed with an Equivalent Claim pursuant to Sub-Clause 9.9.1(c)(iii) and continues not to proceed with an Equivalent Claim despite a subsequent determination pursuant to the Dispute Resolution Procedure that the Construction Contractor should not have so elected; or

(c) the Construction Contractor has elected not to proceed with an Equivalent Claim pursuant to Sub-Clause 9.9.1(c)(iv),

then the Subcontractor shall be entitled to recover from the Construction Contractor the full benefit in respect of a City Event or Project Co Event it would have been entitled to claim as if the Construction Contractor had complied in full with its obligations under this Sub-Clause 9.9 of this Subcontract and as if the Construction Contractor had succeeded in obtaining the full entitlement from the Project Co under the Prime Contract. The Subcontractor shall, except where this Sub-Clause 9.9.10 of this Subcontract applies but the Subcontractor does not make full recovery of the amounts contemplated by this Sub-Clause 9.9.10, have no right or recourse whatsoever directly to the Project Co and shall bring no claim whatsoever against the Project Co in respect of the benefit of such entitlement and its rights and remedies in respect of such entitlement shall be limited to the right to recover from the Construction Contractor under this Sub-Clause 9.9.10. If the parties are unable to agree upon the nature or amount of such entitlement within five (5) Business Days of a written request by either party to agree on the same, either party may refer the matter to the Dispute Resolution Procedure.

9.9.11 Subject to Sub-Clause 9.9.12 the provisions of this Sub-Clause 9.9 set out the sole and exclusive rights and remedies of the Subcontractor in relation to City Events and Project Co Events and the Subcontractor shall not be entitled to any other right or remedy of any kind whatsoever (whether in contract, tort, breach of statutory duty or under any other theory of law or equity) in respect of the same.

9.9.12 The provisions of Sub-Clauses 9.9.1 to 9.9.11, inclusive, are without prejudice to any rights and remedies available to the Subcontractor in respect of this Subcontract, any Applicable Law, and any Construction Contractor Act.

9.10 Project Co-Related Proceedings

9.10.1 This Sub-Clause 9.10.1 applies where Project Co asserts or exercises any right against the Construction Contractor under or in connection with the Project Agreement, in regard to any matter in respect of which the Construction Contractor asserts or exercises a right against the Subcontractor under or in connection with this Subcontract, or to the extent that such right is related to the Subcontracted Works or to the rights or obligations of the Subcontractor under this Subcontract, including, without limitation, reductions in or deductions from payments under the Project Agreement, claims for indemnification and claims for damages for breach of such agreement (an assertion or exercise of such rights

by the Project Co being referred to in this Sub-Clause 9.10.1 of this Subcontract as a "**Project Co Claim**").

9.10.2 If a Project Co Claim is made:

(a) the Construction Contractor shall promptly notify the Subcontractor of such Project Co Claim and challenge and defend the Project Co Claim under and in accordance with the Prime Contract and in accordance with the Subcontractor's reasonable directions;

(b) the Subcontractor shall prepare and both of the Subcontractor and the Construction Contractor shall endeavour in good faith to agree on a protocol for challenge to, and/or defence of, any Project Co Claim, which shall conform to the principles set out in this Sub-Clause 9.10.2 and shall comply with and be consistent with the provisions of the Project Agreement and the Subcontractor and the Construction Contractor will follow and observe any protocol as so agreed;

(c) the Construction Contractor shall consult with the Subcontractor regarding any proposal to make any compromise or admission in relation to any Project Co Claim, and shall not make any such compromise or admission without first obtaining written consent from the Subcontractor, such consent for compromise or admission, shall not be unreasonably withheld or delayed (and any disputes relating to any such consent shall be resolved pursuant to the Dispute Resolution Procedure) and if the Subcontractor unreasonably withholds its consent to any compromise or admission in respect of a Project Co Claim, so that the Construction Contractor is required to continue to defend or challenge such Project Co Claim, then, in addition to the Subcontractor's obligations under Sub-Clause 9.10.4, then the Subcontractor shall be liable for and shall indemnify and hold harmless the Construction Contractor from and against the value to the Construction Contractor of any lost compromise or agreement previously available to the Construction Contractor should the subsequent defence or challenge to the Project Co Claim prove unsuccessful, provided always that the Construction Contractor shall not be entitled to double recovery;

(d) where the Subcontractor challenges or defends any Project Co Claim pursuant to the provisions of Sub-Clause 9.10.2(g), the Subcontractor shall consult with the Construction Contractor regarding any proposal to make any compromise or admission in relation to any Project Co Claim, and shall not make any such compromise or admission without first obtaining written consent from the Construction Contractor, such consent not to be unreasonably withheld or delayed (and any disputes relating to any such consent shall be resolved pursuant to the Dispute Resolution Procedure) and if the Construction Contractor unreasonably withholds its consent to any compromise or admission in respect of a Project Co Claim, so that the Subcontractor is required to continue to defend or challenge such Project Co Claim, then, in addition to the Construction Contractor's obligations under Sub-Clause 9.10.4, the Construction Contractor shall be liable for and shall indemnify and hold harmless the Subcontractor from and against the value to the Subcontractor

of any lost compromise or agreement previously available to the Subcontractor should the defence or challenge to the Project Co Claim prove unsuccessful;

(e) the Construction Contractor and the Subcontractor shall keep each other informed as to the progress of the relevant Project Co Claim and shall provide each other with copies of all the documents relating thereto;

(f) the Subcontractor shall, and shall cause each Subcontractor Party to, provide the Construction Contractor with such information as is in the control or possession of the Subcontractor or a Subcontractor Party and as the Construction Contractor may reasonably require to defend the Project Co Claim, including, without limitation, providing information and making available relevant personnel (and if the Construction Contractor permits the Subcontractor to challenge or defend a Project Co Claim on its behalf pursuant to Sub-Clause 9.10.2(g), the Construction Contractor shall, and shall cause the Construction Contractor Parties to, provide such information and make available relevant personnel to the Subcontractor); and

(g) notwithstanding anything else in this Sub-Clause 9.10.2, the Construction Contractor may, on terms to be mutually agreed, permit the Subcontractor to challenge or defend a Project Co Claim for and on behalf of and in the name of the Construction Contractor. Where the Construction Contractor is failing to diligently challenge or defend a Project Co Claim, the Subcontractor may challenge or defend such Project Co Claim for and on behalf of and in the name of the Construction Contractor, taking into account the interests of the Construction Contractor.

9.10.3 Subject to the Construction Contractor being in material compliance with its obligations under Sub-Clause 9.10.2, any determination or agreement made or reached under the Project Agreement as to the amount, nature and extent of the Construction Contractor's liability in relation to any Project Co Claim shall be binding on the Subcontractor but only if the Subcontractor has mutually agreed in writing to any determination or agreement made or reached under the Project Agreement as to the amount, nature and extent of its liability in relation to any Project Co Claim.

9.10.4 The Subcontractor shall bear and discharge on a current basis, and shall indemnify the Construction Contractor against all Direct Losses reasonably and properly incurred by the Construction Contractor in complying with Sub-Clauses 9.9 or 9.10, not including the costs of the Construction Contractor's own personnel (but including, without limitation, any out of pocket expenses of such personnel and including, without limitation, costs and expenses of the Project Co or other persons where the Subcontractor or the Construction Contractor becomes liable to pay the same) arising from operation of Sub-Clauses 9.9 or 9.10 of this Subcontract, except to the extent that the benefit of an Equivalent Claim or the liability for a Project Co Claim will be shared by the parties, in which case each party shall bear a fair and reasonable proportion of the related costs and expenses.

10.0 TESTS ON COMPLETION

10.1 Subcontractor's Obligations

The Subcontractor shall carry out the Tests on Completion in accordance with this Clause, Sub-Clause 7.4 and the ITP after providing the Construction Contractor with the documents in accordance with Sub-Clause 5.6 and Sub-Clause 5.7 of this Subcontract.

Unless otherwise specified in the ITP, the Subcontractor shall give to the Construction Contractor not less than fifteen (15) days' notice of the date after which the Subcontractor will be ready to carry out each of the Tests on Completion. Unless otherwise specified in the ITP, or agreed in writing, Tests on Completion shall be carried out within fourteen (14) days after this date, on such day or days as the Construction Contractor shall instruct.

The Tests on Completion shall be carried out as specified in Schedule M.

In considering the results of the Tests on Completion, appropriate allowances shall be made for the effect of any use of the Subcontracted Works by the Construction Contractor on the performance or other characteristics of the Subcontracted Works. As soon as the Subcontracted Works, or a Section, have passed each of the Tests on Completion described in the ITP, the Subcontractor shall submit a certified report of the results of these Tests to the Construction Contractor.

10.2 Delayed Tests

If the Tests on Completion are being unduly delayed by the Subcontractor, then the Construction Contractor may by written notice require the Subcontractor to carry out the Tests within ten (10) days after receiving the notice. The Subcontractor shall carry out the Tests on such day or days within that period as the Subcontractor may fix and of which it shall give reasonable prior notice to the Construction Contractor.

If the Subcontractor fails to carry out the Tests on Completion within such period of ten (10) days, the Construction Contractor's Personnel may proceed with the Tests at the risk and cost of the Subcontractor. These Tests on Completion shall then be deemed to have been carried out in the presence of the Subcontractor and the results of the Tests shall be accepted as accurate.

If the Tests on Completion are being unduly delayed by the Construction Contractor, Project Co, the City, or the Independent Certifier, the Subcontractor shall be entitled to an extension of time and any additional incurred costs, in accordance with the provisions of Subclause 8.4 and Clause 9.

10.3 Retesting

If the Subcontracted Works fail to pass the Tests on Completion, Sub-Clause 7.6 of this Subcontract shall apply, and the Construction Contractor or the Subcontractor may require the failed Tests, and Tests on Completion on any related work, to be repeated under the same terms and conditions.

10.4 **Failure to Pass Tests on Completion**

If the Subcontracted Works, or a Section, fail to pass the Tests on Completion repeated under Sub-Clause 10.3 of this Subcontract, the Construction Contractor shall be entitled to:

(a) order further repetition of Tests on Completion under Sub-Clause 10.3 of this Subcontract;

(b) if the failure deprives the Construction Contractor of substantially the whole benefit of the Subcontracted Works or Section, reject the Subcontracted Works or Section (as the case may be), in which event the Construction Contractor shall have the same remedies as are provided in the case of termination of the Subcontract due to a Subcontractor Event of Default; or

(c) issue a Taking-Over Certificate.

In the event of sub-paragraph (c), the Subcontractor shall not be relieved from any obligation under this Subcontract, including the obligation to achieve the passing of the relevant Test on Completion, and any deficiency that the Subcontractor is required to rectify in order to achieve the passing of the relevant Test on Completion will be considered a Punch List Item.

The provisions of Sub-Clause 7.6 of this Subcontract will apply to tests under this Clause 10.

If there is a dispute between the Subcontractor and Construction Contractor as to the Tests on Completion, the matter shall be referred to the expert designated in accordance with the Dispute Resolution Procedure attached to this Subcontract as Schedule I.

11.0 CONSTRUCTION CONTRACTOR'S TAKING OVER

"**Substantial Completion**" means Substantial Completion of the Fixed Component and Substantial Completion of the Vehicle Component.

"**Substantial Completion of Subcontracted Works**" means:

(a) that all of the Subcontracted Works required by Subcontract have been delivered at the location designated by the City in accordance with this Subcontract and have been completed, but for clarity, there shall be no requirement for the publication of a certificate of substantial performance;

(b) the Subcontractor shall have caused compliance with required level of testing as described in the Subcontract and Integrated Test Plan outlined in Schedule 15 – Output Specifications; and

(c)the Subcontractor shall have demonstrated compliance with the test and commissioning requirements as provided for in the Subcontract and in Part 4 of Schedule 15 2 – Output Specifications–Design and Construction Requirements and Schedule 14 – Commissioning.

11.1 Taking Over of the Subcontracted Works and Sections

Upon completion of installation of the Communication Based Train Control System for the System as set out in this Subcontract, Design and Specification Requirements, or any integral part of the Subcontracted Works, the Subcontractor shall test and commission the signalling system Equipment, software, and Documentation to verify compliance with the Design and Specification Requirements. Unless otherwise agreed by the Parties, a failure of the Subcontracted Works to comply with the Design and Specification Requirements shall be corrected by the Subcontractor.

Except as stated in Sub-Clause 10.4 of this Subcontract, the Subcontracted Works shall be taken over by the Construction Contractor when, firstly, the Subcontracted Works have been completed in accordance with the Subcontract, including the matters described for Time for Completion within Sub-Clause 8.2 of this Subcontract and except as allowed in sub-paragraph (a) below, and, secondly, a Taking-Over Certificate for the Subcontracted Works has been issued, or is deemed to have been issued in accordance with this Sub-Clause.

The Subcontractor may apply by notice to the Construction Contractor for a Taking-Over Certificate not earlier than fourteen (14) days before the Subcontracted Works will, in the Subcontractor's opinion, be complete and ready for taking over. If the Subcontracted Works are divided into Sections, the Subcontractor may similarly apply for a Taking-Over Certificate for each Section.

The Construction Contractor shall, within fourteen (14) days after receiving the Subcontractor's application:

(a) issue the Taking-Over Certificate to the Subcontractor, stating the date on which the Subcontracted Works were completed in accordance with the Subcontract, except for any items identified on the list as **"Punch List Items"**, consisting of minor outstanding work and Defects jointly developed by Subcontractor and the Construction Contractor that are not affecting the operational use of the Subcontracted Works for their intended purpose (either until or whilst this work is completed and these Defects are remedied);

(b) reject the application, giving reasons and specifying the work required to be done by the Subcontractor to enable the Taking-Over Certificate to be issued. The Subcontractor shall then complete this work before issuing a further notice under this Sub-Clause; or

(c) If, for reasons not attributable to Subcontractor, the Construction Contractor fails to issue the Taking-Over Certificate within the fourteen (14) days the Taking-Over Certificate shall be deemed to have been issued.

The Punch List Items shall not hold up issuance of the Taking-Over Certificate. The Subcontractor shall correct all items identified as Punch List Items as soon as possible but, in any event, not later than the expiration of the Warranty Period.

In all circumstances, any entry into Revenue Service Commencement by the City prior to Taking-Over Certificate for the Subcontracted Works has been issued shall be considered as acceptance by the Construction Contractor. In such case, the relevant Taking-Over Certificate for the Subcontracted Works shall be deemed to have been issued in respect of the Subcontracted Works.

Notwithstanding the foregoing provisions, operational use of the Communication Based Train Control System by the Construction Contractor or Project Co or the City shall be subject to a safety certification issued by the Subcontractor to the Construction Contractor, which may include applicable operating restrictions where necessary. The Subcontractor shall have no liability in respect of the revenue operation of any part of the Communication Based Train Control System for which such safety certification has not been issued or in respect of the Construction Contractor or Project Co or the City's failure to comply with applicable operating restrictions identified therein.

11.2 Taking-Over of Parts of the Subcontracted Works

Parts of the Subcontracted Works (other than Sections) shall not be taken over or used by the Construction Contractor, except as may be stated in the Subcontract or as may be agreed in writing by both Parties.

11.3 Interference with Tests on Completion

If the Subcontractor is prevented, for more than fifteen (15) days, from carrying out the Tests on Completion by a cause for which the Construction Contractor is responsible, the Subcontractor shall carry out the Tests on Completion as soon as practicable.

If the Subcontractor suffers delay and/or incurs Direct Loss as a result of this delay in carrying out the Tests on Completion, the Subcontractor shall give notice to the Construction Contractor and shall be entitled, subject to Clause 19, to:

(a) an extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.4; and

(b) payment of any such Direct Loss, which shall be added to the Subcontract Price.

After receiving this notice, the Construction Contractor shall proceed in accordance with Sub-Clause 3.5 to agree or determine these matters.

11.4 Punch List Items

With the exception of Minor Deficiencies which are included in the Minor Deficiencies List issued by the Independent Certifier and which are in respect of the Subcontracted Works, the identification of Punch List Items and time for their remediation shall have been mutually agreed to by the Subcontractor and Construction Contractor upon prior to the Construction Contractor issuing the Taking Over Certificate for of the Subcontracted Works. The Construction Contractor will be entitled to retain from payment owing to the Subcontractor, or to require payment from the Subcontractor as such costs estimated by the Independent Certifier under the Project Agreement or by the Construction Contractor under Sub-Clause 3.5. The Subcontractor will complete the Punch List Items no later than fifteen (15) days prior to the date by which the Construction Contractor must complete the corresponding Minor Deficiencies under the Prime Contractor within the time for remediation agreed between the Subcontractor and Construction Contractor.

11.5 Clearance of Site

Upon receiving the Taking Over Certificate, the Subcontractor shall remove any remaining Construction Equipment, surplus material, wreckage, rubbish and Temporary Works from the Site in which the Subcontractor brought and left at the Site.

If all these items have not been removed within fourteen (14) days after the Construction Contractor issues the Taking Over Certificate, the Construction Contractor may remove any remaining items. The Construction Contractor shall be entitled to be paid the direct transportation, removal and storage costs incurred in connection with the removal of the remaining items.

12.0 DEFECTS LIABILITY WARRANTY

12.1 General Warranty

The Subcontractor shall, at its own expense, rectify and make good or cause to be rectified and made good in a timely manner any Defect which are notified to the Subcontractor or of which the Subcontractor or any Subcontractor Personnel otherwise has knowledge within the period starting upon the issuance of a Taking-Over Certificate and ending two (2) years following the Revenue Service Commencement Date (the "**General Warranty Period**").

Warranty on Equipment

The Subcontractor hereby warrants the Equipment to be free from defects in materials and workmanship under normal use and service during the Warranty Period.
The Construction Contractor shall have notified the Subcontractor of the defects in writing within fourteen (14) working days after the defects are discovered.

In case the Construction Contractor wishes the Subcontractor to provide maintenance and support services after the expiry of the above-mentioned warranties, the Parties will enter into a separate annual maintenance and support contract of terms and conditions to be agreed.

Warranty on Software

The Subcontractor warrants that the Software shall be in conformity with the functions described in the Design and Specification Requirements for the Warranty Period.

The Subcontractor does not warrant that the Software shall be error free. During the Warranty Period, the Subcontractor will, at its own expense, promptly correct or bypass, pursuant to its own standards, all reproducible malfunction and/or anomaly within a period of time to be agreed by both Parties depending on the nature and severity of malfunctions.

No Obligation

Notwithstanding any provision of this Subcontract to the contrary, the Subcontractor shall have no obligation under this Clause 12 to repair or replace any Equipment or correct any Software if:

(a) use of Equipment or Software is in violation of the license granted under this Agreement or in a manner inconsistent with the documentation; or

(b) the Equipment or Software has been modified, repaired or reworked by any party other than Subcontractor, without Subcontractor's prior written consent; or

(c) the Defect is the result of:

  (i) any improper maintenance, storage, handling or use of the Equipment or Software by Construction Contractor or third party, or

  (ii) any use of the Equipment or Software by Construction Contractor or a third party in conjunction with another equipment or software that is electronically or mechanically incompatible, or

(iii) modifications on the interface conditions to the Design and Specification Requirements; or

(iv) any damage to the Equipment or Software by power failure, fire, explosion or any act of God or other cause beyond Subcontractor's control; or

(v) defects or damage is caused by the negligent or wilful acts of the Construction Contractor, its employees, contractors, Project Co, City or any third party; or

(vi) consumable items such as fuses, and defects arising from normal wear and tear; or

(vii) Installation by Construction Contractor not performed in accordance with the Subcontractor's procedures and/or instructions.

12.2 **Not Used**

12.3 **Latent Defect Warranty**

The Subcontractor, at its own cost and expense, shall (either itself or by engaging a third party) for the period of time commencing on the expiry of the General Warranty Period and ending on the fifteenth anniversary of the Revenue Service Availability Date (the "**Latent Defect Warranty Period**") repair, replace, strengthen and otherwise correct any and all Defects that, at the end of the General Warranty Period, could not reasonably have been ascertained by a competent person acting in accordance with Good Industry Practice during a visual inspection of the Subcontracted Works at least three months prior to the end of the General Warranty Period (each a "**Latent Defect**"). The Subcontractor acknowledges that Project Co and the Construction Contractor shall perform the visual inspection referred to in the previous sentence and that it shall provide reasonable assistance to the Construction Contractor and Project Co with respect thereto. Costs of removal, shipping and reinstallation, including any related testing and commissioning required to be performed by the Subcontractor shall be to the sole account of the Subcontractor.

Construction Contractor shall give to the Subcontractor written notice of any Latent Defect as soon as reasonably practicable following the date the Construction Contractor first becomes aware of such Latent Defect.

12.4 **Exclusivity/Sole Remedies**

For greater certainty, Construction Contractor's sole remedies against the Subcontractor in respect of Defects are as set out in this Clause 12. The warranties and remedies set out in this Clause shall expire at the end of the General Warranty Period, or the Latent Defect

Warranty Period, as applicable, provided that the remedies set forth in this Clause 12 shall not expire in relation to Claims made prior to the end of such period.

Notwithstanding any other provision of this Subcontract, the Subcontractor shall have no liability in respect of Defects, whether in contract, in tort (including without limitation, negligence) or on any other basis whatsoever except as expressly set forth in this Clause 12 and unless a Claim is made within the General Warranty Period, or the Latent Defect Warranty Period, as applicable, whether or not the basis for the Claim was discoverable during such period.

12.5 **Indemnity in favour of Maintenance Contractor**

The Parties acknowledge that the Construction Contractor will indemnify the Maintenance Contractor for the reasonable and proper additional service costs and losses (in aggregate, subject to the overall limit of liability of the Subcontractor) suffered by the Maintenance Contractor, including any Deductions made by Project Co pursuant to the Maintenance Contract (provided the Maintenance Contractor has taken reasonable steps to mitigate the consequences of such Defect and such costs), as a result of a Defect during the Warranty Period.

The Subcontractor will indemnify the Construction Contractor for any amounts paid under the foregoing indemnity as a result of a Defect for which the Subcontractor is responsible. For clarity, the Subcontractor shall not be responsible for a Defect (and shall not be obligated to provide an indemnity pursuant to this subsection 12.5) which is the result of any of the events listed under 12.1 (a) (b) or (c).

12.6 **Warranty Claim Procedures**

(a) On or before the expiry of the General Warranty Period, Epidemic Defect Warranty Period or Latent Defect Warranty Period, as the case may be, the Construction Contractor may issue written instructions requiring the Subcontractor to comply with its obligations under Sub-Clauses 12.1, 12.2 or 12.3, as the case may be, and the Subcontractor shall as soon as reasonably practicable after receipt of such instructions perform or cause to be performed such obligations at its own expense.

(b) Where the Subcontractor receives notice pursuant to Sub-Clause 12.6(a) in respect of a Defect, then, where it is reasonable to do so based on good engineering practice, the Subcontractor shall inspect all other such components or parts in the Subcontracted Works, and comply with its obligations under Sub-Clauses 12.1, or 12.3 in respect of any Defects in the same.

(c) All work carried out by the Subcontractor pursuant to Sub-Clause 12.6 shall be carried out in accordance with this Subcontract and good construction and engineering practice. Where any Defect in respect of which a Claim has been made pursuant to Sub-Clause 12.6(a) has arisen as a consequence of a failure in

the Design, the Subcontractor will take this into account, and undertake any re-design that is prudent in the circumstances to ensure that such Defect does not recur.

(d) If the Construction Contractor fails to give prompt notice to the Subcontractor after it Has Knowledge of any Defect in respect of which a Claim is made pursuant to Sub-Clause 12.6(a), or fails to permit the Subcontractor to remedy such Defect in a timely manner (having regard to Sub-Clause 12.6), then the Subcontractor shall be relieved of its obligations under this Clause 12 to the extent that its liability was increased as a result of either such failure.

(e) If the Subcontractor fails to take appropriate steps to comply with any notice served under Sub-Clause 12.6(a) within ten (10) Business Days, the Construction Contractor may issue a further notice to the Subcontractor requiring compliance with such obligations within five (5) Business Days after receipt of such further notice, and if the Subcontractor fails to comply, the Construction Contractor may employ and pay other Persons to carry out such obligations and shall be entitled to recover from the Subcontractor all costs, expenses, charges, loss and damage incurred by the Construction Contractor as a result of such failure.

(f) The Subcontractor shall make commercially reasonable efforts to carry out any work required under Sub-Clause 12.6(a) at such times and in such a manner as will minimise disruption to the ongoing Maintenance Services and the Subcontractor shall comply with the reasonable requirements of the Maintenance Contractor in relation to access for, and the timing and method of execution of, any works so required and shall indemnify the Construction Contractor in respect of any claim related to any such disruption.

(g) Where the Subcontractor makes good, or causes to be made good, any Defect pursuant to Sub-Clause 12.6(a), to the extent that it is subsequently agreed or determined that such Defect was not the obligation of the Subcontractor hereunder, then the Subcontractor shall be entitled to recover from the Construction Contractor all costs, expenses and charges incurred by the Subcontractor in making good such Defect or the amounts so paid to the Construction Contractor.

12.7 Urgent Work

The Parties acknowledge that (i) the Maintenance Contractor may carry out temporary remedial works in respect of any Defect which the Construction Contractor is required under the terms of the Construction Contract to remedy, if such remedial works are urgent in nature for public safety reasons or are required to mitigate loss, or to reduce or avoid abatement or deductions that may otherwise be made, provided always that the Maintenance Contractor gives written notice of such Defect to the Construction Contractor as soon as it is practicable to do so and, where practicable, first provides an

opportunity to the Subcontractor to remedy any such Defect, and further that (ii) the Construction Contractor shall reimburse the Maintenance Contractor for the Maintenance Contractor's reasonable costs arising as a direct result of the performance of such work to the extent remedying such Defect formed part of the Construction Contractor's responsibilities under the Construction Contract.

The Subcontractor will reimburse the Construction Contractor for any such payment to the Maintenance Contractor arising due to a Defect for which the Subcontractor is solely responsible.

12.8 **Removal of Defective Work**

If the Defect cannot be remedied expeditiously on the Site and the Construction Contractor gives its written consent, the Subcontractor may remove from the Site for the purposes of repair or replacement such items of Equipment which contain the Defect.

12.9 **Further Tests**

If the work of remedying of any Defect that affects the performance of the Works, the Construction Contractor may by written notice require the repetition of any of the tests described in the Subcontract, including Tests on Completion and/or Tests after Completion after the Defect is remedied.

12.10 **Right of Access**

From the issuance of a Taking-Over Certificate until the Revenue Service Commencement Date, the Subcontractor shall have a right of access to the Subcontracted Works solely for the purpose of completing the fulfillment of its obligations, without interfering with other party and in a manner consistent with the Construction Contractor's safety and security restrictions. From the Revenue Service Commencement Date, all access to the Site shall be subject to the provisions of Sub-Clause 12.6(f) and the prior written approval of the Maintenance Contractor.

12.11 **Subcontractor to Search**

The Subcontractor shall, if required by the Construction Contractor, search for the cause of any Defect, under the direction of the Construction Contractor. Unless the Defect is to be remedied at the cost of the Subcontractor under Sub-Clause 12.1, the Direct Cost of the search shall be agreed or determined in accordance with Sub-Clause 3.5 and shall be added to the Subcontract Price.

12.12 **Performance Certificate**

Performance of the Subcontractor's obligations shall not be considered to have been completed until the Construction Contractor has issued the Performance Certificate to the

Subcontractor, stating the date on which the Subcontractor completed its obligations under the Subcontract.

The Construction Contractor shall issue the Performance Certificate within thirty (30) days after the last of the expiry dates of the Defects Notification Periods, or as soon thereafter as the Subcontractor has supplied all the Subcontractor's Documents and completed and tested all the Subcontracted Works, including remedying any Defects. If the Construction Contractor fails to issue the Performance Certificate accordingly the Performance Certificate shall be deemed to have been issued on the date thirty (30) days after the date on which it should have been issued, as required by this Sub-Clause.

12.13 Subsisting Obligations

After the Performance Certificate has been issued, each Party shall remain liable for the fulfillment of any obligation which remains unperformed at that time.

12.14 Assignment of Warranties

At the expiry of the General Warranty Period, the Construction Contractor may assign all of its rights and obligations under this Clause 12, in whole or in part, to the City, Project Co, the Maintenance Contractor, or a designee of any of them. The Subcontractor agrees to execute any document and do any other things necessary to effectuate such assignment.

13.0 TESTS AFTER COMPLETION

13.1 Procedure for Tests after Completion

This Clause plus the provisions of Sub-Clause 7.4 shall apply to Tests after Completion specified in this Subcontract or in the ITP.

The Tests after Completion shall be carried out as specified in the ITP. The Construction Contractor shall give to the Subcontractor twenty-one (21) days' notice of the date on which the Tests after Completion will commence.

13.2 Retesting

If the Subcontracted Works, or a Section, fail to pass the Tests after Completion:

(a) Sub-Clause 7.6 of this Subcontract shall apply, and

(b) either Party may then require the failed Tests, and the Tests after Completion on any related work, to be repeated under the same terms and conditions, in timely fashion including so as not to delay Revenue Service Commencement.

13.3 **Failure to Pass Tests after Completion**

The provisions of Sub-Clause 7.6 of this Subcontract will apply to tests under this Clause 13.

If the Subcontracted Works fail to pass a Test after Completion and the Subcontractor proposes to make adjustments or modifications to the Subcontracted Works, the Subcontractor may be instructed by (or on behalf of) the Construction Contractor that right of access to the Subcontracted Works cannot be given until a time that is convenient to the Construction Contractor. The Subcontractor shall then remain liable to carry out the adjustments or modifications and to satisfy this Test, within a reasonable period of receiving notice by (or on behalf of) the Construction Contractor of the time that is convenient to the Construction Contractor.

14.0 VARIATIONS AND ADJUSTMENTS

14.1 **Variation Required by the Construction Contractor**

The Construction Contractor may, without invalidating this Subcontract, require an Construction Contractor Variation (including a Variation applicable to the scope of the Subcontracted Works) (request) by clearly identifying same in writing, at any time during the term of this Subcontract pursuant to and subject to the terms of this Clause 14.

In the case of a City Variation or Project Co Variation, the Subcontractor agrees to comply with the Variation Procedure of the Prime Contract, including to the extent that the Variation Procedure requires the Construction Contractor to minimize the cost and impact of a Variation.

In the case of a Construction Contractor Variation, the provisions of Sub-Clauses 14.3 through 14.12.

14.2 **Subcontractor Grounds for Objection**

(a) Subcontractor may only refuse to deliver an Estimate if the Subcontractor can demonstrate to the Construction Contractor's satisfaction, acting reasonably, within the period for delivery of an Estimate specified or agreed pursuant to provisions of this Subcontract, that:

(a) the implementation of the Variation would materially and adversely affect the health and safety of any person;

(b) the implementation of the Variation would:

(c) infringe Applicable Law;

(d) cause to be revoked any of the existing Permits, Licences or Approvals required by the Subcontractor to perform the activities within the Subcontracted Works, and any such Permit, Licence or Approval is not, using commercially reasonable efforts, capable of amendment or renewal;

(e) require any new Permits, Licences or Approvals for the Subcontractor to perform the activities within the Subcontracted Works, any of which will not, using commercially reasonable efforts by the Subcontractor or the Construction Contractor, as applicable, be obtainable;

(f) the proposed Variation would have a material and adverse effect on performance of the activities within the Subcontracted Works (except those activities within the Subcontracted Works which have been specified as requiring amendment in the Variation request) in a manner not compensated pursuant to this Clause 14;

(g) the implementation of the Variation would be a departure from Good Industry Practice (Works) or Good Industry Practice (Highway);

(h) the Construction Contractor does not have the legal power or capacity to require the Variation to be implemented or to do anything envisaged by this Clause 14 in respect of or in connection with the Variation;

(i) the Variation would, if implemented, result in a change in the essential nature of the System or the Highway, as applicable;

(j) the Variation Enquiry does not comply with the requirements of this Clause 14 (including a failure to include adequate information therein to enable Project Co to prepare an Estimate in respect thereof); or

(k) in the case of a Variation relating to the Subcontracted Works, the time specified for commencement and/or completion of such Variation cannot be achieved by the Subcontractor despite commercially reasonable efforts; or

(b) If the Subcontractor refuses to provide an Estimate on the grounds set out in Section (a), the Subcontractor shall, within the period for delivery of an Estimate specified or agreed pursuant to this Sub-Clause 14.2), deliver to the Constructor Contractor a written notice specifying the grounds upon which the Subcontractor rejects the Variation and the details thereof.

14.3 Innovation and Value Engineering

The Subcontractor acknowledges that the City at all times desires to reduce the Monthly Service Payments and the overall cost to the City of the System, the Works and the Maintenance Services, and the Subcontractors agrees to cooperate, explore and work with the Construction Contractor, Project Co, the Maintenance Contractor and the City in

investigating and considering innovation and value engineering and other cost saving measures.

14.4 Works Change in Law

On the occurrence of a Works Change in Law affecting the Subcontracted Works the relevant provisions of the Prime Contract will apply.

14.5 Preliminary Variation Instruction

The Construction Contractor may at any time during the performance of the Subcontracted Works issue to the Subcontractor a Preliminary Variation Instruction which sets out the requested Variation with sufficient detail and information to permit the Subcontractor to prepare and deliver to the Construction Contractor a Variation Report. The Construction Contractor shall identify all Preliminary Variation Instructions as such.

14.6 Variation Report

The Subcontractor will use commercially reasonable efforts to prepare a Variation Report, and consider how to accommodate a proposed Construction Contractor Variation so as to minimize the cost of a Variation and the impact of the Variation on the Approved Subcontract Schedule. The Variation Report will identify all aspects of the Variation as they relate to the Subcontracted Works.

14.7 Subcontractor's Preliminary Variation Report

Upon receipt of a Preliminary Variation Instruction, and subject to Sub-Clause 14.3:

(a) if the Variation Report can reasonably be prepared within fifteen (15) days of receipt of the Preliminary Variation Instruction, or such longer time as the Construction Contractor may have specified in the Preliminary Variation Instruction, then the Subcontractor will within such time prepare and deliver to the Construction Contractor a Variation Report prepared in accordance with Sub-Clause 14.7;

(b) if the Subcontractor acting reasonably determines that the Variation Report cannot reasonably be prepared within the time specified, then within ten (10) days of receipt of the Preliminary Variation Instruction, or such longer time as the Subcontractor may reasonably need, or such longer time as the Construction Contractor may specify in the Preliminary Variation Instruction, the Subcontractor will provide the Construction Contractor with a preliminary report (a "**Preliminary Variation Report**") setting out a brief written summary of the following:

i. a description of the scope of engineering and Design, if any, required to implement the Construction Contractor Variation, with reference to the Subcontracted Works;

ii. a breakdown of the proposed the Variation into the elements that the Subcontractor will need to price separately to prepare a cost estimate described in Sub-Clause 14.7, including as they relate to both the Subcontracted Works;

iii. an estimate of the time the Subcontractor will reasonably require to complete the engineering and Design, if any, and to prepare the Variation Report, with reference to the Subcontracted Works; and

iv. an estimate of the costs, if any, that the Subcontractor will reasonably incur to prepare the Variation Report with reference to the Subcontracted Works; and

(c) upon delivery to the Construction Contractor of a Preliminary Variation Report:

i. the Construction Contractor and the Subcontractor will cooperate with each other and use commercially reasonable efforts to agree on estimates of the reimbursable costs, if any, the approach and the time required for the preparation of the Variation Report;

ii. the Subcontractor will not proceed with the preparation of the Variation Report until receipt of written direction from the Construction Contractor; and

iii. if the Subcontractor does not agree on the costs estimate, approach or time as may be set out in the Construction Contractor's direction for the preparation of the Variation Report, then the Subcontractor may submit the matter to the Dispute Resolution Procedure attached to this Subcontract as Schedule I, pending a decision thereunder, and if so instructed by the Construction Contractor, the Subcontractor will implement the direction.

14.8 Variation Report

Subject to Sub-Clause 14.6, the Subcontractor will deliver to the Construction Contractor a report with reference to the Subcontracted Works containing the information described below, as well as the information required under Sub-Clause 14.8 (c) (a "**Variation Report**"):

(a) an estimate of all Direct Costs which the Subcontractor reasonably expects to incur and any cost savings which can be made by the Subcontractor on the implementation of the Variation (providing with such estimate all necessary

supporting calculations and information as reasonably requested and necessary for the Construction Contractor to be able to understand and evaluate the estimate);

(b) any impact on any amounts payable by Construction Contractor to the Subcontractor as a result of the implementation of the Variation;

(c) any adjustments to the Approved Subcontract Schedule, including any adjustments to the Completion Date, which the Subcontractor will require as a result of the implementation of the Variation;

(d) the Subcontractor's requirements for assistance and resources from the Construction Contractor;

(e) any additional consents or approvals required, including amendments, if any, of any Permits; and

(f) the identity of the Sub-subcontractors which the Subcontractor intends to engage for the purposes of implementing the Variation.

14.9 Valuation of Variations to Design and Construction

(a) The value of an Variation which will solely result in a change to Design or Construction, will be limited to the actual additional work or deletion of work described in the Preliminary Variation Instruction calculated in accordance with this Sub-Clause 14.8 and will not include any allowance for, or take into account, the cost of any work already included in this Subcontract.

(b) Neither the Subcontractor nor the Construction Contractor will use a Preliminary Variation Instruction to correct, or derive benefit from, any errors or omissions in the Design or Construction cost estimates provided by the Subcontractor for any Subcontracted Works.

(c) A Variation Report relating to a change to the Design or Construction will set out the total estimate of costs set out in sufficient detail to allow evaluation by the Construction Contractor, together with a scope of Subcontracted Works of the Variation and showing how the Variation compares to the scope without the Variation if this is not discernable by the Construction Contractor. The details shall set out the major elements and components of the additional costs and will include, but not necessarily show separately, unless requested be the Construction Contractor for those parts of the Variation Report that cannot be understood by the Construction Contractor, will include:

i. all costs reasonably necessary for and directly associated with the proposed Variation, including the cost of labour, Material, and Equipment, together with any quotations from Sub-subcontractors;

ii. estimated Design costs based on the estimated number of hours reasonably required to perform any additional Design; and

iii. estimated additional costs of Site management, including, the supervision of trade foremen, Site overheads, and Site establishment including, without duplication, any costs related to the Subcontractor's management and oversight of the Subcontracted Works that should reasonably be included in the proposed Variation;

(d) Detailed costs need not be provided with the Variation Report but the cost breakdown provided will be of sufficient detail as reasonably required by the Construction Contractor to evaluate the Variation and to understand the magnitude of the cost of the Variation. If the Construction Contractor considers it necessary to examine details set out in the Variation Report, the estimated costs reviewed will be based and evaluated on the following principles, which, if the Subcontractor and the Construction Contractor do not agree on the costs, will be the basis of all estimated costs that can be agreed by the Construction Contractor:

i. Construction labour costs, except labour associated with Design and engineering, regardless of whether in operations, management, or administration roles, based on the hourly rate paid including allowance for all payroll burdens such as overtime premiums (when paid), vacation pay, pension funds, statutory payments, Workmen's Compensation Insurance, union dues, tool money, medical insurance, and any other payments directly paid in the ordinary course;

ii. cost of Design (excluding design and engineering comprised in the cost of supply of Equipment) will be reviewed and determined based on the number of hours reasonably estimated to be required to perform the work multiplied by the Subcontractor's then prevailing hourly rates for such design and engineering work or such other rate as may have been agreed by the Subcontractor and the Construction Contractor for Design services.

iii. cost of supply and delivery of Materials, consumables and Equipment, including associated costs such as cost of associated testing, commissioning, spare parts, manuals and software, and including the Design and engineering related thereto based on the estimated price to be charged by the supplier;

iv. cost of Construction Equipment calculated using the rates as may be agreed between the Subcontractor and the Construction Contractor, and the number of hours such equipment is estimated to be required to carry out the Variation, together with appropriate amounts for delivering such equipment to and from the Site;

v. the cost of any other rental, fabrication facility, or factory costs directly associated with the Variation will be calculated based upon the reasonable direct costs estimated to be paid by the Subcontractor to its supplier;

vi. the costs involved in obtaining and evaluating tenders and awarding a contract for Subcontracted Works that is to be tendered under Sub-Clause 14.8(d)(ii), and the supervision and management of such Sub-subcontract;

vii. all other Design and Construction costs pertaining to the Variation, such as but not limited to costs of additional Site establishment, wastage, disposal, laboratory and testing fees, insurance, bonding, Permits, appropriate disbursements (printing, travel, accommodation), import duties, and so on will be calculated at the estimated direct cost to the Subcontractor, Sub-subcontractor;

viii. appropriate allowances for risk, contingency and warranty obligations; and

ix. mark-ups in accordance with Sub-Clause 14.8(f).

(e) If the Subcontracted Works involved in the Variation can be reasonably accommodated by way of tender as described in Sub-Clause 14.8(d)(ii), then the Subcontractor will obtain at least three competitive tenders for the Subcontracted Works described in the Variation, and the Variation will be valued at the cost of the lowest compliant tender received, marked up as set out in Sub-Clause14.8(f).

14.10 Agreements or Determinations of Variation Valuation

Following receipt by the Construction Contractor of a Variation Report in response to a Preliminary Variation Instruction:

(a) the Parties will use commercially reasonable efforts to reach mutual agreement on the costs and other information contained in the Variation Report with reference to the Subcontracted Works and any agreement so reached in writing will, if recorded in the Variation Certificate issued in accordance with Sub-Clause 14.11, be binding upon Construction Contractor and the Subcontractor with respect to the Variation;

(b) if the Parties are unable to agree on a Variation Report, the Construction Contractor may:

i. elect not to proceed with the Construction Contractor Variation described in the Preliminary Variation Instruction; or

ii. issue to the Subcontractor a Variation Certificate stating the Construction Contractor's determination of the matters referred to in Sub-Clause 14.6(c)(iii) and 14.8; and

(c) if the Subcontractor disagrees with all or any of the determinations set out in the Variation Certificate, then the Subcontractor may deliver to Construction Contractor a Dispute Notice, and the Subcontractor will, without prejudice to its rights with respect to such Dispute, implement the Variation as directed in the Variation Certificate.

14.11 **Payment for Variation**

The Construction Contractor will pay to the Subcontractor all amounts agreed or determined to be due and payable in respect of the Variation pursuant to Sub-Clause 14.9(a) or 14.8(c), as the case may be, in accordance with Sub-Clause 15.3.

14.12 **Variation Certificate**

A Variation will be authorized by the Construction Contractor issuing to the Subcontractor a certificate (the "**Variation Certificate**"). The Subcontractor will not proceed with a Variation prior to the issuance of a Variation Certificate, subject to the Subcontractor's right to Dispute pursuant to Sub-Clause 14.9(c), the Subcontractor will implement the Variation.

14.13 **Responsibility for Variations**

Except as hereinafter provided, the Construction Contractor will bear no risk or liability whatsoever arising from any Variation, other than the liability to make payment for such Variation under Sub-Clause 14.10. The Construction Contractor will indemnify the Subcontractor in respect of any increased costs or any Direct Losses suffered by the Subcontractor as a result of any particular design, materials, goods, workmanship or method of construction which the Construction Contractor specifies must be incorporated in the Variation and which is subsequently shown to be defective (other than as a result of the sole default or negligence of the Subcontractor), provided that the Subcontractor objected in writing to the incorporation of any particular design, materials, goods, workmanship or method of construction, as the case may be, prior to the issue of the relevant Variation Certificate and such objection was considered by the Construction Contractor, or, in the case of disagreement, determined pursuant to the Dispute Resolution Procedure, to be reasonable.

14.14 **Request for Subcontractor's Variation**

Subject to Sub-Clause 14.14, at any time during the term of this Subcontract the Subcontractor may submit to the Construction Contractor a request to permit the Subcontractor to make a Subcontractor's Variation and with such request the Subcontractor will supply such technical and other information as may be necessary to explain the reason for the Subcontractor's Variation being requested and a draft of the proposed Subcontractor's Variation Certificate.

The Subcontractor acknowledges and agrees that (i) in preparing its schedule and budget for the Project, the Construction Contractor relied on information provided by the Subcontractor or Subcontractor Personnel and made assumptions based on the structures, elements and designs set forth in Schedule M hereto, and (ii) any changes, other than changes necessary in order to reach a finalized design, to the structures, elements and designs set forth in Schedule M hereto shall be treated as a Subcontractor's Variation pursuant to this Clause 14.13 and subject to the terms hereof.

14.15 Issue of Subcontractor's Variation Certificate

The Subcontractor will not implement a Subcontractor's Variation unless such Subcontractor's Variation has been approved by the Construction Contractor and a Subcontractor's Variation Certificate has been issued by the Construction Contractor. The Construction Contractor may not refuse to issue a Subcontractor's Variation Certificate if the Subcontractor's Variation is required to comply with a Change in Law. The Construction Contractor may refuse to issue a Subcontractor's Variation Certificate at its sole discretion.

Upon receipt of a proposed Subcontractor's Variation Certificate pursuant to Sub-Clause 14.13, the Construction Contractor will either:

(a) notify the Subcontractor that it refuses to approve the Subcontractor's Variation (including the grounds for such lack of approval); or

(b) issue a Subcontractor's Variation Certificate,

within thirty (30) days of receipt by the Construction Contractor of the proposed Subcontractor's Variation Certificate.

14.16 No Claims by Subcontractor

All Subcontractor's Variation will be implemented solely at the risk and cost of the Subcontractor except to the extent that the Construction Contractor has expressly agreed to bear the cost of such changes under this Subcontract. The Subcontractor will not be entitled to any form of payment, any extension of Time for Completion of the Subcontracted Works or any other relief or remedy as a result of the implementation of a Subcontractor's Variation except as may be expressly agreed to in writing by the Construction Contractor. In addition, no liability will attach to, and the Subcontractor will have no Claim against, the Construction Contractor by reason of a refusal to approve a Subcontractor's Variation on the grounds allowed under Sub-Clause 14.14, provided, however, that nothing in Sub-Clause 14.14 or 14.15 will prevent the Subcontractor from exercising its right to submit a Dispute in respect of any such the Construction Contractor refusal to the Dispute Resolution Procedure. Unless expressly provided herein or

otherwise agreed, the Construction Contractor will not be entitled to any benefit received by the Subcontractor on the implementation of a Subcontractor's Variation.

15.0 SUBCONTRACT PRICE AND PAYMENT

Whereas the Construction Contractor is an unincorporated joint venture and each of its members shall be jointly and severally responsible and liable for the payment to the Subcontractor of amounts that are due according with this Subcontract.

15.1 The Subcontract Price

The Subcontract Price is as stated within Schedule B - Subcontract Price and Payment Milestones.

Unless otherwise stated in Schedule B - Subcontract Price and Payment Milestones attached to this Subcontract:

(a) payment for the Subcontracted Works shall be made on the basis of the fixed, lump sum Subcontract Price indicated in Schedule B - Subcontract Price and Payment Milestones, subject to adjustments in accordance with the Subcontract; and

(b) the Subcontract Price does not include HST. All other Taxes have been included in the Subcontract Price, including all Taxes levied on the Subcontractor's income or on the Subcontractor's capital and in respect of materials delivered to the Site and incorporated into the Subcontracted Works.

15.2 Payment Certification

The Construction Contractor shall be the payment certifier for purposes of the *Construction Lien Act* (Ontario) if applicable.

15.3 Payment Terms and Procedures

The Construction Contractor shall pay the Subcontract Prices in accordance with the terms set out herein and within Schedule B -Subcontract Price and Payment Milestones attached to this Subcontract.

The Construction Contractor shall make payments to the Subcontractor to the bank account stated on the corresponding payment application/invoice in accordance with the payment terms as set out within this Clause.

Milestone Payments

Upon the Subcontractor achieving a payment milestone as set forth in Schedule B attached to this Subcontract or any sum in respect of a Variation, the Subcontractor will

no later than the 25th of the month in which the payment milestone is achieved or such sum becomes due (or failing which, by the 25th of the subsequent month), deliver a payment application to the Construction Contractor in a form and substance reasonably acceptable to the Construction Contractor and in accordance with any requirements of the Prime Contract.

The Construction Contractor shall pay the Subcontractor by Bank Transfer in respect of all undisputed amounts due by irrevocable bank transfer to Subcontractor's designated account NET thirty (30) days of receipt of the Subcontractor's complete payment application.

Payment Application Submission

Payment Applications are to be submitted to the attention of the Construction Contractor at the following address:

OLRT Constructors
195 The West Mall – Toronto, ON – M9C 5L5

15.4 Delayed Payment

If the Subcontractor does not receive payments which are due and owing by the date in which the payment(s) is to be made by the Construction Contractor the Subcontractor shall be entitled to receive interest at the Default Interest Rate and the Subcontractor may, when applicable, enact Subcontractor's Remedies as per Sub-Clause 16.2.2 of this Subcontract.

Default Interest Rate

All payments shall be made according to the terms of payment set out in this Subcontract and Schedule B attached to this Subcontract. Late payments shall automatically and without prior notice bear interest at the Default Interest Rate calculated from the due date until date of full payment. The Default Interest Rate shall be at [redacted]% per annum over the Interest prime rate.

15.5 Currency of Monthly Service Payments

The Subcontract Price shall be paid in Canadian Dollars.

16.0 TERMINATION

16.1 Termination by Construction Contractor

16.1.1 Subcontractor Events of Default

For the purposes of this Subcontract, a Subcontractor Event of Default means any of the following events or circumstances:

(a) failure by the Subcontractor to make any payment to the Construction Contractor when due and owing hereunder, and not being disputed by the Subcontract in accordance with the Dispute Resolution Procedure, and such failure is not remedied within fifteen (15) Business Days of notice from the Construction Contractor;

(b) Not Used;

(c) any written representation or warranty made by the Subcontractor to the Construction Contractor in this Agreement or any agreement ancillary hereto (or any ancillary certificate, statement or notices issued hereto or thereto) is false or misleading in any respect when made or deemed made (other than as a consequence of a breach by the Construction Contractor of its obligations under this Agreement); such false or misleading representation or warranty has resulted in a material adverse effect on the ability of the Subcontractor to perform its obligations under this Subcontract, the Construction Contractor to perform its obligations under this Subcontract or the Prime Contract; and such false or misleading representation or warranty is not remedied within fifteen (15) Business Days of receipt of notice thereof from the Construction Contractor;

(d) the Subcontractor commits any material breach of the terms of any Permit, and such material breach has resulted in material adverse effect on the ability of the Subcontractor to perform its obligations under this Subcontract or on the ability of the Construction Contractor to perform its obligations under this Subcontract or the Prime Contract and such breach has not been remedied within ten (10) Business Days of receipt of notice thereof from the Construction Contractor;

(e) the Subcontractor breaches Sub-Clause 1.8 of this Subcontract;

(f) the Subcontractor repudiates the Subcontract or otherwise refuses to proceed with the Subcontracted Works (with the exception of unsafe working conditions or as otherwise permitted by this Subcontract);

(g) at any time, the Construction Contractor, acting reasonably, determines that Completion will not be achieved or Completion is not achieved due to the sole responsibility of the Subcontractor in accordance with the Approved Subcontract Schedule, or the Subcontractor fails to fulfill any obligation under Clause 8.3.5 or 8.3.6 of this Subcontract;

(h) any of the following events occurs in respect of the Subcontractor:

(i) any arrangement or composition with or for the benefit of creditors being entered into by or in relation to the Subcontractor pursuant to any insolvency law;

(ii) a trustee, receiver, receiver and manager, interim receiver, liquidator, administrator or other custodian or other encumbrance holder taking possession of or being appointed over, or any distress, attachment, execution or other process being levied or enforced upon, the whole or any material part of the assets of the Subcontractor;

(iii) the Subcontractor ceases to carry on business in the normal course or fails to maintain or breaches any franchise, licence, authorisation or right necessary to conduct its business;

(iv) the Subcontractor making an assignment for the benefit of its creditors, being declared bankrupt or committing an act of bankruptcy, becoming insolvent, making a proposal or otherwise taking advantage of provisions for relief under the *Bankruptcy and Insolvency Act* (Canada), the *Companies' Creditors Arrangement Act* (Canada), the *Winding Up and Restructuring Act* (Canada) or any other applicable insolvency legislation or similar legislation in any jurisdiction ("Insolvency Legislation"), or any other type of insolvency proceedings being commenced by or against the Subcontractor under any Insolvency Legislation and, if commenced against the Subcontractor, not stayed, dismissed or otherwise remedied within thirty (30) days of its commencement;

(v) a petition being filed (and not being contested in good faith using all reasonable efforts), or a resolution being passed or an order being made for the winding-up, liquidation, administration, dissolution or other similar proceeding of the Subcontractor;

(vi) any legal proceedings are taken by any Person (and not stayed within thirty (30) days of commencement) with a view to proposing (under any enactment or otherwise) any kind of composition, scheme of arrangement, compromise or arrangement involving the Subcontractor and its creditors generally (or any class of them);

(vii) any Relevant Authority or any person or entity acting or purporting to act under any Relevant Authority takes any action in order to condemn, seize or appropriate, or to assume custody or control of, the Subcontractor or of all or any substantial part of the assets of the Subcontractor or takes action to curtail the Subcontractor's authority in the overall conduct of its business or operations;

(i) insurance required to be obtained by the Subcontractor under this Subcontract or the Performance Security ceases to be in full force and effect and is not replaced in accordance with Clause 4.2 of this Subcontract;

(j) the Subcontractor fails to remove an Encumbrance that arose due to an act or omission of the Subcontractor or any Subcontractor Personnel (other than a Title Encumbrance and any Encumbrance derived through the Construction Contractor, Project Co or the City) within the earlier of:

(i) twenty (20) Business Days of the earlier of:

a. the registration of such Encumbrance against title to the Lands or any part thereof; and

b. the date on which the Subcontractor or any Subcontractor Personnel knew, or ought to have known, about the existence of the Encumbrance;

(ii) five (5) Business Days of the Subcontractor or any Subcontractor Personnel having actual knowledge of such Encumbrance.

(k) the Subcontractor fails to comply with any determination, order or award made against the Subcontractor in accordance with the Dispute Resolution Procedure or against the Construction Contractor pursuant to Attachment 27 – CC Dispute Resolution Procedure or against Project Co pursuant to Schedule 27 – Dispute Resolution Procedure to the Project Agreement which is binding on the Construction Contractor (to the extent this Subcontract expressly provides that such determination shall be binding on the Parties hereunder);

(l) at any time after the Revenue Service Availability Date, the Subcontractor commits a breach of its obligations under this Subcontract which results in a criminal conviction or a conviction under the OHSA against the Subcontractor, any Subcontractor Personnel, the Construction Contractor, any Construction Contractor Personnel or Project Co (an "**H&S Conviction**") provided however that:

(i) an H&S Conviction shall not constitute a Subcontractor Event of Default if, within thirty (30) days from the date of the H&S Conviction (whether or not the H&S Conviction is subject to an appeal or any further judicial process), the involvement in the Subcontracted Works of each relevant Subcontractor Personnel (which in the case of an individual director, officer or employee shall be deemed to include the Subcontractor Personnel of which that person is a director, officer or employee) is terminated in accordance with Sub-Clause 6.11 of this Subcontract or the Subcontractor takes such other disciplinary action against each such Subcontractor Personnel as is acceptable to the Construction Contractor, in its sole discretion; and

(ii) in determining whether to exercise any right of termination for a Subcontractor Event of Default pursuant to this Clause 16.1.1(m), the Construction Contractor shall be entitled with any determination or exercise of discretion of Project Co under the Prime Contract, but shall otherwise:

A. act in a reasonable and proportionate manner having regard to such matters as the gravity of any offence and the identity of the person committing the act leading to the H&S Conviction; and

B. give all due consideration, where appropriate, to action other than termination of this Subcontract; or

(m) Not Used

(n) the Subcontractor fails to comply Sub-Clause 6.11 or 6.12;

(o) the Subcontractor ceasing to be, directly or indirectly, a wholly-owned subsidiary of the Parent;

(p) the accumulation of Delay Liquidated Damages in excess of the limit of liability provided in Sub-Clause 8.6 or the accumulation of liability generally in excess of the limit of liability provided in Sub-Clause 17.5 unless the Subcontractor agrees to re-set the relevant limit at a level acceptable to the Construction Contractor, in its absolute discretion; or

(q) the Subcontractor commits any other breach of this Subcontract which has a material adverse effect on the ability of the Subcontractor to perform its obligations under this Subcontract, on the ability of the Construction Contractor to perform its obligations or carry out its rights under this Subcontract or the Prime Contract, on the ability of Project Co to perform its obligations or carry out its rights under the Prime Contract or Project Agreement or on the ability of the City to perform its obligations or carry out its rights under the Project Agreement, and such breach is not cured within ten (10) Business Days of the Subcontractor's receipt of notice thereof from the Construction Contractor.

16.1.2 Notification

The Subcontractor will notify the Construction Contractor of the occurrence, and details, of any Subcontractor Event of Default and of any event or circumstance which is likely, with the passage of time or otherwise, to constitute or give rise to a Subcontractor Event of Default, in either case promptly on the Subcontractor becoming aware of its occurrence.

16.1.3 Notice of Default or Termination

On the occurrence of a Subcontractor Event of Default, or at any time thereafter, and while it is subsisting, the Construction Contractor may:

(a) subject to Sub-Clause 16.1.3(b), in the case of a Subcontractor Event of Default referred to in Sub-Clause 16.1.1(c), (d), (g), (k) or (q) serve notice of default on the Subcontractor, specifying in reasonable detail the type and nature of the default, requiring the Subcontractor at the Construction Contractor's option either:

(i) to remedy the Subcontractor Event of Default referred to in such notice of default (if it is continuing) within ten (10) Business Days of such notice of default; or

(ii) to put forward within three (3) Business Days of such notice of default a reasonable program (set out, if appropriate, in stages) for remedying the Subcontractor Event of Default and, thereafter, to perform its obligations to achieve all elements of such program in accordance with its terms within the time for the performance of its obligations thereunder. The program will specify in reasonable detail the manner in, and the latest date by, which such Subcontractor Event of Default is proposed to be remedied; and

(b) terminate this Subcontract by notice having immediate effect, in the case of

(i) a Subcontractor Event of Default not referred to in Sub-Clause 16.3.1(a); or

(ii) a Subcontractor Event of Default referred to in Sub-Clause 16.3.1(q) which has resulted in a Construction Contractor Event of Default under the Prime Contract; or

(iii) a failure of the Subcontractor to comply with a notice of default issued under Sub-Clause 16.3.1(a).o.

16.2 Termination by Subcontractor

16.2.1 Construction Contractor Events of Default

For the purposes of this Agreement a Construction Contractor Event of Default means any of the following events or circumstances:

(a) the Construction Contractor fails to pay any amount due and owing to the Subcontractor under this Agreement on the due date and the Construction Contractor has not remedied such failure to pay within thirty (30) days of notice from the Subcontractor or, where such failure is due to a Project Co Event or a City Event, within twenty-five (25) Business Days of notice from the Subcontractor;

(b) except as provided for in paragraph (a) above, the Construction Contractor breaches any other material term, condition, covenant or undertaking contained herein (other than as a consequence of a breach by the Subcontractor of its obligations under this Subcontract or a breach by the City of its obligations under the Project Agreement) and such failure materially and adversely affects the ability of the Subcontractor to perform its material obligations under this Agreement and the Construction Contractor fails to cure such default within thirty (30) days of receiving written notice from the Subcontractor; or

(c) the occurrence of any of the following events other than as a consequence of a breach by the Subcontractor of its obligations under this Subcontract:

(i) the Construction Contractor or any member thereof is declared or adjudged a bankrupt, makes a general assignment for the benefit of creditors, or takes the benefit of any legislation in force for (1) protection against creditors, (2) orderly payment of debts, or (3) winding up or liquidation;

(ii) a receiver or receiver-manager is appointed for the business of the Construction Contractor or any member thereof, unless the appointment is cancelled within thirty (30) days;

2. the Construction Contractor or any member thereof ceases performing a substantial portion of its business, or a substantial portion of such business is suspended or is not being performed, whether voluntarily or involuntarily, that has or is likely to have a material adverse effect on the Construction Contractor's ability to perform its obligations under any this Subcontract; or

(iii) if any execution, sequestration, extent, garnishment or other process of or order by any court becomes enforceable against the Construction Contractor or any member thereof or if a distress or analogous process is levied against any property of the Construction Contractor, any member thereof that materially adversely affects the Construction Contractor's ability to perform its obligations under this Subcontract,

provided that such an event shall not constitute a Construction Contractor Event of Default if any one of Dragados Canada, Inc., SNC-Lavalin Constructors (Pacific) Inc. and EllisDon Corporation have not undergone such an event and are not otherwise in default hereunder, provided the Prime Contract has not been terminated.

16.2.2 Subcontractor's Remedies

On the occurrence of a Construction Contractor Event of Default, which prevents or delays the performance of the Subcontracted Works, or at any time thereafter, and

while it is still subsisting, the Subcontractor may serve notice on the Construction Contractor of the occurrence specifying details of such Construction Contractor Event of Default and:

(a) suspend performance of its obligations under this Subcontract until such time as the Construction Contractor Event of Default is no longer subsisting or the Construction Contractor has demonstrated to the satisfaction of the Subcontractor that the Construction Contractor will perform and is capable of performing its obligations under the Subcontract; and/or

(b) if the relevant matter or circumstance has not been rectified or remedied within thirty (30) Business Days of the Subcontractor's notice, or the Construction Contractor has not demonstrated to the satisfaction of the Subcontract that the Construction Contractor will perform and is capable of performing its obligations under the Subcontract, the Subcontractor may serve a further notice on the Construction Contractor terminating this Agreement with immediate effect.

16.2.3 **Subcontractor Exercise of Termination Rights**

The Subcontractor will not exercise, or purport to exercise, any right to terminate this Agreement as a result of a Construction Contractor Event of Default, except as expressly set out in this Subcontract.

16.3 **Prime Contract Termination**

(a) This Subcontract will terminate automatically forthwith on any termination of the Prime Contract, provided that the Prime Contract will be considered not to have been terminated for the purposes of this Clause 16 where the Construction Contractor is required to continue to perform its obligations under the Prime Contract under its Contractor Direct Agreement with the City or the Lenders' CC Direct Agreement or any agreement contemplated thereunder to replace the Prime Contract.

(b) If the Prime Contract is terminated due to any act, omission or default of the Subcontractor, this Subcontract shall be deemed to have been terminated as a result of a Subcontractor Event of Default for the purposes of Sub-Clause 16.1.3.

(c) If the Prime Contract is terminated due to any act, omission or default of the Construction Contractor, not being due to an act or omission of the Subcontractor, this Subcontract shall be deemed to have been terminated under this Sub-Clause 16.2.4 as a result of a Construction Contractor Event of Default.

(d) Notwithstanding paragraphs (b) and (c), if the Prime Contract is terminated due to a City Event of Default under the Project Agreement or to the persistence of an event of Force Majeure or a Relief Event or to the exercise of the City's right

to terminate the Project Agreement for convenience, this Subcontract shall be deemed to have been terminated and the provisions of Clause 9 will apply.

16.4 **Effect of Termination**

16.4.1 Termination

Notwithstanding any provision of this Subcontract, upon the service of a notice of termination or automatic termination on termination of the Prime Contract pursuant to Clause 16.3(a), this Clause 16.4 shall apply in respect of such termination.

16.4.2 Continued Effect – No Waiver

Notwithstanding any breach of this Subcontract by either Party, and without prejudice to any other rights which the other Party may have in relation to it, the other Party may elect to continue to treat this Subcontract as being in full force and effect and to enforce its rights under this Subcontract. The failure of either Party to exercise any right under this Project Agreement, including any right to terminate this Project Agreement and any right to claim damages, shall not be deemed to be a waiver of such right for any continuing or subsequent breach.

16.4.3 Continued Performance

Subject to any exercise by the Construction Contractor of its rights to perform, or to seek, pursuant to this Subcontract, a third party to perform, the obligations of the Subcontractor, the Parties will continue to perform their obligations under this Subcontract, notwithstanding the giving of any notice of default or notice of termination, until the termination of this Subcontract becomes effective in accordance with this Sub-Clause 16.4.

16.4.4 Effect of Notice of Termination or Automatic Termination

On the service of a notice of termination or upon automatic termination on termination of the Prime Contract pursuant to Clause 16.3(a):

(a) if termination is prior to the Revenue Service Availability Date, in so far as any transfer shall be necessary to fully and effectively transfer such property to the Construction Contractor, the Subcontractor shall transfer to, and there shall vest in, the Construction Contractor, free from all Encumbrances (other than the Title Encumbrances and any Encumbrances caused or consented to by the City), such part of the Subcontracted Works as shall have been constructed and, such items of the plant and equipment as shall have been procured by the Subcontractor, and, if the Construction Contractor so elects:

i. all plant, equipment and materials (other than those referred to in sub-paragraph (b) below) on or near to the Site shall remain available to the Construction Contractor for the purposes of completing the Works; and

ii. all construction, plant and equipment shall remain available to the Construction Contractor for the purposes of completing the Works, subject to payment by the Construction Contractor of the Subcontractor's reasonable charges;

(b) if termination is prior to the Revenue Service Availability Date, the Subcontractor shall deliver to the Construction Contractor (to the extent such items have not already been delivered to the Construction Contractor) one complete set of all Project Data and Drawings [relating to the Subcontracted Works;

(c) not used;

(d) subject to the rights and obligations set forth in Section 1.11 (Intellectual Property), the Construction Contractor will be entitled to retain all Subcontractor Intellectual Property and Third Party Intellectual Property that has been Delivered up to the Termination Date or that is Delivered pursuant to this Clause 16.6, which may thereafter be Used by the Construction Contract, Project Co and the City in accordance with the Licences granted herein;

(e) in so far as title shall not have already passed to the Construction Contractor, the Subcontractor shall hand over to, and there shall vest in, the Construction Contractor, free from all Encumbrances (other than the Title Encumbrances and any Encumbrances caused or consented to by the City), the System together with all other assets and rights capable of being transferred that are necessary for the performance of the Project and the activities within the Project Scope and all facilities and equipment including, notwithstanding that termination may occur prior to the Expiry Date, the verification and transfer of inventory as set forth in Appendix C (Expiry Date), Section 10.3 of the Maintenance and Rehabilitation Requirements (to the extent applicable to the Subcontracted Works), and to the extent that any such assets or rights are not capable of being transferred by the Subcontractor to the Construction Contractor, the Subcontractor shall enter into agreements or make other arrangements in order to permit the use of the assets or rights by the Construction Contractor, Project and the City in order to enable them, or their designated agents or subcontractors, to continue to perform the activities which would have otherwise been performed by the Subcontractor if this Subcontract had not been terminated;

(f) if the Construction Contractor so elects, the Subcontractor shall ensure that this Subcontract and any of the subcontracts between the Subcontractor and a subcontractor, and any other instrument entered into between the Construction Contractor and the Subcontractor for securing the performance by the Subcontractor in respect of the Project Scope or to protect the interests of the

Construction Contractor as well as any other instrument entered into between any such subcontractor and the Subcontractor for securing the performance by such subcontractor of its obligations in respect of the Project Scope or to protect the interests of the Subcontractor, shall be novated or assigned to the Construction Contractor or its nominee, provided that where termination occurs other than as a result of the termination of the Project Agreement due to a Project Co Event of Default, the consent of the Subcontractor or the subcontractor, as applicable, shall be required;

(g) the Subcontractor shall, or shall ensure that any Subcontractor Personnel shall, offer to sell (and if the Construction Contractor so elects, execute such sale) to the Construction Contractor at a fair value (determined as between a willing vendor and willing purchaser, with any Disputes as to such fair value being resolved in accordance with the Dispute Resolution Procedure), free from all Encumbrances (other than the Title Encumbrances and any Encumbrances caused or consented to by the City), all or any part of the stocks of material and other assets, road vehicles, construction equipment, spare parts and other moveable property owned by the Subcontractor or any Subcontractor Personnel and dedicated to or predominantly used in respect of the Highway, the System, and reasonably required by the Construction Contractor, Project Co or the City in connection with the operation of the Highway, the System or the performance of the Maintenance Services;

(h) the Subcontractor shall deliver to the Construction Contractor (to the extent such items have not already been delivered to the Construction Contractor) one complete set of:

i. the most recent As Built Drawings in the format that the Construction Contractor, acting reasonably, considers most appropriate at the time showing all alterations made to each Milestone since the relevant Milestone Acceptance Date; and

ii. the most recent maintenance, operation and training manuals for the System;

(i) the Subcontractor shall use commercially reasonable efforts to assign, or otherwise transfer, to the Construction Contractor, free from all Encumbrances (other than the Title Encumbrances and any Encumbrances caused or consented to by the City), the benefit of all manufacturers' warranties, including all documentation in respect thereof, in respect of mechanical and electrical and equipment used or made available by the Subcontractor under this Subcontract and included in the Highway and the System;

(j) the Subcontractor shall deliver to the Construction Contractor all information, reports, documents, records and the like referred to in Section 37 of the Project Agreement, including as referred to in Schedule 26 – Record Provisions of the Project Agreement, except where such are required by Applicable Law to be

retained by the Subcontractor or the Subcontractor's Personnel (in which case complete copies shall be delivered to the Construction Contractor); and

(k) the Subcontractor will return to the Construction Contractor all City Intellectual Property, Project Co Intellectual Property and Construction Contractor Intellectual Property and Confidential Information of the City, Project Co and the Construction Contractor; and

The Construction Contractor may direct that any transfers and assignments under this Sub-Clause 16.4.4 be made to Project Co, a new concessionaire, the City or other third party, as the case may be. Termination of this Subcontract shall be without prejudice to any accrued rights and obligations under this Subcontract as at the date of termination, and shall not affect any provision of this Subcontract which is expressed to survive termination or which is required to give effect to such termination or the consequences of such termination.

16.4.5 Ownership of Information

Subject to Clause 1.11, all information obtained by the Subcontractor, including the As-Built Drawings and other technical drawings and data, supplier agreements and contracts, utilities consumption information, environmental and technical reports, lease, licence and subletting data and contracts, asset condition data, standard operating procedures, processes and manuals and all other information directly related to the Project Scope accumulated over the course of the terms of this Subcontract shall be the property of the Construction Contractor and upon termination of this Subcontract shall be provided or returned to the Construction Contractor, as applicable, in electronic format acceptable to the Construction Contractor, acting reasonably, where it exists in electronic format, and in its original format, when not in electronic format.

16.4.6 Provision in Subcontracts

The Subcontractor shall make provision in all subcontracts to which it is a party (including requiring the relevant Subcontractor's Personnel to make such provision and to require other Subcontractor's Personnel to make such provision) to ensure that the Construction Contractor shall be in a position to exercise its rights, and the Subcontractor shall be in a position to perform its obligations, under this Sub-Clause 16.4.

1.6.4.7 Transitional Arrangements

On the termination of this Subcontract for any reason, for a reasonable period both before and after any such termination, the Subcontractor shall:

(l) Not Used

(m) as soon as practicable remove from the Site all property belonging to the Subcontractor or any Subcontract Personnel that is not acquired by the

Construction Contractor pursuant to Sub-Clause 16.4.4 or otherwise, in accordance with Sub-Clause 11.5;and

(n) forthwith deliver to the Construction Contractor's Representative:

i. all keys to, and any pass cards and other devices used to gain access to any part of the System; and

ii. to the extent transferable and in addition to and without prejudice to the Construction Contractor's rights pursuant to Clause 1.11, any copyright licences for any computer programs, or licences to use the same, used in connection with the operation of the System; and

(o) as soon as practicable vacate the Lands and leave the Site and the Subcontracted Works in a safe, clean and orderly condition.

16.4.8 Termination upon Aforesaid Transfer

On completion of the Subcontractor's obligations pursuant to this Clause 16.4, this Subcontract shall terminate and, except as provided in Clause 16.4.9, all rights and obligations of the Construction Contractor and the Subcontractor under this Subcontract shall cease and be of no further force and effect.

16.4.9 Survival

Except as otherwise provided in this Subcontract, termination of this Subcontract shall be without prejudice to, and shall not affect:

(a) all representations, warranties and indemnities under this Subcontract;

(b) Clauses 1.3, 1.4, 1.10, 1.11, 1.15, 4.26, 5.6, 7.8, 9, 12.4, 16.4, 16.5, 17, 19, 20, 21 and any other provisions of this Subcontract which are expressed to survive termination or which are required to interpret or give effect to such provisions which survive termination or to such termination or to the consequences of such termination, and any provisions of the Prime Contract or Project Agreement that are incorporated by reference into this Agreement and are stated to survive the termination of the Prime Contract or Project Agreement in Part 2 Section 48.9 of the Prime Contract or section 48.9 of the Project Agreement,

all of which shall survive the termination of this Subcontract.

16.5 Compensation on Termination

16.5.1 Subcontractor Default

If this Subcontract is terminated pursuant to Sub-Clause 16.1 as a result of a Subcontractor Event of Default, subject to the limits and exclusions of liability set out

herein, the Subcontractor shall indemnify the Construction Contractor against all Direct Losses suffered or incurred by the Construction Contractor as a result of such termination and/or the acts or omissions of the Subcontractor leading to such termination.

16.5.2 Construction Contractor Default

If this Subcontract is terminated as a result of a Construction Contractor Event of Default, the Construction Contractor shall pay to the Subcontractor the sum of:

(c) all amounts due and payable to the Subcontractor under this Subcontract prior to such termination, but unpaid;

(d) the actual and verifiable value of Subcontracted Works carried out by the Subcontractor prior to such termination but not yet certified as being complete; and

(e) the Direct Costs flowing from the termination including any reasonable supplier termination costs/penalties and verifiable demobilization costs and any redundancy payments,

but, in the case of a Project Co Event, only to the extent it receives such amounts from Project Co and in proportion to the claims of the Construction Contractor and other subcontractor to amounts received.

16.5.3 City Events of Default, other Project Agreement Termination, and/or Force Majeure

If this Subcontract is terminated due to a City Event of Default, due to the persistence of an event of Force Majeure or a Relief, or for the City's convenience, the Construction Contractor shall pay to the Subcontractor the sum of the amounts indicated in Sub-Clause 16.5.2, but only to the extent it receives such amounts (directly or indirectly) from the City and in proportion to the claims of the Construction Contractor and other subcontractor to the amounts received.

16.5.4 Full Settlement

Any and all amounts paid by a Party to the other Party under Sub-Clause 16.5 will be in full and final settlement of each Party's rights and claims against each other for termination of this Agreement and any Sub-subcontract, whether under contract, tort, restitution or otherwise, but without prejudice to:

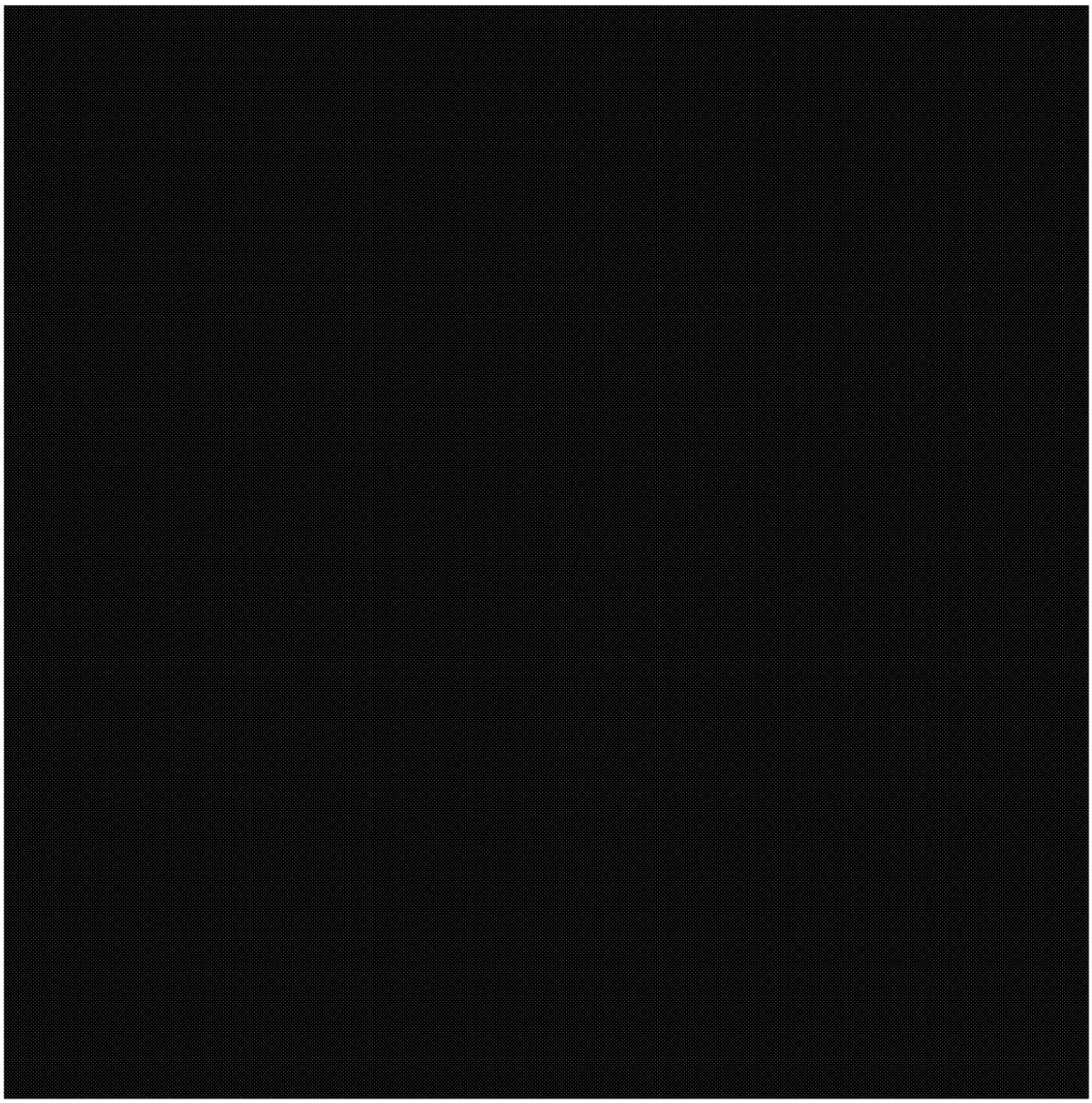
(a) any liability of either Party to the other, including under the indemnities in this Subcontract, that arose prior to the date of termination of this Subcontract (but not from the termination itself or the events leading to such termination) to the extent such liability has not already been taken into account in determining the Termination Payment;

(b) any liabilities arising under or in respect of any breach by either Party of their obligations under Clause 16.4.9 of this Subcontract, or the Clauses referred to therein, which did not lead to such termination and which arises or continues after the date of termination of this Subcontract.

17.0 LIABILITY AND RESPONSIBILITY

Any indemnity given under this Subcontract and any such indemnity shall not extend to Direct Losses which could have been reduced or avoided by the Beneficiary (as defined under Sub-Clause 17.3) complying with this Clause.

17.1 Subcontractor Indemnities to Construction Contractor



17.2 Construction Contractor's Indemnities to Subcontractor

17.3 Conduct of Claims

This Sub-Clause 17.3 shall apply to the conduct of claims made by a third person against a Party having, or claiming to have, the benefit of an indemnity pursuant subsections 17.1 and 17.2 of this Subcontract Agreement. The Party having, or claiming to have, the benefit of the indemnity is referred to as the "**Beneficiary**" and the Party giving the indemnity is referred to as the "**Indemnifier**".

(a) If the Beneficiary receives any notice, demand, letter or other document concerning any claim for which it appears that the Beneficiary is, or may become entitled to, indemnification under this Section 17.3 , the Beneficiary shall give written notice to the Indemnifier as soon as reasonably practicable and in any event within ten (10) Business Days of receipt of the same. Such notice shall specify with reasonable particularity, to the extent that information is available, the factual basis for the claim and the amount of the claim.

(b) Subject to Sub-Clauses 17.3(d), (e) and (f), on the giving of such notice by the Beneficiary, where it appears that the Beneficiary is or may be entitled to indemnification from the Indemnifier in respect of all, but not part only, of the liability arising out of the claim, the Indemnifier shall (subject to providing the Beneficiary with a secured indemnity to the Beneficiary's reasonable satisfaction against all costs and expenses that the Beneficiary may incur by reason of such action) be entitled to dispute the claim in the name of the Beneficiary at the Indemnifier's own expense and take conduct of any defence, dispute,

compromise, or appeal of the claim and of any incidental negotiations. The Beneficiary shall give the Indemnifier all reasonable cooperation, access and assistance for the purposes of considering and resisting such claim. The Beneficiary shall have the right to employ separate counsel in respect of such claim and the reasonable fees and expenses of such counsel shall be to the account of the Indemnifier only where representation of both the Indemnifier and Beneficiary by common counsel would be inappropriate due to any actual or potential conflicting interests between the Indemnifier and Beneficiary.

(c) With respect to any claim conducted by the Indemnifier:

(i) the Indemnifier shall keep the Beneficiary reasonably informed and consult with it about material elements of the conduct of the claim;

(ii) the Indemnifier shall not pay, compromise or settle such claims without the prior consent of the Beneficiary, such consent not to be unreasonably withheld or delayed;

(iii) the Indemnifier shall not admit liability or fault to any third party without the prior consent of the Beneficiary, such consent not to be unreasonably withheld or delayed; and

(iv) the Indemnifier shall use commercially reasonable efforts to have the Beneficiary named as a beneficiary under any release given by the persons bringing the claim to which this Sub-Clause 17.3 relates.

(d) The Beneficiary shall be free to pay or settle any such claim on such terms as it thinks fit and without prejudice to its rights and remedies under this Subcontract Agreement if:

(i) the Indemnifier is not entitled to take conduct of the claim in accordance with Sub-Clause 17.3(c);

(ii) the Indemnifier fails to notify the Beneficiary of its intention to take conduct of the relevant claim within twenty (20) Business Days of the notice from the Beneficiary under Sub-Clause 17.3(b) if the Beneficiary is the Construction Contractor, or if the Indemnifier notifies the Beneficiary that the Indemnifier does not intend to take conduct of the claim; or

(iii) the Indemnifier fails to comply in any material respect with Sub-Clause 17.3(d).

(e) If the Indemnifier pays to the Beneficiary an amount in respect of an indemnity and the Beneficiary subsequently recovers, whether by payment, discount, credit, saving, relief or other benefit or otherwise, a sum or anything else of value (the

"**Recovery Amount**") which is directly referable to the fact, matter, event or circumstances giving rise to the claim under the indemnity, the Beneficiary shall forthwith repay to the Indemnifier whichever is the lesser of:

(i) an amount equal to the Recovery Amount less any out-of-pocket costs and expenses properly incurred by the Beneficiary in recovering the same; and

(ii) the amount paid to the Beneficiary by the Indemnifier in respect of the claim under the relevant indemnity,

provided that there shall be no obligation on the Beneficiary to pursue any Recovery Amount and that the Indemnifier is repaid only to the extent that the Recovery Amount, aggregated with any sum recovered from the Indemnifier, exceeds the loss sustained by the Beneficiary except, however, that if the Beneficiary elects not to pursue a Recovery Amount, the Indemnifier shall be entitled to require an assignment to it of the right to do so.

Any person taking any of the steps contemplated by this Sub-Clause 17.3 shall comply with the requirements of any insurer who may have an obligation to provide an indemnity in respect of any liability arising under this Subcontract.

17.4 Subcontractor's Care of the Subcontracted Works

With the exception of the Construction Contractor and Project Co and any of their subcontractors or other contractors, or any party (in which the Subcontractor is not responsible for) caused damage to the Subcontracted Works, and the Construction Contractor's obligations for the security and safety of the work site, the Subcontractor shall take full responsibility for the care of the Subcontracted Works, Goods and Subcontractor's Design Data from the Commencement Date until the Taking-Over Certificate is issued (or is deemed to be issued under Sub-Clause 11.1 of this Subcontract) for the Subcontracted Works, when the responsibility for the care of the Subcontracted Works shall pass to the Construction Contractor. If a Taking-Over Certificate is issued (or is so deemed to be issued) for any Section of the Subcontracted Works, responsibility for the care of the Section shall then pass to the Construction Contractor.

After the Taking-Over Certificate is issued, the Subcontractor shall remain responsible for the care of the Subcontracted Works, Goods and Subcontractor's Design Data but only in respect of any mutually agreed to Punch List Items stated in a Taking-Over Certificate or any Defects notified and attributable to the Subcontractor, until the work on the Punch List Items or the correction of Defects, as applicable, has been completed and accepted by the Construction Contractor, and in respect of any Subcontracted Works, Goods and Subcontractor's Documents that are actually in the custody of the Subcontractor.

For loss or damage to the Subcontracted Works, Goods or Subcontractor's Design Data for which the Subcontractor is responsible under this Subcontract, and which loss or damage was caused by the Subcontractor or a party (in which the Subcontractor is responsible for) the Subcontractor shall rectify the loss or damage at the Subcontractor's risk and cost, so that the Subcontracted Works, Goods and Subcontractor's Design Data conform with the Subcontract requirements. In this regard, the Subcontractor will develop and submit, or provide necessary assistance to the Construction Contractor in the development of, any Reinstatement Plan required under the Project Agreement and must not commence any work to rectify the loss or damage until the City Representative consents thereto in accordance with Schedule 10 – Review Procedure except to the extent necessary to address any emergency or public safety needs. In respect of loss or damage to the Subcontracted Works, Goods or Subcontractor's Design Data for which the Subcontractor is responsible for under this Subcontract, the Subcontractor will comply with any Reinstatement Plan consented to by the City Representative.

17.5 **Not Used**

17.6 **Limitation of Liability**

(a) The total cumulative, aggregate liability of the Subcontractor to the Construction Contractor, under or in connection with the Subcontract, including liability under any indemnity, shall not exceed [redacted], as may be adjusted in accordance with this Subcontract:

The limitations of liability in this Clause 17.6 shall not apply to, nor shall the calculation thereof include:

(i)

(i) the amount thereof is paid from the proceeds of insurance maintained by the City, Project Co or the Construction Contractor or maintained or required to be maintained by the Subcontractor under this Subcontract; or

(ii) the amount is paid by the Subcontractor and subsequently recovered by the Subcontractor from any insurance proceeds; or

(iii) the amount is paid by the Subcontractor and subsequently recovered by the Subcontractor from the City or any third party (other than an entity providing insurance); or

(iv) the same would have been recovered through insurance if the Subcontractor had maintained the coverage required to be maintained by it under this Subcontract or if the Subcontractor had otherwise complied with its obligations under applicable insurance policies and diligently pursued the relevant insurance claim;

provided that, to the extent that amounts are recoverable by the Subcontractor through insurance with respect to a liability or obligation of the Subcontractor to

the Construction Contractor, but such insurance proceeds have not actually been recovered by the Subcontractor as at the date that a claim of the Construction Contractor is finally determined, the Subcontractor shall, at the request of Construction Contractor, assign to Construction Contractor all rights to receive such insurance proceeds.

(ii) liabilities that arise out of abandonment (other than as a termination or suspension of the Agreement as a consequence of a Construction Contractor Event of Default); or

(iii) gross negligence, wilful misconduct or fraud of the Subcontractor or any Subcontractor Personnel; or

(iv) fines or statutory penalties paid by Construction Contractor as a result of Subcontractor's failure to perform its obligations under the Subcontract in accordance with Applicable Law applicable to Subcontractor; or

(v) any amount paid to Construction Contractor by the Subcontractor as a result of a breach of this Agreement, to the extent that Subcontractor recovers such amounts from the Maintenance Contractor and to the extent that such amounts exceed Subcontractor's recovery of any losses or other damages suffered by Subcontractor; or

(vi) liabilities that arise out of Third Party claims to the extent caused by:

i. Subcontractor's breach its obligations under this Agreement;

ii. Subcontractor's negligent acts or omissions; and/or

iii. the wilful misconduct of the Subcontractor.

including, without limitation, any third party claims for any damage or destruction of property, death or personal injury.

17.7 **Indirect Losses**

Neither Party shall be liable to the other party for Indirect Losses suffered by the other Party in connection with the Subcontract.

18.0 INSURANCE

The parties will conform to the insurance requirements set out in Schedule K.

19.0 MITIGATION

Each Party will take all commercially reasonable steps to mitigate the consequences of any right it may have against the other Party under the provisions of this Subcontract

For greater certainty, this Clause applies to any indemnity given under this Subcontract and any such indemnity shall not extend to Direct Losses which could have been reduced or avoided by the Beneficiary (as defined under Sub-Clause 17.3) complying with this Clause.

20.0 DISPUTE RESOLUTION PROCEDURE

The Dispute Resolution Procedures are set out in Schedule I.

21.0 NOTICES

Addresses for Notice Purposes

Notices pursuant to Sub-Clause 1.3 shall be addressed as follows:

If to the Construction Contractor:

OLRT Constructors
c/o SNC-Lavalin Constructors (Pacific) Inc.
195 The West Mall
Toronto, Ontario
M9C 5L5
Attention: David Whyte
Fax: 416.231.5356
Email: David.Whyte@snclavalin.com

And to:

EllisDon Corporation
89 Queensway Avenue West, Suite 800
Mississauga, Ontario L5B 2V2
Attention: VP, Civil Division
Fax: 905.896.8911

And to:

EllisDon Corporation
2680 Queensview Drive
Ottawa, Ontario K2B 8J9
Attention: Mark Fazio
Fax: 613.565.9267
Email: mfazio@ellisdon.com

If to the Subcontractor:

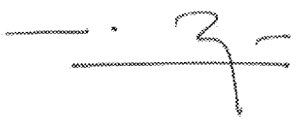
Thales Canada Inc., coba Thales Canada, Transportation Solutions
105 Moatfield Drive
Toronto, Ontario
Attention: Daniel Marion, Vice-President and General Counsel
Fax: 416.742.4493
Email: Daniel.marion@thalesgroup.com

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written in accordance with their respective Laws.

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:



Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA TRANSPORTATION SOLUTIONS

Per:

Name:
Title:

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written in accordance with their respective Laws.

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Per:

Name:
Title:

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA TRANSPORTATION SOLUTIONS
Per:

Name:
Title:

Per:

Name:
Title:

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written in accordance with their respective Laws.

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name: REN AITKEN
Title: VP

Per:

Name: KEVIN LEMAY
Title: VP

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA TRANSPORTATION SOLUTIONS
Per:

Name:
Title:

Per:

Name:
Title:

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written in accordance with their respective Laws.

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

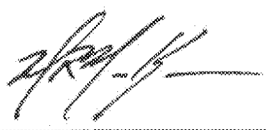
Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA TRANSPORTATION SOLUTIONS

Per:



Name: Michael Mackenzie
Title: COO

SCHEDULE A

LIST OF SCHEDULES

SCHEDULE B

SUBCONTRACT PRICE AND PAYMENT MILESTONES

SCHEDULE C

NOT USED

SCHEDULE D

PERFORMANCE SECURITY – WARRANTY PERFORMANCE SECURITY

SCHEDULE E

OPTION AGREEMENT

SCHEDULE F

NOT USED

SCHEDULE G

NOT USED

SCHEDULE H

TIME FOR COMPLETION, TIME PROGRAMME

SCHEDULE I

DISPUTE RESOLUTION PROCEDURE

SCHEDULE J

NOT USED

SCHEDULE K

INSURANCE

SCHEDULE L

NOT USED

SCHEDULE M

CBTC SYSTEM SPECIFICATION

SCHEDULE N

THALES – ALSTOM
SCOPE SPLIT

SUBCONTRACT		
Schedule No.	*Description*	
Schedule A	List of Schedules	
Schedule B	Subcontract Price and Payment Milestones	
Schedule C	Not used	
Schedule D	Performance Security	
Schedule E	Option Agreement	
Schedule F	Not used	
Schedule G	Not used	
Schedule H	Time for Completion, Time Programme	
Schedule I	Dispute Resolution Procedure	
Schedule J	Not used	
Schedule K	Insurance	
Schedule L	Not used	
Schedule M	CBTC System Specification	
Schedule N	Thales-Alstom Scope Split	
Attachment B	Subcontractor Technical and Program Conditions	
Appendix I	Subcontractor Technical Exceptions and Deviations Rev03 2012-09-28	
	PROJECT AGREEMENT	
Schedule No.	Description	Qualification
Schedule 1	Definitions and Interpretation	

Schedule 5	Direct Agreements	Termination of CC not effective unless effective against City in accordance with this Schedule; liability where City exercises its rights under Schedule 5 due to Subcontractor
Schedule 6	Independent Certifier Agreement	Acknowledge role of IC; cooperate and provide access to allow IC to perform functions
Schedule 8	Energy Matters	Subcontractor responsible for inputs, not model
Schedule 10	Review Procedure	
Schedule 11	Quality Management	In particular, the following clauses: • Clauses 2.3, 2.4 a) i, ii and iv, 2.5 c) and d) i E; • Clause 4; • 5.3, 5.4, 5.5, 5.6, 5.7; • Clause 6; and • Clause 7
Schedule 14	Commissioning	
Schedule 15	Output Specifications	subject to the Schedules 15-1, 15-2, 15-2 Part 1, 15-2 Part 4, 15-2 Part 6, and 15-4, and any applicable qualification in the Subcontract
Schedule 15-1	Technical Definitions and Reference Documents	
Schedule 15-2	Design and Construction General Requirements	
Schedule 15-2 Part 1	Design and Construction General Requirements	
Schedule 15-2 Part 4	Design and Construction Requirements – Vehicles and Systems	
Schedule 15-2 Part 6	Design and Construction Requirements - MSF	
Schedule 15-4	Regulatory Standards	
Schedule 16	Title Encumbrances	Definitions only

Schedule 17	Environmental Obligations	Only to the extent identified in the Subcontract (eg, Contamination for which Subcontractor is responsible), and as flowed down through CC Att 17; Appendices A and B incorporated by reference in to CC Attachment 17; see Blackline of CC Att 17 to PA Sch 17
Schedule 18	Communications and Public Consultation Protocol	Subcontractor responsible for compliance with protocol and for providing relevant information
Schedule 22	Variation Procedure	applies to Variations coming from the City, only as flowed down under CC Att 22; see blackline of CC Att 22 to PA Sch 22
Schedule 23	Compensation on Termination	definition of compensation on termination for certain events of default
Schedule 27	Dispute Resolution Procedure	Applies to Disputes under the PA applicable to Subcontractor's scope
Schedule 30	Insurance Trust Agreement	Reasonable assistance to allow Project Co to comply with its obligations; acknowledgement that this agreement places certain restrictions on the use and availability of Insurance Proceeds (as defined therein)
Schedule 33	Works Reports	
Schedule 35	Additional Vehicles	Applicable to Option Agreement
Schedule 38	Extension and Additional Phases	Referred to in CC Attachment 38; see blackline of CC Att 38 to PA Sch 38
Schedule 39	Operations Matters	Read with CC Attachment 39; Subcontractor responsible for inputs, not model
Schedule 41	Intellectual Property	IP obligations are flowed down through CC Attachment 41; see blackline of CC

		Att 41 to PA Sch 41
	CONSTRUCTION CONTRACT	
Attachment No.	Description	
Attachment 1	CC Definitions and Interpretation	Defines additional terms used in Prime Contract
Attachment 4	Lenders' CC Direct Agreement	Termination of CC not effective unless in accordance with this Attachment; liability where Lenders exercise their rights under CC Attachment 4 due to Subcontractor
Attachment 17	CC Environmental Obligations	Only to the extent identified in the Subcontract (eg, Contamination for which Subcontractor is responsible); flow-down of obligations from PA Schedule 17
Attachment 18	CC Communications and Consultation Protocol	
Attachment 22	CC Variation Procedure	Applies to Variations from Project Co and flows down Variations from City
Attachment 26	CC Record Provisions	
Attachment 27	CC Dispute Resolution Procedure	Applies to Disputes under Construction Contract applicable to Subcontractor's scope
Attachment 35	CC Additional Vehicles	Applicable to Option Agreement
Attachment 38	CC Extension and Additional Phases	Reasonable assistance; compliance with applicable obligations where Subcontract agrees to submit a proposal for inclusion in a CC Extension Proposal
Attachment 39	CC Operations Matters	Subcontractor responsible for its inputs, but not model

Attachment 41	CC Intellectual Property	Flow-down of obligations set out in Schedule 41

SCHEDULE B
Subcontract Price and Payment Milestones

The Subcontract Price is expressed in Canadian dollars. The Subcontract Price is firm and all-inclusive and represents the complete cost to the Construction Contractor for the base Subcontracted Works.

ITEM NO.	ESTIMATED QUANTITY	DESCRIPTION	UNIT	UNIT PRICES	TOTAL
1.0	1 lot	Design, supply, manufacture, inspection, testing, commissioning, packaging, delivery DDP Project Site, in accordance with INCOTERMS 2010, and all other associated Subcontracted Works required for supply of a Train Control System as follows:			
1.1	1 lot	CBTC Central and Wayside Equipment for Mainline	Lump Sum	$	[redacted]
1.2	1 lot	Central and Wayside Equipment for Yard	Lump Sum	$	
1.3	34	Complete Vehicle On-board Equipment Package	each	$	
1.4	1 lot	Fixed Block Train Detection System (including Signals and indicators) Equipment	Lump Sum	$	
1.5	1 lot	Broken Rail Detection System Equipment (if different from 1.4)	Lump Sum	$	
1.6	1 lot	Demonstration of onboard CBTC – Vehicle Interfaces at Vehicle Supplier's Test Track	Lump Sum	$	
1.7	1 lot	Installation Supervision of Train Control System Equipment as per Scope Split	Lump Sum	$	
1.8	1	Dynamic PICO of Complete Vehicle On-board Equipment Package	Lump Sum	$	
1.9	1	Project Management and Engineering	Lump Sum	$	
1.10	1	Final Testing and Commissioning in Ottawa, ON	Lump Sum	$	
1.11	1	Operation and Maintenance Manuals	Lump Sum	$	
1.12	1	Training in Ottawa	Lump Sum	$	
	1	Recommended Spare Parts for 2 Years Operation			
1.13	1	Special Tools and Test Equipment	Lot	$	
1.14	1	Cost of [redacted]% Letter of Credit	Lump Sum	$	
1.15	1	Cost o[redacted]% Letter of Credit	Lump Sum	$	
1.16	1	Export Packaging and DDP Project Site in Ottawa	Lump Sum	$	
1.17	1	All applicable Canadian Taxes	Lump Sum	$	
1.18	1	Others, if any (Details)	Lump Sum	$	
		TOTAL BASE SUBCONTRACT PRICE IN CANADIAN DOLLARS:			

SCHEDULE B
Subcontract Price and Payment Milestones

OPTION PRICING					
ITEM NO.	**ESTIMATED QUANTITY**	**DESCRIPTION**	**UNIT**	**UNIT PRICES**	**TOTAL**
		Option A			
2		Unit price to provide additional Complete Vehicle On-board Equipment Package, as may be ordered by the City pursuant to OLRT PA Schedule 35. The unit price includes Dynamic PICO, is valid for seven (7) years after Financial Close and is subject to escalation for the final two (2) years of that period, with the escalation base period of Feb 2016.	each	$[redacted]	$ N/A
		Option B			
3	1	Provision of Automatic (Unattended) Coupling and Uncoupling	Lump Sum	$	Included in base proposal price.
		Option C			
4	1	Simulation Training and Testing System	Lump Sum	$	Included in base proposal price.

Escalation Formula:

Adjusted Invoice Amount (in CAD) at Invoice Date ($Month_n$) = Invoice Amount per Milestone Payment Plan + Invoice Escalation from $Month_0$ to n

Where:

Invoice Escalation from $Month_0$ to n =

[Invoice Amount per Milestone Payment Plan] x

[redacted]% x the percentage change in Average Weekly Earnings; Professional Industry in Canadian Economic Observer, Reference # v1597126, from $Month_0$ to $Month_n$

[redacted]% x the percentage change in the Industry Product Price Index; Electrical Products Industries (2002 = 100) (Canadian Economic Observer, Reference # v53384935), from $Month_0$ to $Month_n$]

Notes:

1. Base Month ($Year_0$) = March, 2013
2. In the event Statistics Canada discontinues determining the indices cited herein, the parties shall mutually agree upon the appropriate substitute for the discontinued indices

SCHEDULE B
Subcontract Price and Payment Milestones

Schedule of Milestone Payments:

Applications for Interim Payments by the Subcontractor under the Subcontract shall be as follows:

Milestone #	Milestone Description	% of Base Subcontract Price
1	Mobilization (subject to Subcontractor contract being effective)	[redacted] %
2	SDR accepted by Sponsors (incl. System Design doc/drawings, Stakeholders Requirements Analysis, Quality plan, RAMS Plan, Safety Plan, Verification & Validation Plan, Config Control Plan, Schedule etc)	[redacted]
3	PDR accepted by Sponsors (incl. Preliminary design documents/drawings, Subsystem req. Analysis, Training Plan, Test plan, EMC/EMI plan, Prelim Hazard Log, prelim Rams Analysis ,etc)	[redacted]
4	FDR accepted by Sponsors (incl. Final design docs/drawings, Test Procedures, Operations & Maintenance Manuals, Training Courses, Installation docs/drawings, Final Hazard Log, Rams Analysis, FMECA etc)	[redacted]
5	All First Article Inspections, Qualification Test results, Factory Acceptance Test results accepted by Sponsors	[redacted] %
6	MSF & Yard equipment installation and Post Installation Check- Out (PICO) accepted by Sponsors	[redacted] %
7	Yard Train Control T&C accepted by Sponsors	[redacted] %
8	Prototype Vehicle train Control T&C accepted by Sponsors	[redacted] %
9	Training Complete and all equipment, incl. Spares & Special Tools accepted by Sponsors	[redacted]
10	Mainline equipment installation and PICO accepted by Sponsors	[redacted] %
11	Mainline Train Control T&C accepted by Sponsors	[redacted] %
12	System Integration accepted by Sponsors	[redacted] %
13	Contract Milestone "Revenue Service Availability" Achieved	[redacted] %
14	System RAMS Demonstration Accepted by Sponsors	[redacted] %
Total		[redacted] %

In case the Construction Contractor decides to holdback the payment of milestones 13 and 14 beyond 30 days from the date the milestone is achieved until 45 days after RSA, the estimated compensation is established at :

- Milestone 13. [redacted] $ if this milestone is achieved by the Subcontractor on February 27, 2018.
- Milestone 14 [redacted] $ if this milestone is achieved by the Subcontractor by May 24, 2018.

[date]

To: *[beneficiary's legal name and address]*

From: *[issuing bank's name and address or confirming bank adding its confirmation]*

Subject: Irrevocable Standby Letter of Credit – Performance number *[#]*

WHEREAS *[applicant's legal name]* having its head office at *[applicant's address]* (hereinafter referred to as the "Applicant"), has signed a *contract* bearing the date of *[date]* and reference number *[#]* with *[beneficiary's legal name]* having its business address at *[beneficiary's address]* (hereinafter referred to as the "Beneficiary"), for *[short description, purpose of contract]* (hereinafter referred to as the "Contract");

WHEREAS under article number 4.2 of the Contract, the Applicant is required to provide to the Beneficiary an irrevocable standby letter of credit – performance, as per the format specified in the Contract, in the amount of [ ] Dollars ($] CDN) to guarantee the performance of all of its obligations under the Contract;

We, *[issuing bank's name]* having our business address at *[issuing bank's address]* (hereinafter referred to as the "Bank"), agree to act as a guarantor on behalf of the Applicant, and hereby issue in favor of the Beneficiary our irrevocable standby letter of credit - performance in the amount of [ ] Dollars ($[3,] CDN), (hereinafter referred to as the "Credit").

We hereby irrevocably and unconditionally undertake to pay to the Beneficiary at sight, without protest or notification, and without inquiring any further proof, and without consideration for any objections or protests which the Applicant or any third party may make, any sum or sums not exceeding the aggregate sum of [t] Dollars ($[3,] CDN), free of all imposts, taxes, duties, charges, fees, withholdings and/or deductions whatsoever both present and future, of any nature whatsoever and by whomsoever imposed, and without set-off or counterclaim, upon presentation to the Bank of a demand against this Credit, provided the demand is in the form set out in Exhibit **"A"** hereto, which forms an integral part of this Credit, and that such demand is made no later than on the *[date]* (hereinafter referred to as the "Expiry Date") or any New Expiry Date or Final Expiry Date (as defined below).

This Credit shall be automatically extended for one (1) year periods from the Expiry Date or

from any subsequent expiry date (hereinafter referred to as "New Expiry Date") successively, unless the Bank sends by express courier to the Beneficiary with a copy to the Applicant at the above-mentioned addresses, a written notice at least sixty (60) days prior to the Expiry Date or a New Expiry Date, stating that the Bank elects not to extend this Credit for any such additional period. In the event the Bank elects not to extend the Expiry Date or any New Expiry Date of this Credit, then the Bank hereby unconditionally and irrevocably undertakes to pay to the Beneficiary the total amount then outstanding under this Credit upon presentation to the Bank by the Beneficiary, prior to the Expiry Date or the New Expiry Date, excluding the Final Expiry Date mentioned herein, of a demand for payment stating that the Bank has elected not to extend this Credit and that the Beneficiary is therefore entitled to such payment, provided the demand is in the form set out in Exhibit **"B"** attached hereto signed by two (2) of Beneficiary's authorized officers, which forms an integral part of this Credit.

Notwithstanding the foregoing, in no event will this Credit extend beyond [*date*] (hereinafter referred to as the "Final Expiry Date").

The terms of this Credit set forth in full the terms of our undertaking and this undertaking is not in any way modified, amended or amplified by reference to any document, instrument referred to in this Credit, or in which this Credit is referred to, or to which this Credit is related, and any such reference does not incorporate by reference any document, instrument or agreement.

Partial drawings are authorized. All costs related to this Credit are for the account of the Applicant including confirmation charges if applicable.

The language to be used, related to this Credit, is English.

This Credit is subject to the Uniform Customs and Practice for Documentary Credits (2007 Revision) of the International Chamber of Commerce, Publication Number 600 (hereinafter referred to as the "Publication") and for matters not covered by the Publication, it shall be governed by and interpreted in accordance with the laws of the province of Ontario and Canada applicable therein.

NAME OF BANK

*per:*_____

*Signature:*_____

*Signature:*_____

EXHIBIT "A"

This is the form of demand specified in Irrevocable Standby Letter of Credit – Performance number *[#]* issued on the *[date]*, by *[name of the issuing bank]*

" *[date]*

To: *[issuing bank's name and address or confirming bank]*

_____

_____

From: *[name & address of the Beneficiary]*

_____

_____

Subject: This is the demand specified in Irrevocable Standby Letter of Credit – Performance number *[#]* issued on the *[date]*, by *[name of the issuing bank]*

Dear Sirs,

We, the undersigned, being the Beneficiary under the above captioned Irrevocable Standby Letter of Credit - Performance issued by *[issuing bank's name and address]* on the instructions of *[applicant's name]* (the "Applicant"), hereby request the Bank to pay to the Beneficiary on receipt by the Bank of the present demand the amount of *[currency and amount in figures and letters]*.

We state and declare:

that the Applicant is in breach of performing its obligation(s) under *[contract OR purchase order OR agreement]* number *[#]* (the "Contract");
and

that as a result thereof, we have become entitled under the terms of the Contract to be paid the amount claimed above;
and

that said amount has not otherwise been paid to us, whether directly or indirectly, by or on behalf of the Applicant.

(Beneficiary's name)
(*name of signatory*)

_____
(*signature*) "

EXHIBIT "B"

" Date *[date]*

To: *[issuing bank's name and address]*
_____
_____

From: *[beneficiary's, name and address]*
_____
_____

Subject: This is the form of demand specified in Irrevocable Standby Letter of Credit number *[#]* issued on the *[date]*, by *[name of the issuing bank]*

Dear Sirs,

We, the undersigned, being the Beneficiary under the above captioned Irrevocable Standby Letter of Credit issued by *[issuing bank's name and address]* on the instructions of *[applicant's name]* (the Applicant), hereby request you to pay to us on receipt by you of the present demand the amount of *[currency and amount in figures and letters]* only.

We state and declare:

that the Beneficiary and the Applicant have been notified by the Bank of its election not to extend the Credit; and

that thirty (30) days has elapsed since the Bank notice has been received by the Beneficiary and the Applicant and as of the date of the present demand for payment the Applicant has not provided the Beneficiary with a substitute Irrevocable Standby Letter of Credit or alternate satisfactory security.

[beneficiary's, name and address]

per: _____ per: _____
Name:_____ Name:_____
Title: _____ Title: _____"

[date]

To: *[SNC-L, beneficiary's legal name and address]*

From: *[issuing bank's name and address or confirming bank adding its confirmation]*

Subject: Irrevocable Standby Letter of Credit – Performance number *[#]*

WHEREAS *[applicant's legal name]* having its head office at *[applicant's address]* (hereinafter referred to as the "Applicant"), has signed a *[contract OR purchase order OR agreement]* bearing the date of *[date]* and reference number *[#]* with *[SNC-L, beneficiary's legal name]* having its business address at *[beneficiary's address]* (hereinafter referred to as the "Beneficiary"), for *[short description, purpose of contract]* (hereinafter referred to as the "Contract");

WHEREAS under article number *[#]* of the Contract, the Applicant is required to provide to the Beneficiary an irrevocable standby letter of credit – warranty performance, as per the format specified in the Contract, in the amount of *[currency and amount in figures and letters]* to guarantee the performance of all of its obligations under the Contract for the General Warranty Period;

We, *[issuing bank's name]* having our business address at *[issuing bank's address]* (hereinafter referred to as the "Bank"), agree to act as a guarantor on behalf of the Applicant, and hereby issue in favor of the Beneficiary our irrevocable standby letter of credit – warranty performance in the amount of *[currency and amount in figures and letters]* (hereinafter referred to as the "Credit").

We hereby irrevocably and unconditionally undertake to pay to the Beneficiary at sight, without protest or notification, and without inquiring any further proof, and without consideration for any objections or protests which the Applicant or any third party may make, any sum or sums not exceeding the aggregate sum of *[currency and amount in figures and letters]*, free of all imposts, taxes, duties, charges, fees, withholdings and/or deductions whatsoever both present and future, of any nature whatsoever and by whomsoever imposed, and without set-off or counterclaim, upon presentation to the Bank of a demand against this Credit, provided the demand is in the form set out in Exhibit **"A"** hereto, which forms an integral part of this Credit, and that such demand is made no later than on the *[date]* (hereinafter referred to as the "Expiry Date") or any New Expiry Date (as defined below).

This Credit shall be automatically extended for one (1) year periods from the Expiry Date or

from any subsequent expiry date (hereinafter referred to as "New Expiry Date") successively, unless the Bank sends by express courier to the Beneficiary with a copy to the Applicant at the above-mentioned addresses, a written notice at least sixty (60) days prior to the Expiry Date or a New Expiry Date, stating that the Bank elects not to extend this Credit for any such additional period. In the event the Bank elects not to extend the Expiry Date or any New Expiry Date of this Credit, then the Bank hereby unconditionally and irrevocably undertakes to pay to the Beneficiary the total amount then outstanding under this Credit upon presentation to the Bank by the Beneficiary, prior to the Expiry Date or the New Expiry Date, excluding the Final Expiry Date mentioned herein, of a demand for payment stating that the Bank has elected not to extend this Credit and that the Beneficiary is therefore entitled to such payment, provided the demand is in the form set out in Exhibit **"B"** attached hereto signed by two (2) of Beneficiary's authorized officers, which forms an integral part of this Credit.

Notwithstanding the foregoing, in no event will this Credit extend beyond [*date*] (hereinafter referred to as the "Final Expiry Date").

This Credit shall become effective upon the Bank receipt of a notification from the Beneficiary or the Applicant confirming that the Applicant has received the Taking Over Certificate from the Beneficiary.

The terms of this Credit set forth in full the terms of our undertaking and this undertaking is not in any way modified, amended or amplified by reference to any document, instrument referred to in this Credit, or in which this Credit is referred to, or to which this Credit is related, and any such reference does not incorporate by reference any document, instrument or agreement.

Partial drawings are authorized. All costs related to this Credit are for the account of the Applicant including confirmation charges if applicable.

The language to be used, related to this Credit, is English.

This Credit is subject to the Uniform Customs and Practice for Documentary Credits (2007 Revision) of the International Chamber of Commerce, Publication Number 600 (hereinafter referred to as the "Publication") and for matters not covered by the Publication, it shall be governed by and interpreted in accordance with the laws of the province of Ontario and Canada applicable therein.

NAME OF BANK

per: _____

Signature: _____

Signature: _____

EXHIBIT "A"

This is the form of demand specified in Irrevocable Standby Letter of Credit – Warranty Performance number *[#]* issued on the *[date]*, by *[name of the issuing bank]*

" *[date]*

To: *[issuing bank's name and address or confirming bank]*

_____

_____

From: *[name & address of the Beneficiary]*

_____

_____

Subject: This is the demand specified in Irrevocable Standby Letter of Credit – Warranty Performance number *[#]* issued on the *[date]*, by *[name of the issuing bank]*

Dear Sirs,

We, the undersigned, being the Beneficiary under the above captioned Irrevocable Standby Letter of Credit – Warranty Performance issued by *[issuing bank's name and address]* on the instructions of *[applicant's name)* (the "Applicant"), hereby request the Bank to pay to the Beneficiary on receipt by the Bank of the present demand the amount of *[currency and amount in figures and letters]*.

We state and declare:

that the Applicant is in breach of performing its obligation(s) under *[contract OR purchase order OR agreement]* number *[#]* (the "Contract") *for the General Warranty Period*;
and

that as a result thereof, we have become entitled under the terms of the Contract to be paid the amount claimed above;
and

that said amount has not otherwise been paid to us, whether directly or indirectly, by or on behalf of the Applicant.

(Beneficiary's name)
(*name of signatory*)

_____
(*signature)* "

EXHIBIT "B"

" Date *[date]*

To: *[issuing bank's name and address]*
_____
_____

From: *[beneficiary's, name and address]*
_____
_____

Subject: This is the form of demand specified in Irrevocable Standby Letter of Credit – Warranty Performance number *[#]* issued on the *[date]*, by *[name of the issuing bank]*

Dear Sirs,

We, the undersigned, being the Beneficiary under the above captioned Irrevocable Standby Letter of Credit issued by *[issuing bank's name and address]* on the instructions of *[applicant's name)* (the Applicant), hereby request you to pay to us on receipt by you of the present demand the amount of *[currency and amount in figures and letters]* only.

We state and declare:

that the Beneficiary and the Applicant have been notified by the Bank of its election not to extend the Credit; and

that thirty (30) days has elapsed since the Bank notice has been received by the Beneficiary and the Applicant and as of the date of the present demand for payment the Applicant has not provided the Beneficiary with a substitute Irrevocable Standby Letter of Credit or alternate satisfactory security.

[beneficiary's, name and address]

per: _____ per: _____
Name:_____ Name:_____
Title: _____ Title: _____"

Schedule E – Option Agreement

Additional Complete Vehicle Onboard Equipment Packages Agreement

This Additional Complete Vehicle Onboard Equipment Packages Agreement (the "Option Agreement") is made as of this 12 day of February, 2013

BETWEEN

OLRT CONSTRUCTORS, an unincorporated joint venture, comprising **SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.**, **DRAGADOS CANADA, INC.** and **ELLISDON CORPORATION**, and having an office at 195 The West Mall, Toronto, Ontario M9C 5L5 (hereinafter called the "**Construction Contractor**") of the one part; and

THALES CANADA INC. coba THALES CANADA, TRANSPORTATION SOLUTIONS having its registered office at 105 Moatfield Drive, Toronto, Ontario M3B 0A4 CANADA (hereinafter called the "**Subcontractor**") of the other part

(the Construction Constructor together with the Subcontractor , the "Parties" and, individually any one of them, a "Party")

In consideration of the execution of an agreement between the Subcontractor with the Construction Contractor for the supply of automatic train control systems for the Project (the "**CBTC Supply Agreement**"), OLRT Project Subcontract No 507528-P002A, and other good and valuable consideration, the receipt of which is hereby acknowledged and confirmed, Thales agrees to abide by the terms of this Option Agreement as set forth below.

1. All capitalized terms not defined in this Option Agreement will have the meaning ascribed thereto in the CBTC Supply Agreement. In the case of any inconsistency, the meaning ascribed in the CBTC Supply Agreement will take precedence.

Additional Complete Vehicle Onboard Equipment Packages

2. The Construction Contractor and the Subcontractor agree that during the Option Term, the Construction Contractor shall have the option to purchase from Thales (the "**Option**") additional complete vehicle onboard equipment packages ("**Additional CBTC Packages**") at the fixed unit price described as Option A in Schedule B – Subcontractor Price and Payment Milestones of the CBTC Supply Agreement. The fixed unit price includes Dynamic PICO, which price is valid for any Order issued within seven (7) years after the Financial Close date and is subject to escalation for the final two (2) years of that period, with the escalation base period of Feb 2016. The Escalation Formula is as specified in Schedule B – Subcontractor Price and Payment Milestones of the CBTC Supply Agreement.

3. The Option shall be exercised by written notice (the "**Order**") given by the Construction Contractor to the Subcontractor and will specify, among others, the number of Additional CBTC Packages that the Construction Contractor wishes to purchase and the delivery date.

Terms & Conditions for the Order

4. Subject to the provisions of this Section 4, the terms and conditions that will apply to each Order shall be in accordance with the applicable terms of the CBTC Supply Agreement and the provisions of Schedule 35 of the Project Agreement (only if and to the extent applicable to this Option Agreement for the Additional CBTC Packages).

Price and Payment

a. The price of each Additional CBTC Package per Additional Vehicle will be described as Option A in Schedule B – Subcontractor Price and Payment Milestones of the CBTC Supply Agreement.

b. The Construction Contractor shall, for the Additional CBTC Packages under an Order, make payment of the aforementioned price as per the following milestones:

[redacted]% on placement of order
% on delivery of Additional CBTC Packages
% on issuance of an acceptance certificate by the Construction Contractor, which shall issued within 30 days of receipt of a safety certificate from Thales that is satisfactory to Construction Contractor (acting reasonably)

Delivery Terms

- Delivery Duty Paid (DDP) Ottawa in accordance with INCOTERMS 2010

- Delivery will be 18 months from Subcontractor's receipt of order and not before the completion of the deliveries of all thirty four (34) VOBC's of the CBTC Supply Agreement

- Dynamic PICO/VOBC Safety validation completion would be 1 month after the completed train is made available for Thales CBTC testing

- Construction Contractor shall make train equipped with VOBCs purchased under this Option Agreement available to Subcontractor for dynamic testing of VOBC units within 4 months of delivery of such VOBC's or 22 months from Subcontractor's receipt of order for such VOBC's, whichever is later.

- Delivery Address is: Ottawa

c. All payments under any Order shall be conditional on their being in place a valid and enforceable Letter of Credit for the relevant agreement.

Performance Letter of Credit

d. Within 15 days of receipt of each Order, the Subcontractor will deliver a letter of credit ("**Letter of Credit**") in the amount of [redacted] of the price of the total Additional CBTC Packages to be purchased and sold under the Order in a form substantially similar to that

attached as Exhibit "A" to this Option Agreement. The Subcontractor shall ensure that the Performance Letter of Credit is valid and enforceable with respect to each Order until the date when the City takes possession of the Additional Vehicles and deficiencies, if any, in the Additional CBTC Packages have been solved ("**City's Takeover Date**").

e. The Performance Letter of Credit shall be issued by a first class Canadian bank approved by the Construction Contractor. In the case where the rating of the issuer's senior unsecured debt has been downgraded by S&P below an A- rating, the Construction Contractor may on ten (10) Business Days' notice demand that the Subcontractor provide replacement Performance Letter of Credit which meets the requirements of this Clause.

f. The Construction Contractor will bear costs associated with a delayed City's Takeover Date unless such delay arises because of the Subcontractor's failure to comply with the terms of this Option Agreement or an Order. If the terms of the Performance Letter of Credit specify its expiry date, and the Subcontractor has not become entitled to receive the Performance Letter of Credit by the date 28 days prior to the expiry date, the Subcontractor shall extend the validity of the Performance Letter of Credit until the obligations under the Order have been completed and any defects have been remedied, failing which the Construction Contractor may immediately demand payment.

g. The Construction Contractor shall not make a claim under the Performance Letter of Credit, except for amounts to which the Construction Contractor is entitled under the Subcontract in the event of:

(a) failure by the Subcontractor to extend the validity of the Performance Letter of Credit as described in the preceding paragraph or failure by the Subcontractor to Provide replacement Performance Letter of Credit as required in the event of a downgrade of the issuer, in which event the Construction Contractor may claim the full amount of the Performance Letter of Credit,

(b) failure by the Subcontractor to remedy a default under this Option Agreement or an Order within ten (10) Business days, or such extended time period as agreed to between the Subcontractor and Construction Contractor, after receiving the Construction Contractor's notice requiring the default to be remedied, or

(c) circumstances which entitle the Construction Contractor to termination of this Option Agreement or an Order, irrespective of whether notice of termination has been given.

Warranty Letter of Credit

h. For each Order, the Subcontractor shall provide the Construction Contractor with a performance security ("**Warranty Letter of Credit**") in a form substantially similar to that attached as Exhibit B for proper performance of its warranty obligations under this

Option Agreement and each Order relating to the Additional CBTC Packages provided under this particular Order, equal in value to [redacted]%) of the total value of the Order.

i. The Warranty Letter of Credit shall be issued to the Construction Contractor 30 days prior to the expiry of the Performance Letter of Credit for each Order, so as to be in effect from the City's Takeover Date and shall expire two years after the City's Takeover Date. For greater certainty, the Warranty Letter of Credit for an Order shall only take effect upon the expiry of the Performance Letter of Credit for that Order.

j. The Warranty Letter of Credit shall be issued by a first class Canadian bank approved by the Construction Contractor. In the case where the rating of the issuer's senior unsecured debt has been downgraded by S&P below an A- rating, the Construction Contractor may on ten (10) Business Days' notice demand that the Subcontractor provide replacement Warranty Letter of Credit which meets the requirements of this Clause.

k. The Construction Contractor shall return the Performance Letter of Credit to the Subcontractor upon the City's Takeover Date.

l. Other than as specified here, the terms and conditions of the CBTC Supply Agreement related to the Warranty Performance Security will apply mutatis mutandis to the Letter of Credit, including the draw conditions and provisions related to the replacement of letters of credit.

m. The exercise of the options available under the Option Agreement shall not have the effect of extending the expiry of the Warranty Performance Security applicable to the Subcontracted Works performed under the Subcontract. The Warranty Performance Security does not entitle the Construction Contractor to a General Warranty Period under the CBTC Supply Agreement that would extend past May 24, 2020.

n. The Construction Contractor shall not make a claim under the Warranty Performance Security except for amounts to which the Construction Contractor is entitled in the event of a failure by the Subcontractor to remedy a default of its warranty obligations under this Option Agreement and each Order with respect to the particular VOBC Package that is the subject of the Warranty Performance Security, within thirty (30) business days after Subcontractor receiving the Construction Contractor's notice requiring the default to be remedied.

Warranty

o. The warranty provisions of the CBTC Supply Agreement will apply *mutatis mutandis* to the Additional CBTC Packages to be purchased and sold under an Order. The General Warranty Period in relation to the hardware and such software embedded provided under an Order will commence on the City's Takeover Date for the relevant Order and continue until two years after the City's Takeover Date thereof. The Latent Defect Warranty

Period will continue until 15 years after issuance of the City's Takeover Date for the relevant order of Complete Vehicle Onboard Equipment Packages for Additional Vehicles. For clarity, the warranty provisions hereunder shall not have the effect of extending the General Warranty Period for equipment and software provided under the CBTC Supply Agreement.

Limitation of Liability

p. The total cumulative, aggregate liability of Subcontractor to the Construction Contractor, under or in connection with this Option Agreement or each individual Order other than as specified below shall not exceed the price of the relevant/individual Order. Except with respect to the quantum of the limitation of liability (which is as set out herein) the provisions of the CBTC Supply Agreement regarding limitations of liability and exclusions thereof will apply *mutatis mutandis* to each order.

Indemnities

q. The indemnity provisions of section 17 of the CBTC Supply Agreement will apply *mutatis mutandis* to this Option Agreement and each of the Thales P&S Agreement.

5. The Construction Contractor, as applicable, will forward to Subcontractor any notice, request or other communication that it receives relating to Subcontractor's rights and obligations under this Option Agreement or any Order, without undue delay, and in any case within two Business Days of receipt by Construction Contractor. The Construction Contractor and Subcontractor acknowledge that Project Co is bound by an equivalent provision under the Construction Contract.

6. The Construction Contractor may assign its interest in this Option Agreement or any Order at any time to Project Co (or as Project Co may direct) or the Maintenance Contractor. Upon assignment to the Project Co (or as Project Co may direct), or the Maintenance Contractor (as the case may be), all of the corresponding obligations of the Construction Contractor arising from and after, but not prior to, the date of assignment shall transfer to the assignee. In addition all applicable requirements pertaining to the use, care and maintenance of the Equipment shall transfer to the assignee.

7. This Option Agreement and any Order placed against this Option Agreement will continue in force notwithstanding any termination or unenforceability of the Construction Contract or the CBTC Supply Agreement.

8. Upon the occurrence of any event which would entitle Subcontractor to terminate this Option Agreement or an Order, Subcontractor shall serve notice (a "**Default Notice**") on the Construction Contractor, Project Co and the Collateral Agent of the occurrence, specifying details of such event and, if the relevant matter or circumstance has not been rectified or remedied by the Construction Contractor (or otherwise) within 30 Business Days of delivery of the Default Notice (the "**Default Period**"), Subcontractor may serve a further notice on the Construction Contractor

terminating this Option Agreement or the relevant Order with immediate effect, with a copy of such notice to Project Co and the Collateral Agent, provided that, at any time prior to the expiry of the Default Period, Subcontractor acknowledges and agrees that either the Collateral Agent or Project Co may, but is not obligated to, (i) assign the Construction Contractor's rights under this Option Agreement or any Order to a replacement contractor and/or (ii) cure the event which gave rise to the Subcontractor's right to terminate this Option Agreement or an Order, within 30 days from the Subcontractor's issuance of the further notice and the Subcontractor shall not be obligated to perform its obligations under the relevant agreement until such event which gave rise to the Subcontractor's right to terminate the relevant agreement has been cured; provided further that, unless agreed by the parties otherwise, upon assignment the replacement contractor shall be responsible for any obligations of the Construction Contractor (or the replacement contractor) arising from future performance of the relevant agreement.

9. With regards to this Option Agreement and any Order placed against the Option Agreement, the Subcontractor shall have the same rights and remedies in relation to the Construction Contractor (but not the Maintenance Contractor) as provided to the Subcontractor within the CBTC Supply Agreement, and/or Prime Contract, and/or Project Agreement, and such rights and remedies shall be applicable to this Option Agreement and any Order placed against the Option Agreement

10. This Option Agreement shall enure to the benefit of and bind the successors and permitted assigns of the parties.

11. This Option Agreement, and each of the documents contemplated by or delivered under or in connection with this Option Agreement, shall be governed by and construed in accordance with the laws of Ontario and the laws of Canada applicable therein and shall be treated in all respects as an Ontario contract, without regard to conflict of laws principles.

12. The Subcontractor and Construction Contractor both agree that any dispute arising out of this Option Agreement will be subject to the Dispute Resolution Procedure under the CBTC Supply Agreement. Except as aforesaid, all parties hereby irrevocably attorn to the exclusive jurisdiction of the courts of the Province of Ontario and all courts competent to hear appeals therefrom.

13. Each party shall do all things, from time to time, and execute all further documents as necessary to give full effect to this Option Agreement.

14. This Option Agreement may be executed in one or more counterparts. Any single counterpart or a set of counterparts executed, in either case, by all the parties shall constitute a full, original and binding agreement for all purposes. Counterparts may be executed either in original or faxed form provided that any party providing its signature in faxed form shall promptly forward to the other party an original signed copy of this Option Agreement which was so faxed.

In witness whereof, the authorized representatives of the parties have set their signatures below:

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

_____
Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

_____
Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

_____
Name:
Title:

_____
Name:
Title:

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA, TRANSPORTATION SOLUTIONS

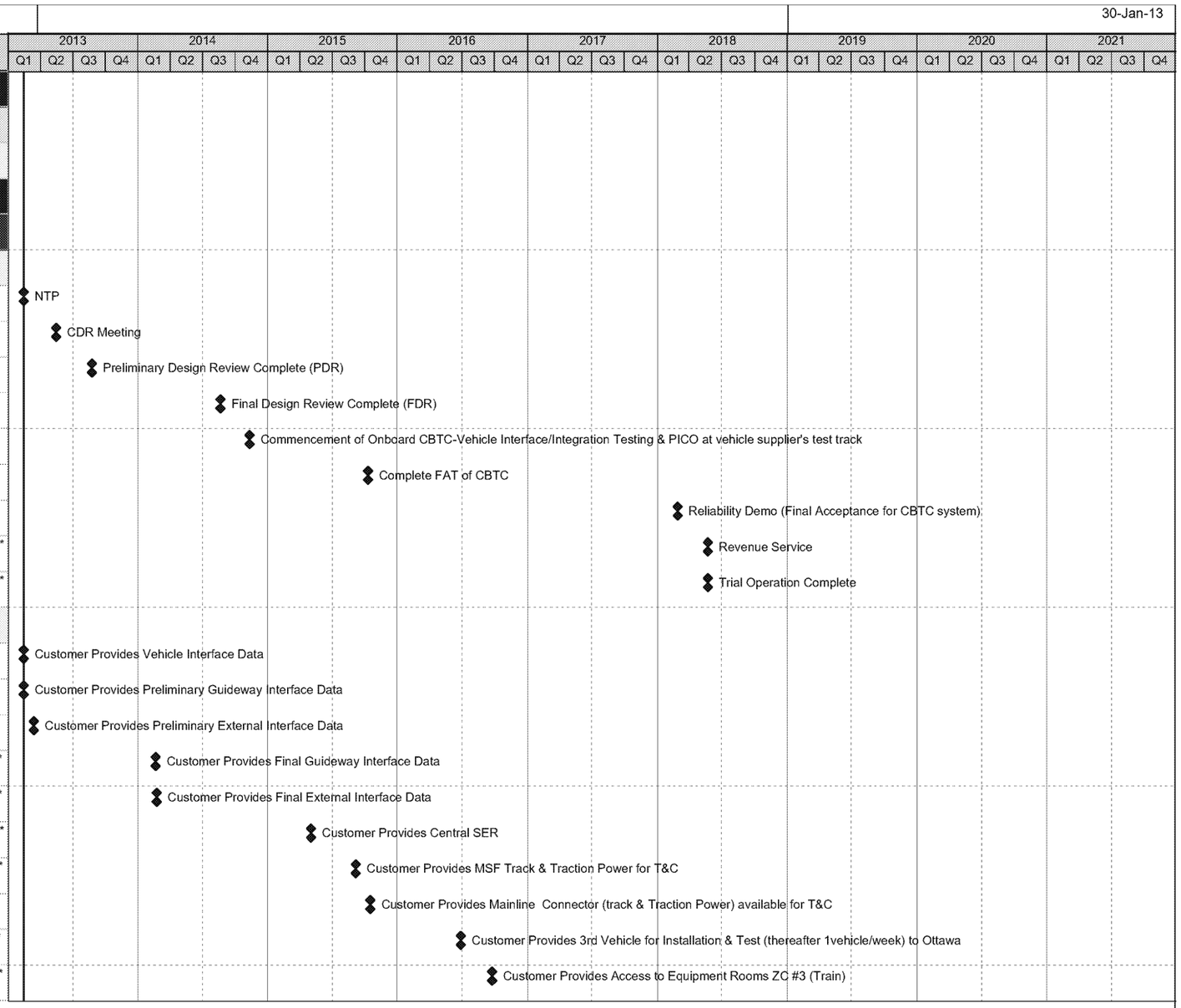
Per:

_____
Name:
Title:

Ottawa LRT - Preliminary Schedule Rev 03A

30-Jan-13

Activity ID	Activity Name	Original Duration	Start	Finish
Total		1748d	15-Feb-13	24-May-20
Ottawa LRT - Preliminary Schedule Rev 03A		1748d	15-Feb-13	24-May-20
Management		1339d	15-Feb-13	24-May-18
Program Management		1339d	15-Feb-13	24-May-18
Program Management Office		1339d	15-Feb-13	24-May-18
Milestones		1339d	15-Feb-13	24-May-18
MS100	NTP	0d	15-Feb-13*	
MS110	CDR Meeting	0d		16-May-13
MS120	Preliminary Design Review Complete (PDR)	0d		23-Aug-13
MS130	Final Design Review Complete (FDR)	0d		22-Aug-14
MS210	Commencement of Onboard CBTC-Vehicle Interface/Integration Testing & PICO at vehicle supplier's test track	0d		11-Nov-14
MS190	Complete FAT of CBTC	0d		09-Oct-15
MS170	Reliability Demo (Final Acceptance for CBTC system)	0d		27-Feb-18
MS150	Revenue Service	0d		24-May-18*
MS160	Trial Operation Complete	0d		24-May-18*
Customer Milestones		1180d	15-Feb-13	16-Oct-17
CUS100	Customer Provides Vehicle Interface Data	0d		15-Feb-13
CUS110	Customer Provides Preliminary Guideway Interface Data	0d		15-Feb-13
CUS120	Customer Provides Preliminary External Interface Data	0d		14-Mar-13
CUS200	Customer Provides Final Guideway Interface Data	0d		21-Feb-14*
CUS201	Customer Provides Final External Interface Data	0d		21-Feb-14*
CUS170	Customer Provides Central SER	0d		04-May-15*
CUS160	Customer Provides MSF Track & Traction Power for T&C	0d		04-Sep-15*
CUS240	Customer Provides Mainline Connector (track & Traction Power) available for T&C	0d		15-Oct-15*
CUS140	Customer Provides 3rd Vehicle for Installation & Test (thereafter 1vehicle/week) to Ottawa	0d		27-Jun-16*
CUS303	Customer Provides Access to Equipment Rooms ZC #3 (Train)	0d		23-Sep-16*

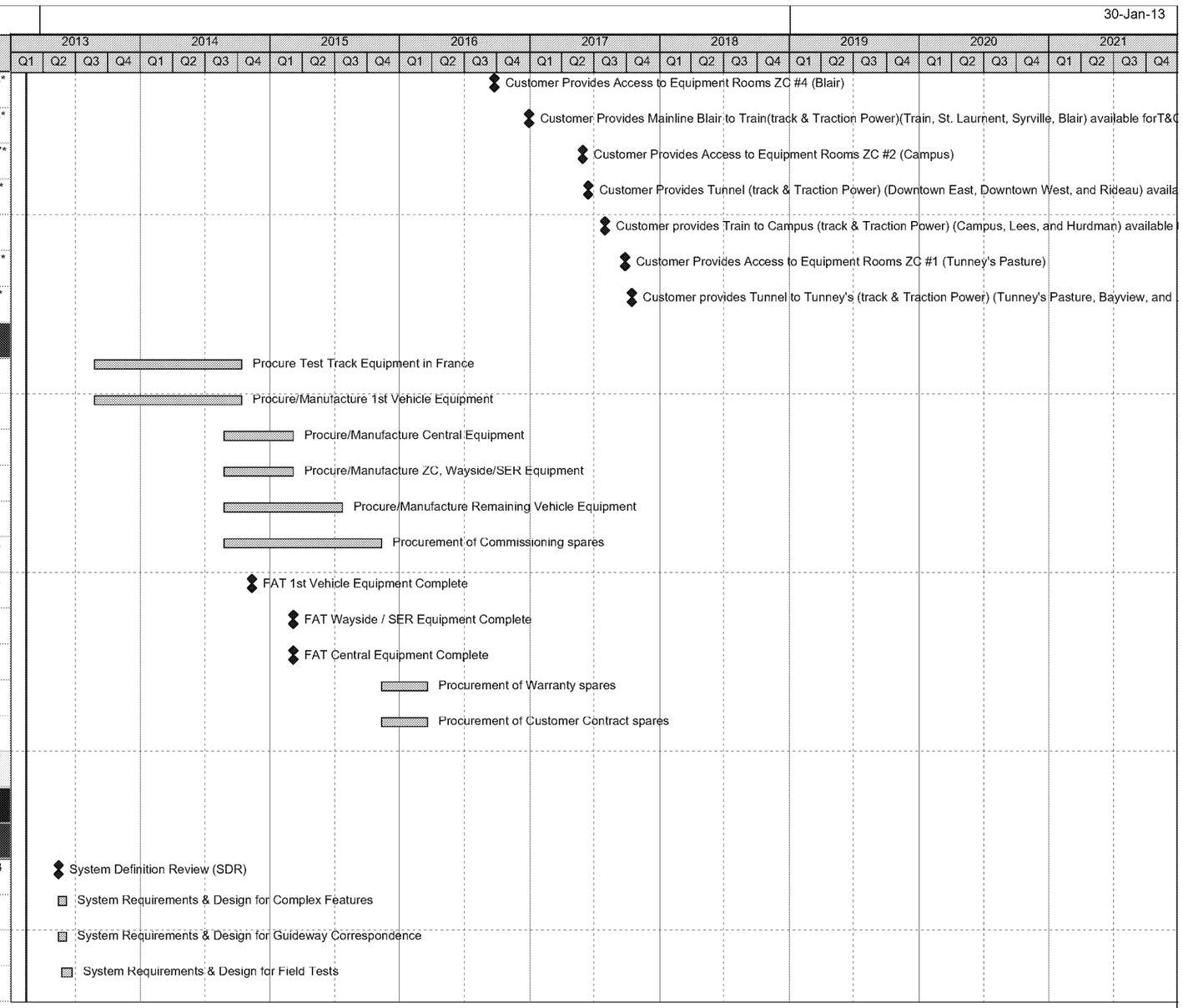


Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Baseline Milestone

Ottawa LRT - Preliminary Schedule Rev 03A

30-Jan-13

Activity ID	Activity Name	Original Duration	Start	Finish
CUS304	Customer Provides Access to Equipment Rooms ZC #4 (Blair)	0d		23-Sep-16*
CUS180	Customer Provides Mainline Blair to Train(track & Traction Power)(Train, St. Laurnent, Syrville, Blair) available forT&C	0d		30-Dec-16*
CUS302	Customer Provides Access to Equipment Rooms ZC #2 (Campus)	0d		30-May-17*
CUS130	Customer Provides Tunnel (track & Traction Power) (Downtown East, Downtown West, and Rideau) available for T&C	0d		15-Jun-17*
CUS320	Customer provides Train to Campus (track & Traction Power) (Campus, Lees, and Hurdman) available to T&C	0d		31-Jul-17*
CUS300	Customer Provides Access to Equipment Rooms ZC #1 (Tunney's Pasture)	0d		26-Sep-17*
CUS330	Customer provides Tunnel to Tunney's (track & Traction Power) (Tunney's Pasture, Bayview, and Lebreton) available to T&C	0d		16-Oct-17*
Project Procurement Management		638d	23-Aug-13	18-Mar-16
PR100	Procure Test Track Equipment in France	284d	23-Aug-13	14-Oct-14
PR110	Procure/Manufacture 1st Vehicle Equipment	284d	23-Aug-13	14-Oct-14
PR140	Procure/Manufacture Central Equipment	131d	25-Aug-14	06-Mar-15
PR150	Procure/Manufacture ZC, Wayside/SER Equipment	131d	25-Aug-14	06-Mar-15
PR160	Procure/Manufacture Remaining Vehicle Equipment	227d	25-Aug-14	22-Jul-15
PR180	Procurement of Commissioning spares	304d	25-Aug-14	11-Nov-15
TV110	FAT 1st Vehicle Equipment Complete	0d		11-Nov-14
TV140	FAT Wayside / SER Equipment Complete	0d		06-Mar-15
TV150	FAT Central Equipment Complete	0d		06-Mar-15
PR190	Procurement of Warranty spares	85d	12-Nov-15	18-Mar-16
PR200	Procurement of Customer Contract spares	85d	12-Nov-15	18-Mar-16
System Engineering		1140d	16-May-13	17-Nov-17
System Design and Subsystem Definition		1140d	16-May-13	17-Nov-17
System Requirements		40d	16-May-13	15-Jul-13
SD1010	System Definition Review (SDR)	0d		16-May-13
SD1040	System Requirements & Design for Complex Features	15d	16-May-13	07-Jun-13
SD1030	System Requirements & Design for Guideway Correspondence	15d	16-May-13	07-Jun-13
SD1020	System Requirements & Design for Field Tests	21d	24-May-13	24-Jun-13

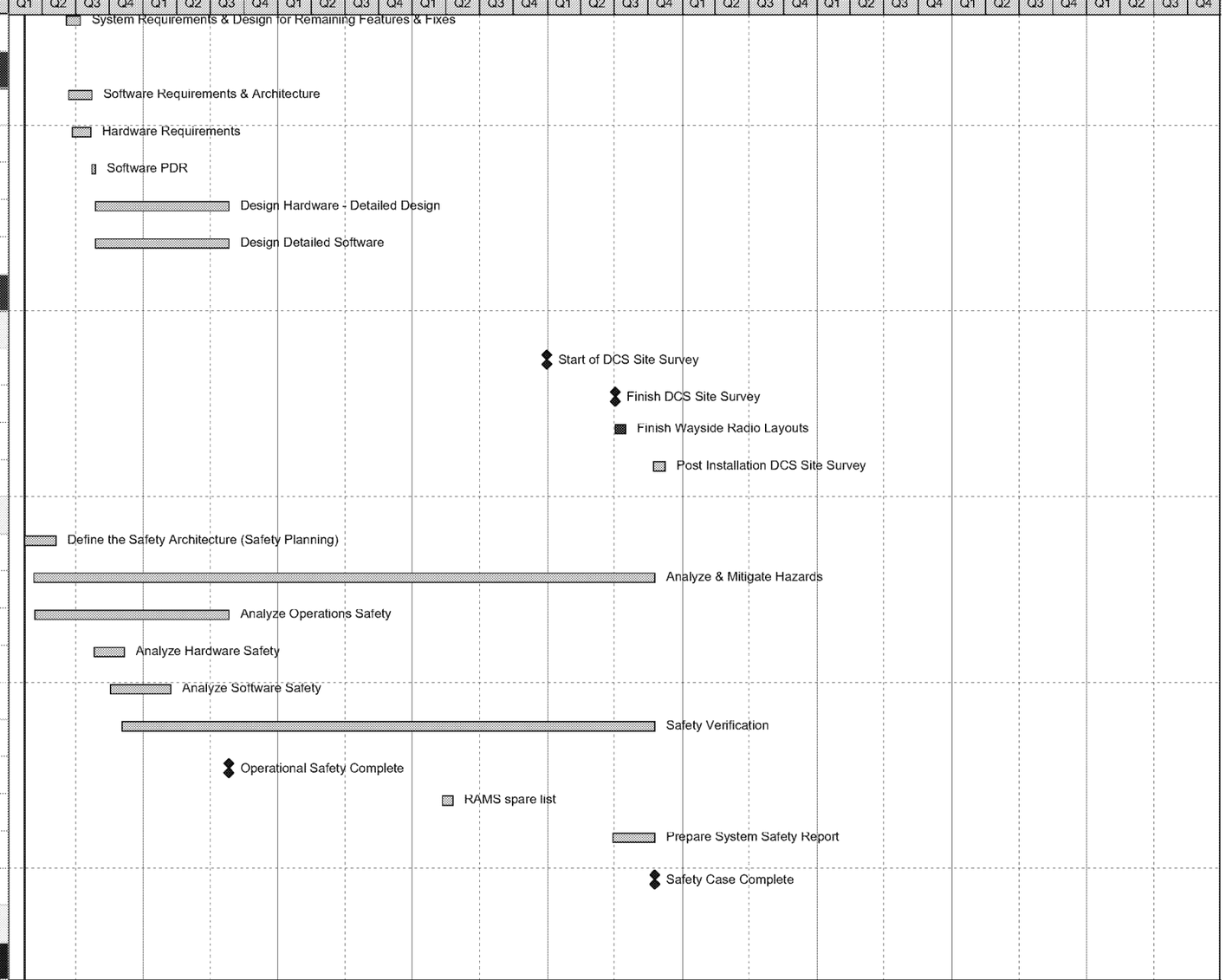


Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone

Ottawa LRT - Preliminary Schedule Rev 03A

30-Jan-13

Activity ID	Activity Name	Original Duration	Start	Finish
SD1050	System Requirements & Design for Remaining Features & Fixes	26d	06-Jun-13	15-Jul-13
System Design Description		297d	14-Jun-13	22-Aug-14
SW1000	Software Requirements & Architecture	43d	14-Jun-13	16-Aug-13
HW1000	Hardware Requirements	34d	21-Jun-13	12-Aug-13
SW1020	Software PDR	5d	16-Aug-13	23-Aug-13
HW1020	Design Hardware - Detailed Design	249d	23-Aug-13	22-Aug-14
SW1010	Design Detailed Software	249d	23-Aug-13	22-Aug-14
Sub-system Definition		230d	30-Dec-16	17-Nov-17
DCS Subsystem		230d	30-Dec-16	17-Nov-17
DCS1060	Start of DCS Site Survey	0d	30-Dec-16	
DCS1080	Finish DCS Site Survey	0d		03-Jul-17
DCS1050	Finish Wayside Radio Layouts	20d	03-Jul-17	31-Jul-17
DCS1070	Post Installation DCS Site Survey	24d	16-Oct-17	17-Nov-17
Safety		1183d	15-Feb-13	18-Oct-17
SF1000	Define the Safety Architecture (Safety Planning)	60d	15-Feb-13	09-May-13
SF1010	Analyze & Mitigate Hazards	1167d	11-Mar-13	18-Oct-17
SF1020	Analyze Operations Safety	360d	14-Mar-13	20-Aug-14
SF1040	Analyze Hardware Safety	55d	22-Aug-13	11-Nov-13
SF1050	Analyze Software Safety	109d	04-Oct-13	18-Mar-14
SF1060	Safety Verification	1000d	05-Nov-13	18-Oct-17
SF1070	Operational Safety Complete	0d		20-Aug-14
SF2010	RAMS spare list	21d	21-Mar-16	18-Apr-16
SF1080	Prepare System Safety Report	81d	27-Jun-17	18-Oct-17
SF1090	Safety Case Complete	0d		18-Oct-17
System Development		1063d	22-Oct-13	23-May-18
Vehicle On-Board Controller (VOBC)		206d	25-Aug-14	22-Jun-15

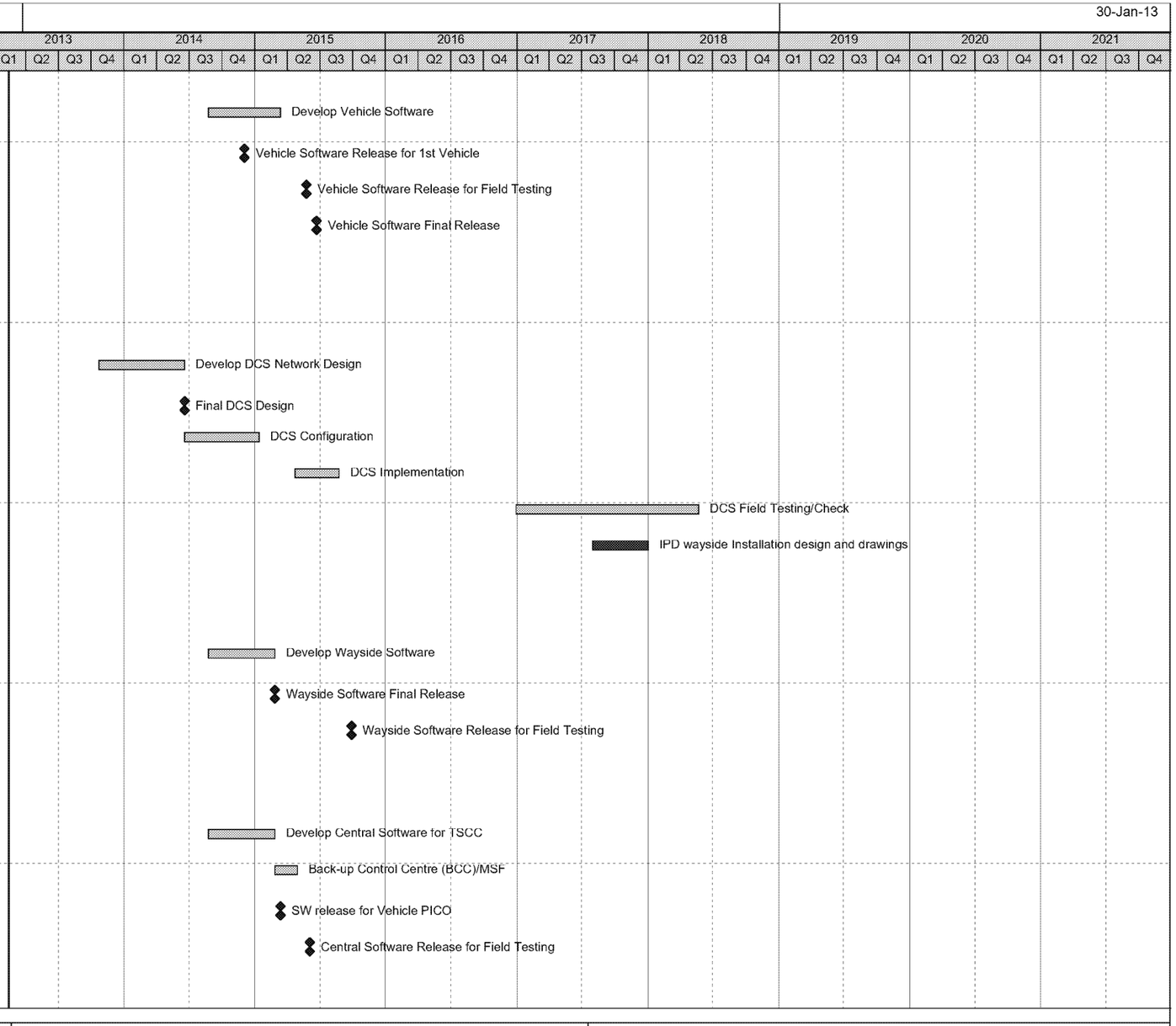


Remaining Level of Effort
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone

Ottawa LRT - Preliminary Schedule Rev 03A

30-Jan-13

Activity ID	Activity Name	Original Duration	Start	Finish
VOBC Software		206d	25-Aug-14	22-Jun-15
VS1000	Develop Vehicle Software	136d	25-Aug-14	13-Mar-15
VS1020	Vehicle Software Release for 1st Vehicle	0d		03-Dec-14
VS1050	Vehicle Software Release for Field Testing	0d		25-May-15
SW2110	Vehicle Software Final Release	0d		22-Jun-15
DCS Subsystem		1063d	22-Oct-13	23-May-18
DCS Network Configuration		1063d	22-Oct-13	23-May-18
DCS Network Device Configuration		1063d	22-Oct-13	23-May-18
DCS4070	Develop DCS Network Design	163d	22-Oct-13	18-Jun-14
DCS4125	Final DCS Design	0d		18-Jun-14
DCS4300	DCS Configuration	138d	18-Jun-14	13-Jan-15
DCS4305	DCS Implementation	83d	24-Apr-15	24-Aug-15
DCS5000	DCS Field Testing/Check	83d	30-Dec-16	23-May-18
DCS4010	IPD wayside Installation design and drawings	110d	31-Jul-17	01-Jan-18
Wayside		273d	25-Aug-14	28-Sep-15
Wayside Software		273d	25-Aug-14	28-Sep-15
WS1040	Develop Wayside Software	125d	25-Aug-14	26-Feb-15
WS2040	Wayside Software Final Release	0d		26-Feb-15
WS1010	Wayside Software Release for Field Testing	0d		28-Sep-15
ATS Subsystem		192d	25-Aug-14	02-Jun-15
ATS Software		192d	25-Aug-14	02-Jun-15
SW1510	Develop Central Software for TSCC	125d	25-Aug-14	26-Feb-15
SW1570	Back-up Control Centre (BCC)/MSF	45d	27-Feb-15	30-Apr-15
SW1580	SW release for Vehicle PICO	0d		13-Mar-15
SW1555	Central Software Release for Field Testing	0d		02-Jun-15
Verification and Testing		885d	07-Nov-14	25-Apr-18



Remaining Level of Effort | Remaining Work | Milestone
Actual Level of Effort | Critical Remaining Work
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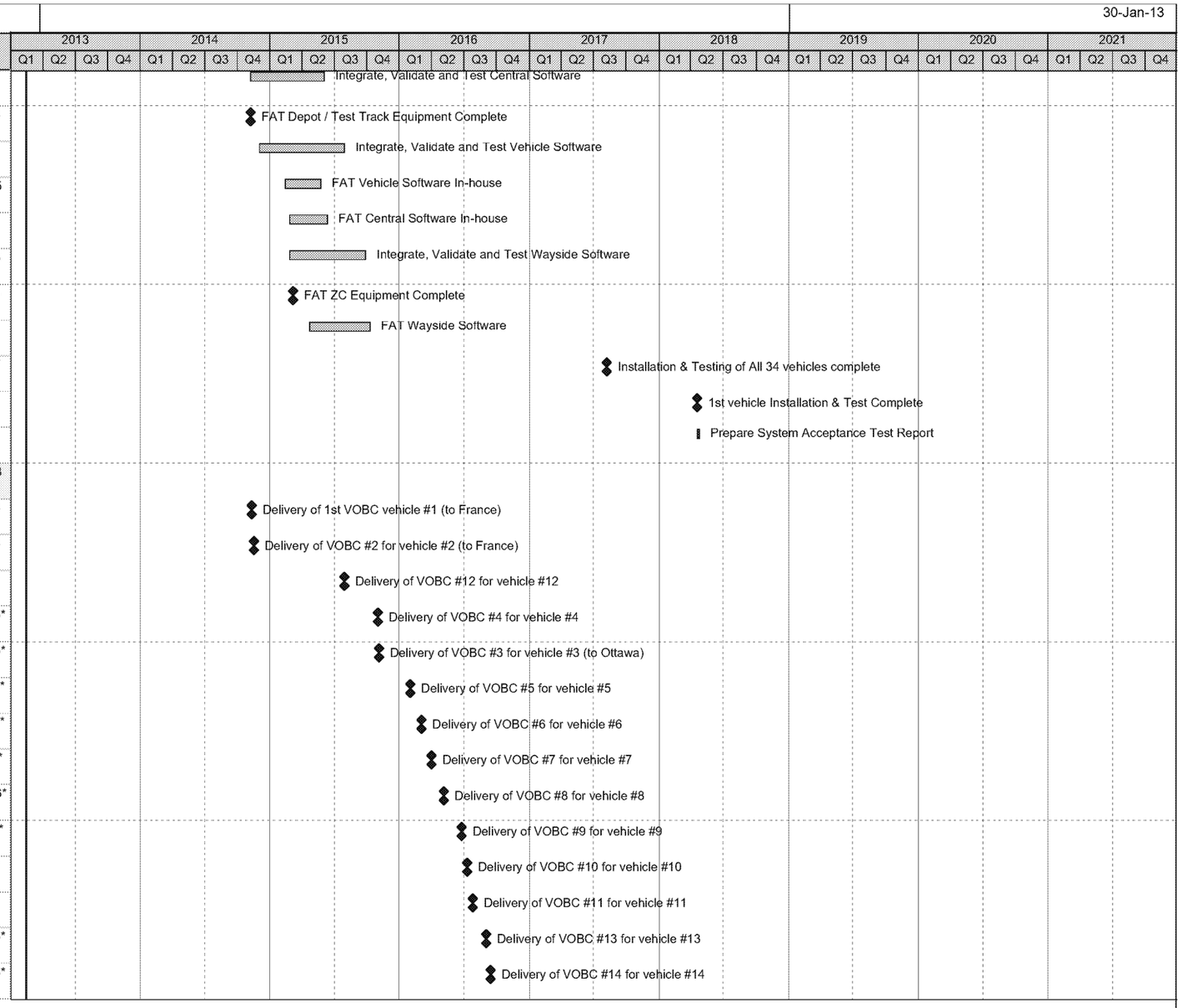
Activity ID	Activity Name	Original Duration	Start	Finish
TV130	Integrate, Validate and Test Central Software	140d	07-Nov-14	02-Jun-15
TV100	FAT Depot / Test Track Equipment Complete	0d		07-Nov-14
TV180	Integrate, Validate and Test Vehicle Software	161d	03-Dec-14	28-Jul-15
TV200	FAT Vehicle Software In-house	71d	13-Feb-15	25-May-15
TV170	FAT Central Software In-house	74d	27-Feb-15	11-Jun-15
TV220	Integrate, Validate and Test Wayside Software	190d	27-Feb-15	28-Sep-15
TV160	FAT ZC Equipment Complete	0d		06-Mar-15
TV210	FAT Wayside Software	116d	24-Apr-15	09-Oct-15
TV230	Installation & Testing of All 34 vehicles complete	0d		07-Aug-17
TV190	1st vehicle Installation & Test Complete	0d		18-Apr-18
TV250	Prepare System Acceptance Test Report	6d	18-Apr-18	25-Apr-18
System Delivery		903d	11-Nov-14	24-May-18
MS300	Delivery of 1st VOBC vehicle #1 (to France)	0d		11-Nov-14
MS310	Delivery of VOBC #2 for vehicle #2 (to France)	0d		17-Nov-14
MS410	Delivery of VOBC #12 for vehicle #12	0d		30-Jul-15*
MS330	Delivery of VOBC #4 for vehicle #4	0d		02-Nov-15*
MS320	Delivery of VOBC #3 for vehicle #3 (to Ottawa)	0d		03-Nov-15*
MS340	Delivery of VOBC #5 for vehicle #5	0d		01-Feb-16*
MS350	Delivery of VOBC #6 for vehicle #6	0d		04-Mar-16*
MS360	Delivery of VOBC #7 for vehicle #7	0d		01-Apr-16*
MS370	Delivery of VOBC #8 for vehicle #8	0d		06-May-16*
MS380	Delivery of VOBC #9 for vehicle #9	0d		23-Jun-16*
MS390	Delivery of VOBC #10 for vehicle #10	0d		08-Jul-16*
MS400	Delivery of VOBC #11 for vehicle #11	0d		26-Jul-16*
MS420	Delivery of VOBC #13 for vehicle #13	0d		01-Sep-16*
MS430	Delivery of VOBC #14 for vehicle #14	0d		15-Sep-16*



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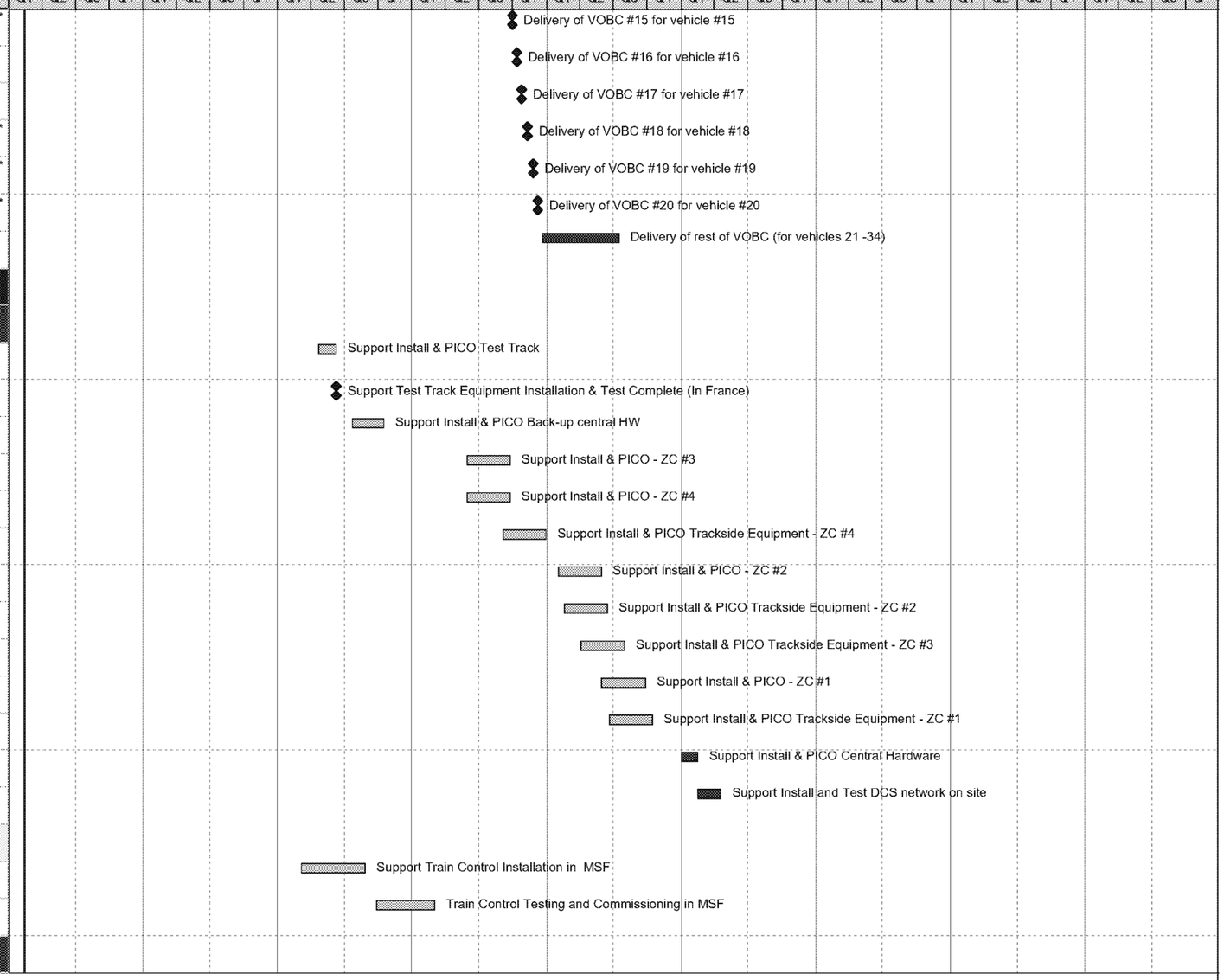
Activity ID	Activity Name	Original Duration	Start	Finish
MS440	Delivery of VOBC #15 for vehicle #15	0d		29-Sep-16*
MS450	Delivery of VOBC #16 for vehicle #16	0d		12-Oct-16*
MS460	Delivery of VOBC #17 for vehicle #17	0d		26-Oct-16*
MS470	Delivery of VOBC #18 for vehicle #18	0d		10-Nov-16*
MS480	Delivery of VOBC #19 for vehicle #19	0d		24-Nov-16*
MS490	Delivery of VOBC #20 for vehicle #20	0d		07-Dec-16*
MS500	Delivery of rest of VOBC (for vehicles 21 -34)	148d	21-Dec-16*	17-Jul-17
Installation		856d	10-Dec-14	18-Apr-18
Wayside Installation & PICO		800d	06-Mar-15	18-Apr-18
HW3005	Support Install & PICO Test Track	33d	24-Apr-15	10-Jun-15
HW3010	Support Test Track Equipment Installation & Test Complete (In France)	0d		10-Jun-15
HW4750	Support Install & PICO Back-up central HW	59d	22-Jul-15	16-Oct-15
HW3030	Support Install & PICO - ZC #3	84d	30-May-16	23-Sep-16
HW3040	Support Install & PICO - ZC #4	84d	30-May-16	23-Sep-16
HW4000	Support Install & PICO Trackside Equipment - ZC #4	84d	05-Sep-16	30-Dec-16
HW4520	Support Install & PICO - ZC #2	84d	01-Feb-17	30-May-17
HW3095	Support Install & PICO Trackside Equipment - ZC #2	84d	17-Feb-17	15-Jun-17
HW3007	Support Install & PICO Trackside Equipment - ZC #3	84d	04-Apr-17	31-Jul-17
HW4440	Support Install & PICO - ZC #1	84d	31-May-17	26-Sep-17
HW3090	Support Install & PICO Trackside Equipment - ZC #1	84d	20-Jun-17	16-Oct-17
HW1570	Support Install & PICO Central Hardware	33d	01-Jan-18	15-Feb-18
HW4910	Support Install and Test DCS network on site	44d	15-Feb-18	18-Apr-18
Maintenance & Storage Facility (MSF)		246d	06-Mar-15	02-Mar-16
HW3015	Support Train Control Installation in MSF	120d	06-Mar-15	26-Aug-15
HW3020	Train Control Testing and Commissioning in MSF	104d	29-Sep-15	02-Mar-16
Vehicle PICO		675d	10-Dec-14	07-Aug-17



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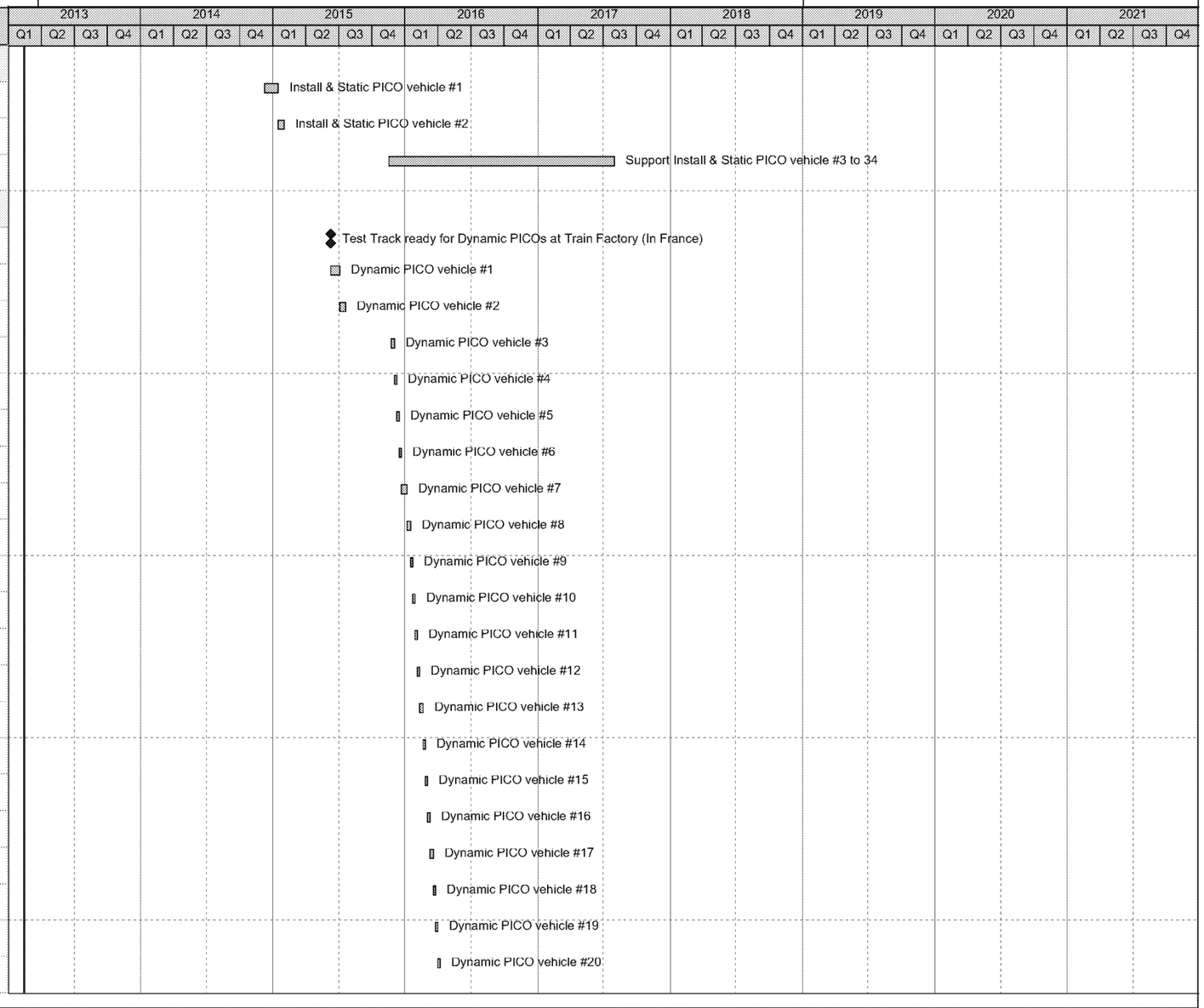
Activity ID	Activity Name	Original Duration	Start	Finish
Installation/Vehicle Static PICO		238d	10-Dec-14	31-Jul-17
VH1000	Install & Static PICO vehicle #1	20d	10-Dec-14	15-Jan-15
VH1010	Install & Static PICO vehicle #2	11d	16-Jan-15	30-Jan-15
VH1020	Support Install & Static PICO vehicle #3 to 34	6d	17-Nov-15	31-Jul-17
Dynamic PICO		552d	10-Jun-15	07-Aug-17
VH2000	Test Track ready for Dynamic PICOs at Train Factory (In France)	0d		10-Jun-15
VH2010	Dynamic PICO vehicle #1	16d	11-Jun-15	03-Jul-15
VH2020	Dynamic PICO vehicle #2	11d	06-Jul-15	20-Jul-15
VH2030	Dynamic PICO vehicle #3	5d	24-Nov-15	01-Dec-15
VH2040	Dynamic PICO vehicle #4	5d	01-Dec-15	08-Dec-15
VH2050	Dynamic PICO vehicle #5	5d	08-Dec-15	15-Dec-15
VH2060	Dynamic PICO vehicle #6	5d	15-Dec-15	22-Dec-15
VH2070	Dynamic PICO vehicle #7	5d	22-Dec-15	07-Jan-16
VH2080	Dynamic PICO vehicle #8	5d	07-Jan-16	14-Jan-16
VH2090	Dynamic PICO vehicle #9	5d	14-Jan-16	21-Jan-16
VH2100	Dynamic PICO vehicle #10	5d	21-Jan-16	28-Jan-16
VH2110	Dynamic PICO vehicle #11	5d	28-Jan-16	04-Feb-16
VH2120	Dynamic PICO vehicle #12	5d	04-Feb-16	11-Feb-16
VH2130	Dynamic PICO vehicle #13	5d	11-Feb-16	18-Feb-16
VH2140	Dynamic PICO vehicle #14	5d	18-Feb-16	25-Feb-16
VH2150	Dynamic PICO vehicle #15	5d	25-Feb-16	03-Mar-16
VH2160	Dynamic PICO vehicle #16	5d	03-Mar-16	10-Mar-16
VH2170	Dynamic PICO vehicle #17	5d	10-Mar-16	17-Mar-16
VH2180	Dynamic PICO vehicle #18	5d	17-Mar-16	24-Mar-16
VH2190	Dynamic PICO vehicle #19	5d	24-Mar-16	31-Mar-16
VH2200	Dynamic PICO vehicle #20	5d	31-Mar-16	07-Apr-16



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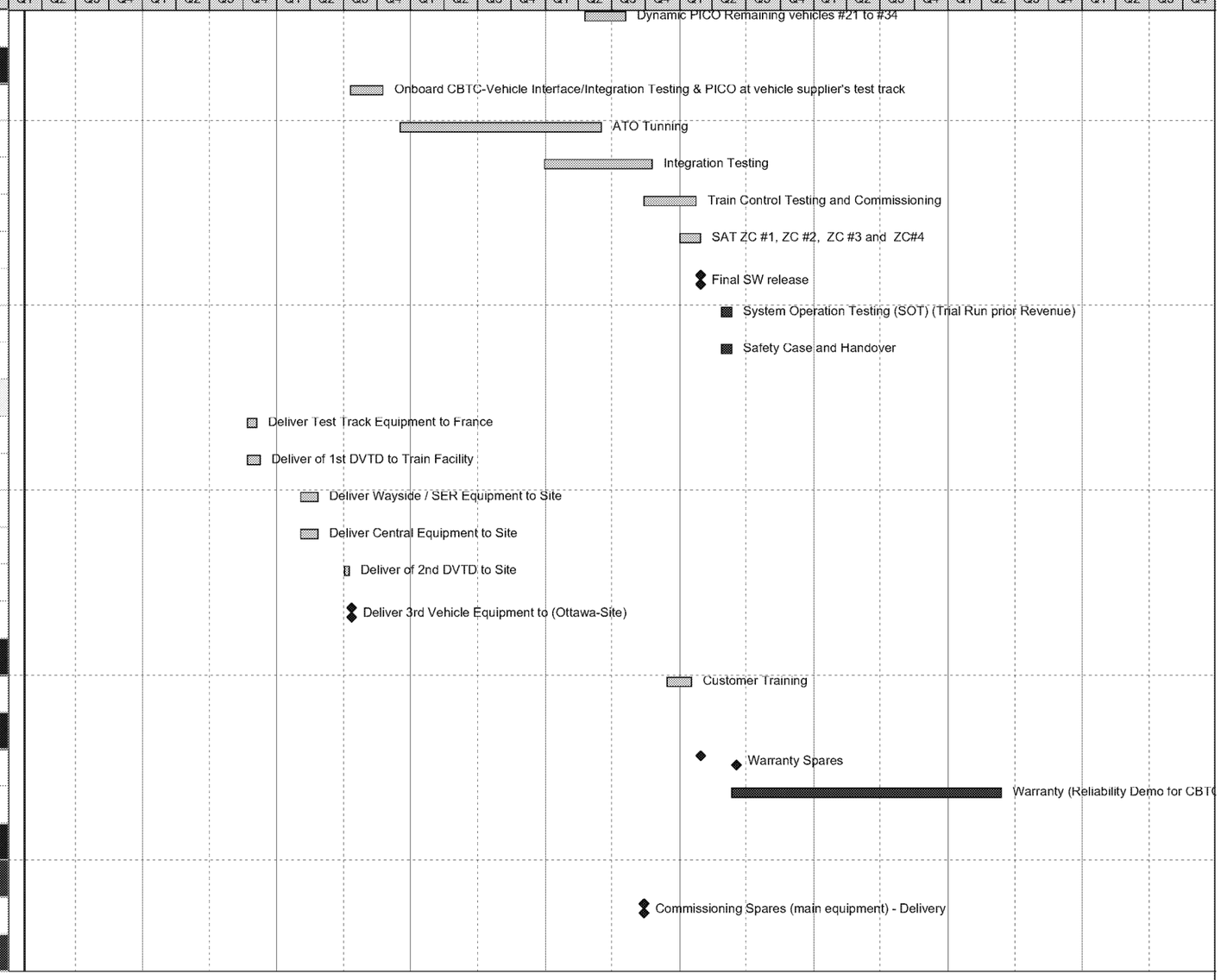
VH2210	Dynamic PICO Remaining vehicles #21 to #34	77d	20-Apr-17	07-Aug-17
Commissioning		733d	21-Jul-15	24-May-18
STD1001	Onboard CBTC-Vehicle Interface/Integration Testing & PICO at vehicle supplier's test track	60d	21-Jul-15	15-Oct-15
STD1070	ATO Tunning	386d	01-Dec-15	01-Jun-17
STD1140	Integration Testing	207d	30-Dec-16	17-Oct-17
STD1120	Train Control Testing and Commissioning	101d	26-Sep-17	13-Feb-18
STD1040	SAT ZC #1, ZC #2, ZC #3 and ZC#4	40d	03-Jan-18	27-Feb-18
STD1100	Final SW release	0d		27-Feb-18
STD1080	System Operation Testing (SOT) (Trial Run prior Revenue)	21d	25-Apr-18	24-May-18
STD1090	Safety Case and Handover	21d	25-Apr-18	24-May-18
Logistics		1315d	15-Oct-14	24-May-20
WH1000	Deliver Test Track Equipment to France	17d	15-Oct-14	07-Nov-14
WH1060	Deliver of 1st DVTD to Train Facility	25d	15-Oct-14	18-Nov-14
WH1040	Deliver Wayside / SER Equipment to Site	34d	06-Mar-15	24-Apr-15
WH1050	Deliver Central Equipment to Site	34d	06-Mar-15	24-Apr-15
WH1070	Deliver of 2nd DVTD to Site	10d	06-Jul-15	17-Jul-15
WH1010	Deliver 3rd Vehicle Equipment to (Ottawa-Site)	0d		22-Jul-15
Manuals and Training		46d	29-Nov-17	01-Feb-18
CC1000	Customer Training	46d	29-Nov-17	01-Feb-18
Warranty Services		437d	26-Feb-18	24-May-20
CC7000	Warranty Spares	0d		26-Feb-18
CC4000	Warranty (Reliability Demo for CBTC system)	523d	24-May-18	24-May-20
Spares & Repair Parts		16d	26-Sep-17	17-Oct-17
Commissioning Spares		0d	26-Sep-17	26-Sep-17
CC2000	Commissioning Spares (main equipment) - Delivery	0d		26-Sep-17
Spare Parts List		16d	26-Sep-17	17-Oct-17



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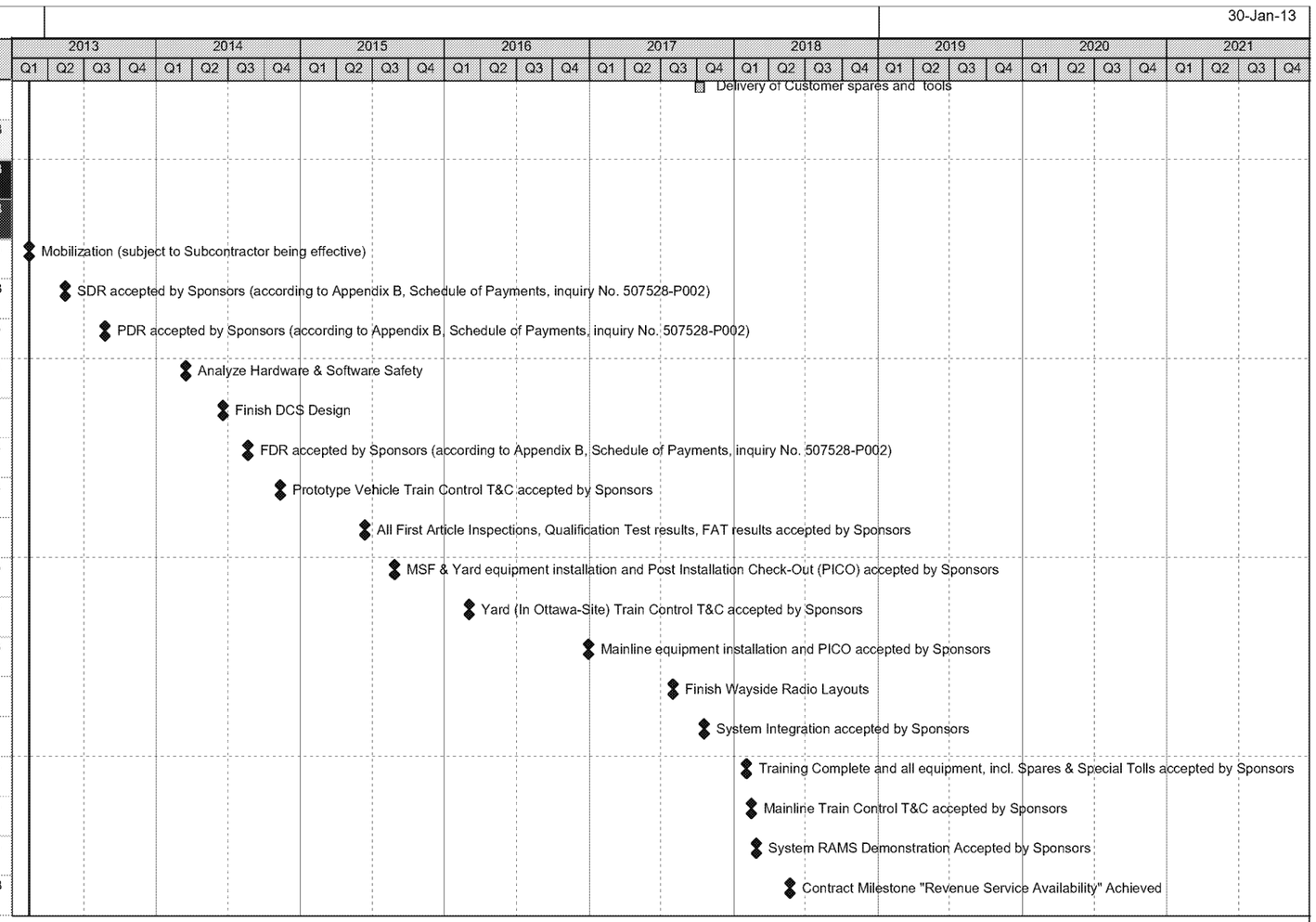
Activity ID	Activity Name	Original Duration	Start	Finish
CC3000	Delivery of Customer spares and tools	16d	26-Sep-17	17-Oct-17
FINANCE COSTS		1339d	15-Feb-13	24-May-18
FINANCE MILESTONES		1339d	15-Feb-13	24-May-18
BILLING MILESTONES		1339d	15-Feb-13	24-May-18
BILLM100	Mobilization (subject to Subcontractor being effective)	0d		15-Feb-13
BILLM110	SDR accepted by Sponsors (according to Appendix B, Schedule of Payments, inquiry No. 507528-P002)	0d		16-May-13
BILLM120	PDR accepted by Sponsors (according to Appendix B, Schedule of Payments, inquiry No. 507528-P002)	0d		23-Aug-13
BILLM127	Analyze Hardware & Software Safety	0d		18-Mar-14
BILLM125	Finish DCS Design	0d		18-Jun-14
BILLM130	FDR accepted by Sponsors (according to Appendix B, Schedule of Payments, inquiry No. 507528-P002)	0d		22-Aug-14
BILLM170	Prototype Vehicle Train Control T&C accepted by Sponsors	0d		11-Nov-14
BILLM140	All First Article Inspections, Qualification Test results, FAT results accepted by Sponsors	0d		11-Jun-15
BILLM150	MSF & Yard equipment installation and Post Installation Check-Out (PICO) accepted by Sponsors	0d		26-Aug-15
BILLM165	Yard (In Ottawa-Site) Train Control T&C accepted by Sponsors	0d		02-Mar-16
BILLM190	Mainline equipment installation and PICO accepted by Sponsors	0d		30-Dec-16
BILLM166	Finish Wayside Radio Layouts	0d		31-Jul-17
BILLM210	System Integration accepted by Sponsors	0d		17-Oct-17
BILLM180	Training Complete and all equipment, incl. Spares & Special Tolls accepted by Sponsors	0d		01-Feb-18
BILLM200	Mainline Train Control T&C accepted by Sponsors	0d		13-Feb-18
BILLM230	System RAMS Demonstration Accepted by Sponsors	0d		27-Feb-18
BILLM220	Contract Milestone "Revenue Service Availability" Achieved	0d		24-May-18



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SCHEDULE I
DISPUTE RESOLUTION PROCEDURE

1. GENERAL

1.1 Subject to Section 2.1 below, all disputes, controversies, or claims arising out of or relating to any provision of this Subcontract, or the alleged wrongful exercise or failure to exercise by a Party of a discretion or power given to that Party under this Subcontract, or the interpretation, enforceability, performance, breach, termination, or validity of this Subcontract, including, without limitation, this Schedule I to the Subcontract, or any matter referred to for resolution pursuant to this Schedule I (collectively and individually, a "**Subcontract Dispute**") shall be resolved in accordance with the provisions of this Schedule I (the "**Subcontract Dispute Resolution Procedure**").

1.2 The Parties agree that at all times, both during the period from the Commencement Date until Completion and after Completion, each of them will make bona fide efforts to resolve by amicable negotiations any and all Subcontract Disputes arising between them. In the event that either Party determines that it is not possible to resolve a Subcontractor Dispute by way of amicable negotiations then, subject to Section 1.1 of this Schedule I, either Party may deliver to the Construction Contractor Representative or the Subcontractor Representative, as applicable, a written notice of dispute (the "**Notice of Subcontract Dispute**"), which Notice of Subcontract Dispute shall initiate the dispute resolution process described in Sections 2 to 4 of this Schedule I. To be effective, the Notice of Subcontract Dispute must expressly state that it is a notice of dispute, set out the particulars of the matter in dispute, describe the remedy or resolution sought by the Party issuing the Notice of Subcontract Dispute and be signed by the Construction Contractor Representative, if given by the Construction Contractor, or by the Subcontractor Representative, if given by the Subcontractor.

1.3 The issuance of a Notice of Subcontract Dispute by either Party shall constitute a referral of the Subcontract Dispute to the Senior Representative Panel in accordance with Section 3 of this Schedule I.

2. INTERACTION WITH OTHER DISPUTES AND CLAIMS

2.1 Where any Subcontract Dispute relates to the same matter or is otherwise related to, or has issues in common with, a dispute between Project Co and the City, such Subcontract Dispute shall be referred to the Dispute Resolution Procedure in the Project Agreement, and the Construction Contractor and Subcontractor shall stay any and all proceedings commenced pursuant to the Subcontract Dispute Resolution Procedure and participate in proceedings referred to the Dispute Resolution Procedure in the Project Agreement, and the Subcontractor shall comply with such requirement and be bound by any decision or determination made under the Dispute Resolution Procedure in the Project Agreement.

2.2 With respect to any Subcontract Dispute which gives rise to an Equivalent Claim or any City Claim, the Parties shall proceed in accordance with the applicable provisions of Part 1 and not in accordance with the Subcontract Dispute Resolution Procedure. The

foregoing sentence shall be without prejudice to the Parties' rights to refer matters to the Subcontract Dispute Resolution Procedure in relation to Equivalent Claims or City Claims where the applicable provisions of Part 1 include a right to do so.

3. REFERRAL TO SENIOR REPRESENTATIVE PANEL

3.1 The Senior Representative Panel shall be comprised of three (3) senior representatives of the Construction Contractor and three (3) senior representatives of the Subcontractor (collectively the "**Subcontract Senior Representative Panel**"), provided that such individuals shall have the right at any time to designate in writing a representative with respect to any Subcontract Dispute.

3.2 Within 20 days (or such shorter period of time necessary for Construction Contractor to comply with the terms of the Construction Contract) after delivery of a Notice of Subcontract Dispute in accordance with Section 1.2 of this Schedule I, the Subcontract Senior Representative Panel shall convene a meeting to attempt to reach a mutually acceptable resolution of the Subcontract Dispute. Unless otherwise agreed by the Parties in writing, the Senior Representative Panel shall issue a written notice (the "**Subcontract Senior Representative Panel Notice**") within thirty (30) days after delivery of the Notice of Subcontract Dispute (or such other period of time as may have been agreed by the Parties in writing) stating: (i) the terms of any unanimous resolution of the Subcontract Dispute reached by the Subcontract Senior Representative Panel; or (ii) the inability of the Subcontract Senior Representative Panel to reach a unanimous resolution of the Subcontract Dispute. No meeting of the Subcontract Senior Representative Panel shall take place without representation of both Parties.

3.3 If the Subcontract Senior Representative Panel reaches a unanimous resolution of the Subcontract Dispute, the Subcontract Senior Representative Panel Notice shall be signed by each member of the Subcontract Senior Representative Panel and shall be binding and conclusive on the Parties.

4. SUBCONTRACT ARBITRATION

4.1 Either Party may, in the event that the Subcontract Senior Representative Panel issues a Subcontract Senior Representative Panel Notice stating that the Subcontract Senior Representative Panel has been unable to resolve all of the Subcontract Dispute(s), or fails to issue a Subcontract Senior Representative Panel Notice, or otherwise require resolution of a Subcontract Dispute by providing written notice to the other Party (a "**Subcontract Arbitration Notice**") within thirty (30) days after receipt of the Subcontract Senior Representative Panel Notice or the Subcontract Senior Representative Panel's failure to issue such Subcontract Senior Representative Panel Notice within the time for doing so hereunder, and then by submitting such Subcontract Dispute to arbitration in accordance with the provisions of the *Arbitration Act, 1991* (Ontario), and the provisions of this Section 4 (the "**Subcontract Arbitration Procedure**") shall apply.

4.2 A single qualified and independent arbitrator knowledgeable in the subject matter of the Subcontract Dispute shall be jointly appointed by the Parties to preside over the

Subcontract Arbitration Procedure. Should the Parties be unable to agree upon an arbitrator within five (5) Business Days of delivery of the Subcontract Arbitration Notice, the Parties shall each appoint a single qualified and independent mediator or arbitrator knowledgeable in the subject matter of the Subcontract Dispute (each, a "**Subcontract Dispute Representative**"), and the Subcontract Dispute Representatives shall, within five (5) Business Days, appoint a single qualified and independent arbitrator knowledgeable in the subject matter of the Subcontract Dispute to preside over the Subcontract Arbitration Procedure. The decision of the Subcontract Dispute Representatives regarding the identity of the arbitrator shall be final and binding upon the Parties and the Parties agree that there shall be no appeal available to either or both of them to the decision of the Subcontract Dispute Representatives in this regard. An arbitrator with the requisite qualifications that is appointed pursuant to this Section 4.2 is hereinafter referred to as the "**Subcontract Arbitrator**".

4.3 Within ten (10) Business Days of the appointment of the Subcontract Arbitrator, the Parties shall submit their written positions to the Subcontract Arbitrator. Within five (5) Business Days of receiving the submissions of the Parties, the Subcontract Arbitrator shall coordinate with the Parties hearing dates that shall occur no later than twenty (20) Business Days following the deadline for the Subcontract Arbitrator's receipt of the Parties' submissions. Meetings and hearings of the Subcontract Arbitrator will take place either in the City of Ottawa or the City of Toronto. Subject to the foregoing, the Subcontract Arbitrator may fix the date, time and place of meetings and hearings in the arbitration and will give all parties adequate notice of same. Subject to any adjournments which the Subcontract Arbitrator allows, the final hearing will be continued on successive Business Days until it is concluded. All meetings and hearings will be in private unless the Parties agree otherwise and both Parties are entitled to be represented at any meetings or hearings by legal counsel. Either Party may examine and re-examine all its own witnesses at the arbitration and may cross-examine all of the other Party's witnesses.

4.4 The arbitration will be kept confidential and the existence of the proceeding and any element of it (including, but not limited to, any pleadings, briefs or other documents submitted and exchanged, and testimony or other oral submission and any awards) will not be disclosed beyond the Subcontract Arbitrator, the Parties, their counsel, the Finance Parties (as defined in the Project Agreement and as required under the Lending Agreements, also as defined in the Project Agreement), and any person necessary to the conduct of the proceeding, except as may be lawfully required in judicial proceedings relating to the arbitration or otherwise.

4.5 The Subcontract Arbitrator shall have the authority to award any remedy or relief that a court or judge of the Superior Court of Justice (Ontario) could order or grant in the circumstances, subject to and in accordance with this Subcontract, including, specific performance of any obligation created under this Subcontract, the issuance of an interim, interlocutory or permanent injunction, or the imposition of sanctions for abuse or frustration of the Subcontract Arbitration Procedure.

4.6 The Subcontract Arbitrator will make and send a decision in writing not later than fifteen (15) Business Days after the conclusion of the hearing and, unless the Parties agree otherwise, will set out reasons for the decision.

4.7 The decision of the Subcontract Arbitrator will be final and binding on the Parties and subject only to judicial review or appeal only in accordance with the provisions of the *Arbitration Act, 1991* (Ontario).

5. FAST TRACK SUBCONTRACT DISPUTE RESOLUTION PROCEDURE

5.1 Notwithstanding the provisions of Sections 3 and 4 of this Schedule C, if the Subcontract Dispute relates to a matter that may reasonably be expected to have an adverse impact on the Approved Subcontract Schedule or the Works Schedule (and unless the Parties otherwise agree) the Subcontract Dispute shall be resolved by arbitration pursuant to Section 4 of this Attachment 27 (without the requirement for reference to the Executive Panel pursuant to Section 3 of this Attachment 27) and with the following amendments to Section 4 (such amended Subcontract Dispute Resolution Procedure referred to hereinafter as the "**Fast Track Subcontract Dispute Resolution Procedure**"):

(a) The Subcontract Arbitration Procedure referenced in Section 4.1 shall be initiated within two (2) Business Days of receipt by either Party of a Subcontract Arbitration Notice from the other Party;

(b) the Parties shall agree upon a Subcontract Arbitrator to preside over the Subcontract Dispute pursuant to Section 4.2 in one (1) Business Day, and if they are unable to agree, shall each appoint a single Subcontract Dispute Representative in one (1) Business Day, and the Subcontract Dispute Representatives shall, within one (1) Business Day of being appointed, appoint a Subcontract Arbitrator;

(c) the Parties shall submit their written positions to the Subcontract Arbitrator within two (2) Business Days, and, within two (2) Business Days of receiving the submissions of the Parties, the Subcontract Arbitrator shall coordinate with the Parties hearing dates that shall occur no later than three (3) Business Days following the deadline for the Subcontract Arbitrator's receipt of the Parties' submissions;

(d) Subject to the Subcontract Arbitrator's sole discretion, any hearing in respect of the Fast Track Subcontract Dispute Resolution Procedure shall take place over a maximum of two (2) Business Days with one (1) Business Day for each Party to present its respective position to the arbitrator, provided that the Parties may, upon written agreement, extend the length of the hearing and the amount of time that each of them shall have to present their evidence; and

(e) the Subcontract Arbitrator shall send a decision in writing not later than five (5) Business Days after the conclusion of the hearing.

6. COSTS

6.1 The Parties shall instruct the Subcontract Arbitrator to award the costs of the arbitration.

7. MISCELLANEOUS

7.1 Construction Contractor and the Subcontractor shall diligently carry out their respective obligations under this Subcontract (including, for greater certainty, payment of any undisputed amounts and payment of any Delay Liquidated Damages) during the pendency of any Subcontract Disputes. If during the pendency of any Subcontract Dispute that is also a Dispute under Schedule 27 to the Project Agreement or under Attachment 27 to the Construction Contract, a direction is given by the City in accordance with section 13.1 of Schedule 27 of the Project Agreement, then without prejudice to the Subcontractor's rights in respect of the Subcontract Dispute, the Subcontractor shall proceed in accordance with the direction of the Construction Contractor (passing through the direction of the City), and in the event the matter in dispute is determined in favour of the Subcontractor, proceeding in accordance with the City's position, the provisions of Part 1 relating to Equivalent Project Relief shall apply.

SCHEDULE K
INSURANCE REQUIREMENTS

1. DESIGN AND CONSTRUCTION WORKS INSURANCE COVERAGE

1.1 INSURANCES REQUIRED

1.1.1 Subject to Article 8, from the date that is 15 days after execution of this Subcontract and until the Revenue Service Availability Date, the Subcontractor shall, at its own expense, obtain and maintain, or cause to be obtained and maintained, the following insurances, which are designated in Exhibit 1 to this Schedule K as insurances for which the Subontractor is responsible, as such insurances are further described in this Schedule K, and Part 1 of Appendix A to Schedule 25 to the Project Agreement, an extract of which has been attached hereto as Exhibit 1. These insurances are in addition to insurance protection afforded to the Subcontractor through insurance arranged by Project Co or the Construction Contractor, all in accordance with Article 1.1 of Schedule 25 of the Project Agreement and to the extent of the policies issued therefor:

(a) Automobile Liability;

(b) Commercial General Liability and Non-Owned Automobile Liability with respect to off-Site operations and activities;

(c) Aircraft and Watercraft Liability (if any exposure);

(d) Not used.

(e) “All Risks” Contractors’ Equipment;

(f) Comprehensive Crime; and

(g) WSIB.

1.1.2 The Parties acknolwedge that Project Co and Construction Contractor are required under Attachement 25 to the Construction Contract, from and after execution of the Project Agreement and until the Revenue Service Availability Date, at their own expense, to obtain and maintain, or cause to be obtained and maintained, subject to Article 8 of Attachment 25 to the Construction Contract, the insurances designated in Appendix A to the Attachement 25 to the Construction Contract as insurances for which Project Co and Construction Contractor, respectively, are responsible, as such insurances are further described in Appendix A to Attachement 25 to the Construction Contract and Part 1 of Appendix A to Schedule 25 to the Project Agreement.)

1.1.3 Notwithstanding anything else contained herein with respect to the Subcontracted Work, Subcontractor represents and warrants that it maintains and shall continue to maintain general liability insurance including coverage for products and completed operations (as that term is

generally understood in the Canadian insurance industry) for a limit equal to [redacted] Candian dollars ($[redacted] CDN), until two (2) years following the date stated in the actual Taking-Over Certificate. This insurance does not have to be specific to the Project but shall include coverage for the Project. Subcontractor shall be responsible for any deductible or self-insured retentions applicable to this insurance. Subcontractor shall deliver proof of such insurance coverage through a certificate of insurance addressed to Construction Contractor at delivery of the equipment and annually thereafter at the renewal date of such insurance. In the event of material alteration or cancellation of this insurance, the Subcontractor shall ensure that its insurer(s) provide thirty (30) days' notice of such material alteration or cancellation to Construction Contractor. All other terms and conditions of this Schedule K do not apply to this article 1.1.3.

1.2 OTHER PROVISIONS

1.2.1 With respect to the insurances for which the Subcontractor is responsible, the Subcontractor shall comply with the applicable requirements set out in this Schedule K, including Exhibit 1.

1.2.2 The Subcontractor shall be liable for any increase in the insurance premiums in respect of the insurance policies that the Construction Contractor or Project Co is required to obtain and maintain, or cause to be obtained and maintained, under the Construction Contract, where such increase is caused by the Subcontractor as a result of Subcontractor's adverse loss experience, including losses under Project Co or Contractor controlled insurance policies where such loss is caused by Subcontractor in the course of performance of the present Agreement, or an increased exposure to loss that could not have been reasonably ascertained by Construction Contractor at the signing of this agreement.

1.2.3 The Subcontractor shall, with respect to each of the insurances that it is required to obtain and maintain or cause to be obtained and maintained pursuant to this Schedule K, pay or cause to be paid each insurance premium when due and, on request from the Construction Contractor, produce receipts for such payment, if available.

1.2.4 Neither compliance nor failure to comply with the insurance provisions of this Subcontract shall relieve the Subcontractor or Construction Contractor of their respective liabilities and obligations under this Subcontract.

2. REFERENCES

2.1 The Subcontractor shall:

(a) ensure that where "Lenders" are required to appear in the insurance documentation, as specified in Article 2.1(c), each of the following appear in such insurance documentation: the Administrative Agent (in its capacity as administrative agent for the Senior Creditors) and the Collateral Agent (in its capacity as collateral agent for the Senior Creditors), each as defined hereafter:

Collateral Agent and Insurance Trustee:

BNY Trust Company of Canada
320 Bay Street, 11th Floor
Toronto, ON M5H 4A6

Administrative Agent:
National Bank Financial Inc.
130 King Street West, Suite 3200
Toronto, Ontario M5X 1J9

(b) ensure that the "Lenders" (as described in Article 2.1(a)) are noted as additional named insured to the extent of Subcontractor's indemnification obligations as defined in the Subcontract, and are afforded waivers of subrogation, in each case to the extent set out in the following Table 1:

Table 1 – Subcontractor Insurance Coverage

Policy	**"Lenders" as additional named insured**	**Subrogation waiver in favour of "Lenders"**
Automobile Liability	No	No
Commercial General Liability and Non Owned Automobile Liability	Yes	Yes
Aircraft and Watercraft Liability (if any exposure)	Yes	Yes
~~"All Risks" Marine Cargo (if any exposure)~~	~~Yes~~	~~Yes~~
"All Risks" Contractors' Equipment	No	Yes
Comprehensive Crime	No	No
WSIB	No	No

(c) ensure that each of the insurance policies described in Article 2.1(a), Table 1, shall contain a separation of insureds clause, as understood in the insurance industry, where appropriate;

(d) ensure that each of the insurance policies described in Article 2.1(b), Table 1, have modification and cancellation notice in accordance with Articles 15.1 and 15.2 and that the recipients of notice will include the "Lenders" (as described in Section 10.20(a)); and

(e) cause all insurance to be placed with insurance companies that are Qualified Insurers.

2.2 References herein to defined terms not otherwise defined in this Schedule K or in the Subcontract shall have the meaning prescribed in the Project Agreement or Construction Contract.

3. NO LIMIT ON RECOVERY

3.1 Notwithstanding any other provision of this Schedule K or the Subcontract, it is hereby agreed that the limits of liability specified in this Schedule K or the applicable provisions of Attachment 25 to the Construction Contract or Schedule 25 to the Project Agreement for insurance policies, whether such policies are required to be obtained (or caused to be obtained) by the Subcontractor, by Project Co or by the Construction Contractor, shall in no way limit the Subcontractor's liability or obligations to the Construction Contractor or the Construction Contractor's liability or obligations to the Subcontractor, as applicable.

4. ADDITIONAL COVER

4.1 Without prejudice to the other provisions of this Subcontract, the Subcontractor shall, at all relevant times and at its own expense, obtain and maintain, or cause to be obtained and maintained, those insurances which it is required to obtain and maintain, or cause to be obtained and maintained, by Applicable Law, or that it considers necessary.

4.2 The Construction Contractor reserves the right to require the Subcontractor to purchase such additional insurance coverage or requests higher or lower limits of insurance or otherwise alters the types of coverage requirements, their minimum amounts and deductibles (taking into consideration, without limitation, such as matters as the nature of the Subcontracted Works, operations and maintenance requirements, contract value, industry standards, and availability of insurance) , as the Construction may reasonably require from time to time. Any additional costs of such additional and/or amended insurance shall be borne by the Construction Contractor

5. RESPONSIBILITY FOR DEDUCTIBLES

5.1 The Party responsible for the matter giving rise to a claim, to the extent responsible therefor, shall be responsible and liable for the payment of deductibles under any policy of insurance under which it is an insured party or under any policy of insurance the Construction Contractor or Project Co is required to maintain (or cause to be maintained) under Attachment 25 to the Construction Contract or this Schedule K. In the event that responsibility for the matter giving rise to the claim is indeterminable, the First Named Insured under the policy of insurance is responsible and liable for the payment of deductibles. The Parties agree that, as between the Parties, Construction Contractor shall be entitled to all delay in start-up insurance proceeds.

6. COOPERATION WITH INSURER'S CONSULTANT

6.1 For insurance policies where the Subcontractor is included as an insured, If an insurer or an insurer's appointed consultant, for underwriting purposes or as a term of an insurance

policy, needs to review any part of the performance of the Subcontract, then the Construction Contractor shall, and shall require the Subcontractor to:

(a) cooperate with the insurer and its consultant, including providing them with such information and documentation as they may reasonably require; and

(b) allow the insurer and its consultant to attend meetings between any of Project Co, the City, the Construction Contractor or the Subcontractor (or, as applicable, and if reasonably required by the insurer, between the Subcontractor and those engaged by or through the Subontractor.

7. NOT USED

8. UNINSURABLE RISKS

8.1 The term "**Uninsurable Risk**" means a risk, or any component of a risk, against which the Subcontractor is required to insure under this Schedule K or Project Co or the Construction is required to insure pursuant to Attachment 25 and for which, at any time after the date of the Subcontract, either:

(a) the insurance required (including the terms and conditions specified for such insurance therein) is not available in relation to that risk:

(i) where Applicable Laws require that the insurer must be licensed in the Province of Ontario to insure such a risk, by insurers licensed in the Province of Ontario; or

(ii) where Applicable Laws do not require that the insurer must be licensed in the Province of Ontario to insure such a risk, by any insurer otherwise permitted under the terms of this Subcontract;

(b) the insurance premium payable or the terms and conditions for insuring that risk are such that the risk is not generally being insured against in the worldwide insurance market.

A risk, or component of a risk, shall not constitute an Uninsurable Risk under this Subcontract if it does not constitute a Uninsurable Risk as defined in (and for the purposes of) the Project Agreement. The Subcontractor shall provide such assistance (including documentation) to Project Co or the Construction Contractor as may be reasonably required by Project Co or the Construction Contractor in support of Project Co's demonstration to the City that the definition of Uninsurable Risk under the Project Agreement applies to a particular risk.

8.2 If the Subcontractor shall become aware of an Uninsurable Risk, the Subcontractor shall notify the Construction Contractor as soon as possible and, in any event, within 5 Business Days of becoming aware of same and shall provide the Construction Contractor (and, if required, Project Co) with all relevant details in relation to such risk, including a copy of the relevant insurance policy.

8.3 The Construction Contractor and the Subcontractor shall, as soon as possible following the provision of the notice referred to in Article 8.2, meet to discuss, in good faith, the appropriate means by which the Uninsurable Risk should be managed and, if Construction Contractor and the Subcontractor are able to agree to alternative arrangements, the Uninsurable Risk shall be managed in accordance with such alternative arrangements. The Subcontractor shall, to the extent permitted by Project Co and the City, participate in any discussions between Project Co and the City with respect to an Uninsurable Risk, and the Subcontractor shall abide by any agreement or arrangement reached by Project Co and the City.

8.4 The Subcontractor acknowledges that in the event that Project Co and the City are unable to agree to alternative arrangements with respect to the management of an Uninsurable Risk, the City may, in its absolute discretion, either:

(a) elect to assume responsibility for an Uninsurable Risk in relation to which the Subcontractor was required to insure, in which case, Construction Contractor shall withhold from any payment or payments due to the Subcontractor or collect as a debt from the Subcontractor an amount equal to any such amounts withheld or to be withheld by the City, and this Subcontract shall continue in full force and effect; or

(b) terminate the Project Agreement as though the Project Agreement had been terminated as a result of Project Co and the City having failed to reach agreement in accordance with section 47.2 of the Project Agreement following the occurrence of an event of Force Majeure (as defined in the Project Agreement), in which case, this Subcontract will automatically terminate.

8.5 The Subcontractor acknowledges that on the occurrence of an Uninsurable Risk, the City may, in its absolute discretion, either:

(a) pay to Project Co an amount equal to the insurance proceeds that would have been payable to the Subcontractor in connection with such Uninsurable Risk had the relevant insurance continued to be available, in which case, the Subcontractor will be entitled to such payment and this Subcontract shall continue in full force and effect and, to the extent that the Subcontractor would have been entitled to insurance proceeds had the relevant insurance continued to be available; or

(b) terminate the Project Agreement in accordance with section 47.2 of the Project Agreement, as though the Project Agreement had been terminated as a result of Project Co and the City having failed to reach agreement in accordance with section 47.2 of the Project Agreement following the occurrence of an event of Force Majeure, (as defined in the Project Agreement), in which case, this Subcontract will automatically terminate.

8.6 With respect to any Uninsurable Risk against which the Subcontractor is responsible to insure, the Subcontractor:

(a) shall continue to approach the insurance market on a regular basis and, in any event, at intervals of not less than 180 days and use reasonable efforts to obtain (or

cause to be obtained) insurance to cover as much or all of the Uninsurable Risk as can be insured in the available insurance market from time to time; and

(b) shall be relieved of its obligation to maintain (or cause to be maintained) insurance in respect of the Uninsurable Risk.

8.7 Where a risk against which the Subcontract is responsible to insure ceases to be an Uninsurable Risk, the Subcontractor shall, at its own expense, obtain and maintain, or cause to be obtained and maintained, insurance in accordance with the requirements of this Schedule K and the provisions of this Article 8 shall no longer apply to such risk.

9. TOTAL OR SUBSTANTIAL DESTRUCTION

9.1 In the event of damage to, or destruction of, all or substantially all of the System for which there is coverage under property and asset related insurance policies, the Subcontractor acknowledges that the Insurance Trust Agreement restrict the payment of insurance proceeds, including by requiring that any insurance proceeds shall first be applied to the reinstatement, restoration or replacement of the assets in respect of which insurance proceeds have been paid.

10. SUBCONTRACTORS

10.1 The Subcontractor shall require that all Sub-subcontractors are covered by, or obtain, the insurance described in this Schedule K, provided that the Subcontractor shall determine the applicable limits to be obtained for such insurance relating to the Sub-subcontractors, such limits to be in compliance with the requirements under Schedule K. The Subcontractor shall be solely responsible and liable for any damages which Project Co may suffer as a direct result of the Subcontractor's failure to comply with the foregoing.

10.2 The Subcontractor shall at immediately notify the Construction Contractor at any time Sub-subcontractor is not covered by any insurance required by Schedule K to be obtained (or caused to be obtained) by the Sub-subcontractor, and the Subcontractor:

(a) shall ensure that such insurance coverage is put in place forthwith;

(b) shall remove the Sub-subcontractor from the Site and ensure that it does not perform any further part of the Subcontracted Works at Site until after such insurance coverage is put in place; or

(c) acknowledges and agrees that if the Sub-subcontractor cannot be covered by a particular policy as required by this Schedule K, the Subcontractor shall replace the Sub-subcontractor with a new Sub-subcontractor who can be covered by insurance required by this Schedule K.

11. RENEWAL AND REINSTATEMENT

11.1 The Subcontractor shall provide to the Construction Contractor as soon as possible prior to the expiry date of any policy of insurance required to be obtained (or caused to be obtained) the

by Subcontractor pursuant to Schedule K to the Subcontract, evidence of the renewal of each such policy satisfactory to the Construction Contractor, Project Co, the "Lenders", the City, HMQ and IO, acting reasonably.

11.2 In the event that the limits of any of the insurance policies required to be placed and maintained by the present agreement or by the Construction Contractor or Project Co under Attachment 25 are eroded due to a claim or claims, and where Construction Contractor or Project Co is required by the City, Infrastructure Ontario, Her Majesty the Queen in Right of Ontario, the Lenders or any combination thereof to reinstate such insurance limits, insofar as the claim giving rise to the erosion of the policy limits to be reinstated is attributable in whole or in part to the fault of the Subcontractor, the Subcontractor shall be responsible for its proportional share of the insurance premium, brokers commission, and insurance premium tax incurred by the City, Project Co or the Construction Contractor to reinstate the limits of the insurance policy, up to a maximum cumulative aggregate sum of [redacted] Canadian dollars ($[redacted] CDN).

12. NAMED AND ADDITIONAL INSUREDS AND WAIVER OF SUBROGATION

12.1 Subcontractor pursuant to Schedule K to this Subcontract, shall:

(a) include the **Construction Contractor, Project Co, the City, HMQ IO and the "Lenders"** and any other party specified in Table 1 or Exhibit 1 as Additional Insureds to the extent specified in Table 1 or Exhibit 1, but only to the extent of Subcontractor's indemnifiction obligations as defined in the Subcontract;

(b) Not used;

(c) except with respect to Automobile Liability, Comprehensive Crime and WSIB, contain a waiver of subrogation as against the City, City Parties (as defined in the Project Agreement) and their respective shareholders, officials, directors, officers, employees, servants, consultants (other than design consultants) and agents and, to the extent indicated in Table 1, the "Lenders";

(d) contain a breach of warranty provision whereby a breach of a condition by the Subcontractor will not eliminate or reduce coverage for any other insured; and,

(e) be primary insurance with respect to any similar coverage provided by any insurance obtained by or available to the City without any right of contribution of any insurance carried by the City.

12.2 The Subcontractor acknowledges that, notwithstanding that the City includes each board commission or other subdivision, department or branch of the City and "HMQ" includes each ministry, agency, board or other subdivision, department or branch of HMQ, for purposes of Schedule K to this Subconract, certain department and branches of the City and certain ministries and agencies of HMQ are listed as Named Insureds and/or Additional Insureds for greater certainty and for insurance evidence requirements.

13. CERTIFICATES OF INSURANCE POLICIES

13.1 Prior to the commencement of any part of the Subcontracted Works, the Subcontractor will provide the Construction Contractor with certificates of insurance, confirming that the insurances specified, and for which the Subcontractor is responsible in Article 1.1 have been obtained and are in full force and effect.

14. FAILURE TO MEET INSURANCE REQUIREMENTS

14.1 If the Subcontractor fails to obtain or maintain, or cause to be obtained and maintained, the insurance required by this Schedule K, or, the policy lapses, is cancelled, or is materially altered, then in addition to any other rights of the Construction Contractor may have, including in respect of a Subcontractor Event of Default, the Construction Contractor, shall have the right, without obligation to do so, to obtain and maintain such insurance itself in the name of the Subcontractor, and the cost thereof shall either, at the Construction Contractor's option, be payable by the Subcontractor to the Construction Contractor on demand or be deducted by the Construction Contractor from the next payment or payments otherwise due to the Subcontractor.

14.2 If coverage under any insurance policy required to be obtained (or caused to be obtained) by the Subcontractor should lapse, be terminated or be cancelled, then, if directed by the Construction Contractor, the City or Project Co, all work by the Subcontractor shall immediately cease until satisfactory evidence of renewal is produced.

15. MODIFICATION OR CANCELLATION OF POLICIES

15.1 Except as noted in Exhibit 1, all insurance provided by the Subcontractor shall contain endorsements confirming that the policy will not be cancelled without the insurer(s) giving at least thirty (30) days prior written notice by registered mail, at the addresses specified, to the Construction Contractor, Project Co, the City HMQ, IO and the "Lenders".

15.2 All insurance provided by the Subcontractor pursuant to this Schedule K shall contain endorsements confirming that, in the event of cancellation for non-payment of premium, the insurer(s) will give at least fifteen (15) days prior written notice by registered mail, at the addresses specified, to the Construction Contractor, Project Co, the City and the "Lenders".

15.3 Not used.

16. INSURERS

16.1 All policies of insurance to be obtained (or caused to be obtained) by the Construction Contractor, Project Co or the Subcontractor in accordance with this Schedule K to the Subcontract shall be issued by financially sound insurers acceptable to Project Co, the Construction Contractor, the City and the Lenders, acting reasonably, and, where required by statute, be licensed to insure such risk in the Province of Ontario.

16.2 To be eligible to provide insurance, an insurer must be acceptable to the Senior Creditors' Insurance Advisor (as defined in the Credit Agreement) and have the capacity to provide the particular insurance and shall have current ratings from time to time of either:

(a) a Financial Strength Rating of not lower than "A-" for three out of the previous five years but not lower than "B" at any time during those five years, and a Financial Size Category not lower than VII, such ratings being those established by A. M. Best Company (Best); or

(b) a Long-Term Financial Strength Rating of not lower than "A-" for three out of the past five years but not less than "BBB" at any time during those five years, a Short-Term Financial Strength Rating of not lower than "A-3" for three out of the previous five years and a Financial Enhancement Rating of not lower than "A-" for three out of the previous five years but not less than "BB+" at any time during those five years, such ratings being those established by Standard and Poor's (S&P); or

(c) if the insurer is not rated by Best or S&P, an insurer that is acceptable to Project Co, the Construction Contractor, the City and the Lenders, acting reasonably, with respect to the insurances required by this Schedule K to the Subcontract.

17. POLICY TERMS AND CONDITIONS

17.1 All policies of insurance to be obtained (or caused to be obtained) by the Subcontractor in accordance with this Schedule K to the Subcontract shall be in form and substance consistant with insurance industry standards.

17.2 To achieve the minimum limits for any type of insurance required under Appendix A, it is permissible to arrange the insurance under a single policy, or by a combination of primary, umbrella and/or excess policies.

18. FAILURE TO COMPLY

18.1 Neither failure to comply nor full compliance by the Subcontractor with the insurance provisions of this Schedule K to the Subcontract shall relieve the Subcontractor of its liabilities and obligations under this Subcontract.

19 NOT USED

20. INSURANCE PROCEEDS

20.1 Insurance proceeds shall be applied strictly in accordance with the provisions of the Project Agreement, Construction Contract, the Subcontract and, where applicable, the Insurance Trust Agreement.

Exhibit 1 to Schedule K (Insurance)
From first Access to Site until the Revenue Service Availability Date (Insurance for Design and Construction Works)

Insurances to be provided by Subcontractor

Type	Amount	Maximum Deductibles	Principal Cover
Automobile Liability	$[redacted] (Minimum) for vehicles		Standard Ontario Owners Form For all vehicles operated by Subcontractor in connection with the Project. Business Automobile Liability insurance covering third party property damage and bodily injury liability (including accident benefits) arising out of any licensed vehicle.
Commercial General Liability and Non-Owned Automobile Liability including Direct and Contingent Employers Liability, Products and Completed Operations Liability, and Owner's and Contractor's Protective extensions	(i).1.1 $[redacted] each occurrence, and in the annual aggregate with respect to Broad Form Completed Operations Limits of liability may be structured as any combination of Primary plus supplementary layers and Umbrella and/or Excess, or Primary plus Umbrella and/or Excess • Owner's and Contractor's Protective • Blanket Contractual (written) • Direct and Contingent Employers Liability • Personal Injury (nil participation)		Commercial General Liability insurance covering all operations on an occurrence basis against claims for Bodily Injury (including Death), Broad Form Property Damage (including Loss of Use), and including Broad Form Products and Completed Operations Liability. This Commercial General Liability Insurance will cover off-site activities connected to the project and Products and Completed Operations Liability beyond the "Wrap-Up" Commercial General Liability Insurance policy's Products and Completed Operations extension period. this insurance shall be maintained in effect during the Design and Construction Works and until twelve (12) months following the earlier of the termination of the Subcontractors involvement in the Design and Construction Works..

Type	Amount	Maximum Deductibles	Principal Cover
			• Cross Liability and Severability of Interest with respect to each insured party • Blasting / demolition / excavating / underpinning / pile driving / shoring / caisson work / work below ground surface / tunnelling/grading and similar operations associated with the Initial Works as applicable • Elevator and Hoist Collision Liability • Non-Owned Automobile Liability • Prairie or Forest Fire Fighting Expenses – subject to sub-limit • Permission for Unlicensed Vehicles' (partial road use) • Unlicensed Equipment • Loss of Use Without Property Damage • Loading and Unloading of Automobiles • Broad Form Property Damage • Broad Form Completed Operations • Intentional Injury, committed to Protect Persons or Property • Worldwide Territory, subject to suits being brought in Canada or the US Permitted Exclusions: • Injury to employees, where

Type	Amount	Maximum Deductibles	Principal Cover
	WSIB provides valid coverage • Property in the care, custody or control of the insured, except as provided under Broad Form Products and Completed Operations • Operation of licensed motor vehicles, other than attached machinery, while used for its purpose or at the Site • Cyber risk • Mould, fungi and fungal derivatives • Professional liability of engineers, architects and other professional consultants • Nuclear or radioactive contamination, except release of radioactive isotopes intended for scientific, medical, industrial or commercial use		
Comments	• Project Co, Construction Contractor,The City, HMQ, IO and the Lenders will be identified as Additional Insureds		
Underwriters	Eligible insurers as defined herein.		

From First Access to Site until the Revenue Service Availability Date (Insurance for Design and Construction Works)

Insurances to be provided, or caused to be provided, by Project Co

Type	Amount	Maximum Deductibles	Principal Cover
Aircraft and Watercraft Liability **(If any exposure)**	Minimum $[redacted] inclusive, including $[redacted] passenger hazard – Owned Aircraft Minimum $[redacted] inclusive – Non-Owned Aircraft Minimum $[redacted] inclusive Owned or Non-Owned Watercraft	To be determined	Policies shall be endorsed to preclude cancellation, except upon 90 days prior written notice provided to the City, HMQ, IO and the Lenders.
Comments	• The City, HMQ, IO and the Lenders will be identified as Additional Insureds or insured clients of Project Co and its Affiliates		
[redacted]			
	•		
"All Risks" Contractors' Equipment To cover Subcontractor	If Site equipment is three years old or less, the sum insured shall be equal to [redacted]% of the replacement value of all contractors equipment used at the project. If Site equipment is more than three years old, actual cash value basis of loss settlement is acceptable.		All Risks coverage on all owned, rented, leased or borrowed contractors' equipment, used at the Site.
Comments	• Waiver of Subrogation rights against Project Co, the City, HMQ, IO, the Construction Contractor,		

From First Access to Site until the Revenue Service Availability Date (Insurance for Design and Construction Works)

Insurances to be provided, or caused to be provided, by Project Co

Type	Amount	Maximum Deductibles	Principal Cover
Employee Dishonesty (Crime)	$[redacted] per loss		Employee Dishonesty insurance against the fraudulent/dishonest acts of employees of Project Co and its Affiliates including additional coverage for Broad Form Money and Securities, Money Orders and Counterfeit Paper, Depositors' Forgery, Computer Fraud and Funds Transfer Fraud, Audit Expenses and Credit Card Forgery. Insurance primary without right of contribution of any other insurance carried by the City, HMQ, IO or the Lenders.
Underwriters (All non-IOCIP Initial Works insurance to be provided or caused to be provided by Project Co)	Principal underwriters in compliance with **Error! Reference source not found.** of this Schedule 25		
WSIB	In accordance with Ontario Act's established benefits and schedules	Not Applicable	Prior to commencement of the Design and Construction Works, Subcontractor shall provide satisfactory written confirmation of compliance, from the appropriate authority, including confirmation that all required assessments have been paid to date. Upon the termination of the Subcontractor involvement in the Design and Construction Works, Construction Contractor shall be provided with satisfactory written confirmation that all required assessments have been paid to date. On request, within 30 days of such request, Subcontractor shall deliver to the Construction Contractor evidence of the workers compensation coverage maintained by any person involved in the Design and Construction Works, or confirmation of that person's exemption from workers compensation coverage.

"Construction Contractor" means OLRT Constructors, an unincorporated joint venture consisting of SNC-LAVALIN CONSTRUCTORS (PACIFIC) DRAGADOS CANADA, INC., ELLISDON CORPORATION

"**Project Co**" means Rideau Transit Group General Partnership.

"**City**" means City of Ottawa.

"**IO**" means Ontario Infrastructure and Lands Corporation, a non-share capital corporation continued under the *Ontario Infrastructure and Lands Corporation Act*, S.O. 2011, c.9, Schedule 32, as amended.

"**HMQ**" means Her Majesty the Queen in Right of Ontario.

OTTAWA LIGHT RAIL TRANSIT PROJECT

COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION

Prepared by::	M. Palmer	
Reviewed by:	K. Brown	
Approved by:	J. Selke	
	Name	Signature

Document No.	**507528-0000-48EG-0001, Rev. 02**

	12/09/18 yy/mm/dd DATE

SPECIFICATION REVISION INDEX

Revision No.	Prepared / Date	Pages Revised	Remarks
00	2012/03/15		Issued for RFP
01			Section 6.0 Scope Split
02	2012/09/14		Updated to incorporate PA amendments and to clarify Thales' scope of work.

TABLE OF CONTENTS

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1.0 INTRODUCTION

1.1 Purpose

This document specifies the system requirements for the Provision of the Communications Based Train Control ("CBTC") system that is required for the Ottawa Light Rail Transit Project ("OLRT").

1.2 Scope

The CBTC system is a component of the electrical and mechanical systems of the OLRT Project. Drawing 3030-48DK-SW-0300-FI (the CBTC System Context Diagram) displays the scope of the CBTC System.

The mandate of the CBTC System is to provide the following, as a minimum:

- vital Automatic Train Protection ("ATP") functionality with a moving or virtual block signalling design,
- non-vital Automatic Train Operation ("ATO") functionality, operating within the limits established by the vital ATP system,
- non-vital Automatic Train Supervision ("ATS") functionality to non-vitally adjust the Train speed limits, and to adjust station dwell times to optimize Headway and Train spacing and to reduce energy usage,
- a minimum sustained operating Headway of 105 seconds under typical operating conditions and a minimum designed Headway of under 90 seconds,
- fixed block Train detection functionality to allow the CBTC system to locate trains in the event of communications failure,
- a high level of availability and reliability, and
- user interfaces for the System Users.

1.3 Definitions, Acronyms, and Abbreviations

1.3.1 Definitions

The following definitions are utilised in this specification:

- **City** and **Client** shall refer to the City of Ottawa.
- **Fail-Safe** shall refer to the condition where failure of any system, equipment or component results in a safe condition.
- **Headway** shall be defined as the time required for two consecutive trains, travelling in the same direction on the same track, with the same stopping pattern, to traverse an identical reference point.
- **Line** shall refer to the OLRT Line in Ottawa, Ontario, Canada.
- **Project** shall refer to the Ottawa Light Rail Transit Project.
- **Specification** shall refer to this document, the OLRT Project CBTC System Specification.
- **Works** shall refer to the work to be undertaken to facilitate the design, engineering, manufacturing, testing, delivery, installation (if applicable), commissioning and warranty of

the work hereunder to the System as set out in Client's Project Agreement and Request for Proposal dated October 27, 2011 for the OLRT (each as amended).

1.3.2 Acronyms and Abbreviations

The following acronyms and abbreviations are utilised in the definition of this Specification:

AAR	Association of American Railroads
AP	Access Point
AREMA	American Railway Engineering and Maintenance-of-Way Association
ATC	Automatic Train Control
ATCS	Automatic Train Control System
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
AW2	vehicle weight with driver, all passenger seating full, and with passengers standing at 4/m²
AW4	vehicle weight with driver, all passenger seating full, and with passengers standing at 8/m²
bps	bits per second
BRT	Bus Rapid Transit
CBTC	Communications Based Train Control
CIH	Central Instrument House
CRO	CRO Control Room Operator
CS	Communications System
E&M	Electrical and Mechanical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
GUI	Graphic User Interface
HVAC	Heating, Ventilation, and Air Conditioning
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronics Engineers
ESB	ESB Emergency Stop Button
km	Kilometre(s)
km/h	Kilometres per Hour
LRV	Light Rail Vehicle

LRT	Light Rail Transit
m/s	Metres per Second
MSF	Maintenance and Storage Facility
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
NEMA	National Electrical Manufacturer's Association
OBC	On Board Computer
OCC	Operations Control Centre
OCS	Overhead Catenary System
OLRT	Ottawa Light Rail Transit
pphpd	Passengers Per Hour Per Direction
RAMS	Reliability, Availability, Maintainability and Safety
RFID	Radio Frequency Identification
SCADA	Supervisory Control And Data Acquisition
SIL	Safety Integrity Level
STTS	Simulation Training and Testing System
TBA	To Be Advised
TBD	To Be Determined
TSCC	Transportation Services Control Centre
UPS	Uninterruptible Power Supply
VLS	Vehicle Location System
VMIS	Vital Microprocessor Interlocking System
VMS	Variable Message Sign
YCC	Yard Control Centre

1.4 References

The following references have been utilised in the definition of this Specification:

[1] OLRT Project Agreement, as amended, Schedule 15-2, Part 4, Article 5, Train Control,.

[2] OLRT Project Agreement, as amended, Schedule 15-2, Part 4, Article 6, Communications,.

[3] OLRT Project Agreement, as amended, Schedule 14, Commissioning,

[4] OLRT Project Agreement, as amended, Schedule 15-2, Part 1, Article 2, Operational Performance Requirements

[5] EN50121, Railway Applications – Electromagnetic Compatibility.

[6] EN50125, Railway Applications – Environmental Conditions for Equipment.

[7] EN50126, Railway Applications – The Specification and Demonstration of Dependability, Reliability, Availability, Maintainability, and Safety .

[8] EN50128, Railway Applications – Software for Railway Control and Protection Systems.

[9] EN51029, Railway Applications – Safety Related Electronic Systems for Signalling.

[10] EN50155, Railway Applications – Electronic Equipment Used on Rolling Stock.

[11] EN50159, Railway Applications – Part 2: Safety Related Communication in Open Transmission Systems.

[12] IEC 61508, Functional Safety of Electrical / Electronic / Programmable Electronic Safety related Systems.

[13] IEEE 1474.1, CBTC Performance and Functional Requirements.

[14] IEEE 1474.2, Functioning of and Interfaces Among Propulsion, Friction Brake and Train-borne Master Control on Rail Rapid Transit Vehicles.

[15] IEEE 1474.3, Recommended Practice for CBTC System Design and Functional Allocations.

[16] IEEE 1483, Verification of Vital Functions in Processor Based Systems Used in Rail Transit Control.

2.0 SYSTEMS SUMMARY

2.1 Overview

2.1.1 Ottawa Light Rapid Transit Project Overview

The OLRT Project will provide an integrated LRT System capable of delivering public transit service in a safe, reliable, and efficient manner and in accordance with the operational performance parameters that have been specified for the Project in the Project Agreement.

Responsibility for operation of the OLRT will rest with the Client. The design and construction of the CBTC system shall thoroughly consider the operational requirements and functionality of the Line as specified in the Project Agreement and shall validate the operational capabilities through performance simulation.

In order to meet the high capacity operational needs of the Project, the Line shall be designed and constructed to be highly integrated and highly reliable across all major rail systems including, but not limited to, the following:

- vehicles,
- train control and signalling,
- traction power,
- stations,
- tunnel ventilation[1], and
- track and special trackwork.

The Project shall consist of surface track and two below-grade track sections - a downtown area underground section and a second underground section that provides access to the MSF.

The Project shall include thirteen stations comprised of the following:

- three new underground stations located in the downtown area of the Project,
- four transfer stations (including two terminal stations),
- four BRT to LRT station conversions, and
- two new at-grade stations that are located along the surface alignment.

An MSF shall be provided for the Project to service and store the LRVs. This facility shall contain everything required for the maintenance and storage of the LRVs.

Specification and drawings of the functional details of the OLRT CBTC system may be found in Section 4.0 and 5.0 herein respectively. A summary of the operating characteristics and functional requirements are provided below.

[1] The tunnel will be partitioned into a number of tunnel ventilation zones. The CBTC system shall be capable of restricting the maximum number of controlled trains present at any given time in each tunnel ventilation zone

2.1.2 Operating Characteristics

2.1.2.1 Headways

The CBTC system shall be capable of reliably supporting a minimum sustained operating Headway of 105 seconds, under typical operating conditions, and a minimum designed Headway of under 90 seconds.

The CBTC system shall be capable of reliably supporting a minimum sustained operating Headway of 900 seconds (15 minutes) during a single track outage at any location throughout the Line to support maintenance activities and continued operation during unplanned outages.

The Client seeks to minimize operating costs by maximizing Train capacity and peak operating Headways to achieve the required capacity and has identified the Headways stated for the planned operating scenarios (refer to section 2.1.2.3 herein). If required, alternate operating Headways for each of the planned scenarios should be established, based upon the actual supplied vehicle, provided the other CBTC system capacity criteria and operational performance requirements are met.

2.1.2.2 Hours of Operation

The CBTC system shall support the following hours of train operation:

- Monday through Thursday: 05:00 – 01:00
- Friday: 05:00 – 02:00
- Saturday and select Holidays: 06:00 – 02:00
- Sunday and select Holidays: 08:00 – 23:00

Operational scenarios are anticipated during which train operation will extend beyond the above hours of operation. For example, passengers entering the Line at any station during the above hours must be able to travel to any other station even if a portion of their journey takes place outside of the above hours of operation.

Passenger facilities in stations shall be available for use by passengers from 15 minutes prior to the departure of the first scheduled train from that station until 15 minutes after the departure of the last scheduled train from that station.

2.1.2.3 Planned Operating Scenarios

The following operating service scenarios have been established by the Client:

- Operating Scenario 1: Opening day operation with peak period Headways of approximately 3.25 minutes (195 seconds) utilizing train consists of approximately 120 metres in length to provide a passenger carrying capacity of 11,360 (minimum) pphpd.

- Operating Scenario 2: Year 2031 operation with peak period Headways of approximately 2.1 minutes (126 seconds) utilizing train consists of approximately 120 metres in length to provide a passenger carrying capacity of 18,040 (minimum) pphpd.

- Operating Scenario 3: Ultimate capacity operation with peak period Headways of 2 minutes (120 seconds) or less utilizing train consists of approximately 150 metres in length to provide a passenger carrying capacity of 24,000 pphpd.

The CBTC system shall be capable of supporting Operating Scenario 1 and Operating Scenario 2 and shall be capable of being expanded in the future to support Operating Scenario 3, without undue modification or loss of investment in the initial CBTC system.

2.1.2.4 Travel Times and Average Speeds

To ensure an efficient and effective service, the CBTC system and the rolling stock shall support a maximum terminal to terminal travel time (start to stop) during the peak period. Actual terminal to terminal travel times shall be determined using stochastic operations simulation analysis of the proposed Line under manual and ATO operations.

The maximum terminal to terminal travel time during the peak period shall be 24 minutes in manual mode (including dwell time and accounting for underperformance resulting from driver-controlled vehicle movement) and 23 minutes in ATO mode (including dwell time).

2.1.2.4.1 Manual Operating Mode

Trip times for manual operations shall be determined through simulation with stochastic variations in driver performance and dwell times.

Dwell time variance shall consider the effect of late trains based on industry experience as documented in the simulation report. In the absence of delay-based dwell time simulation, a randomized uniform distribution around the nominal calculated dwell times of not less than plus and minus 5 seconds shall be applied.

Driver performance variations shall be set such that the average terminal to terminal running time shall be at least [redacted]% greater that the ideal trip time under full performance.

2.1.2.4.2 ATO Operating Mode

Trip times for ATO operations shall be determined through simulation with stochastic variations of dwell times, and appropriate variations in vehicle performance based on performance tolerances of the vehicle and the ATO equipment.

For analysis purposes, dwell time variation for ATO operations shall follow a uniform distribution around the nominal, calculated dwell times based on experience and recommendations, but no less than plus and minus 5 seconds.

2.1.2.4.3 Dwell Times

Dwell times at each station, which shall be included in the calculation of the maximum travel time, shall be based on the directional peak hour passenger boardings and alightings.

The absolute minimum dwell time shall be 20 seconds at all stations during the peak period.

Passenger loading and unloading time at terminal stations is considered part of the terminal layover time, and shall not be included in the calculation of the maximum travel time.

2.1.2.4.4 Terminal Times

Terminal time shall be defined based on the proposed Headway for each operating scenario and shall be maximized to the capacity of each terminal station. A minimum terminal time shall be no less than one operating Headway.

The absolute minimum terminal time shall not exceed the calculated time required for passenger loading and unloading at the terminal stations during the peak hour including an appropriate allowance for variations in passenger flow.

An operational simulation validating compliance with these terminal times shall report the distribution of terminal times at each terminal station and discuss the ability of the CBTC system to reliably meet the terminal time requirements.

2.1.2.5 Fleet Size and Train Lengths

A sufficient fleet of LRVs shall be procured to support the needs of the Line based on the following:

- the planned service capacity as documented in the Operating Service Plan, and
- the effective execution of the rail fleet maintenance program with an appropriate maintenance spare ratio.

34 vehicles shall be required for revenue service commencement.[2]

The platforms lengths for scenarios 1 and 2 are 90 m, and with envisioned provision for a 10m extension in scenario 3.

The maximum train consist length shall be compatible with normal platform lengths of 90m for Operating Scenario 1 and Operating Scenario 2 (identified in section 2.1.2.3 herein). For off-peak periods within these operating scenarios, the CBTC system shall be capable of operating with shorter train consist lengths.

The CBTC System shall be configured to maximize train throughput, and to be generally compatible with long term plans (Operating Scenario 3) to operate headways down to 105s.

2.1.2.5.1 Maintenance and Storage Facility

The MSF shall be designed and constructed to accommodate the LRVs that are required to meet the operational performance requirements for Operating Scenario 1 and Operating Scenario 2 (refer to section 2.1.2.3) as well as any non-revenue and specialty vehicles required to fulfil the Line's maintenance requirements and obligations.

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[2] Even though only 34 vehicles are required for Scenario 1, CBTC software subsystems and databases shall support up to 80 unique VOBC IDs in the 2018 delivery

2.1.3 Train Control Functional Summary

The CBTC system shall be based on a proven CBTC architecture which allows automatic operation of LRVs under manual supervision in a segregated guideway with short Headways.

The CBTC system shall provide the ability to also operate the LRVs manually (line of sight).

Trains shall bi-directionally communicate to the wayside equipment through a high availability communications medium.

The design of the CBTC system shall be fail-safe to maximize the safety and security of all personnel and passengers.

The CBTC system is a safety critical computer based control system that provides the following minimum functionality:

- vehicle identification,
- vehicle location control and monitoring,
- maintaining a safe distance between vehicles,
- vehicle speed control,
- maintaining safe brake rates,
- vehicle route selection and fleet management,
- interlocking control,
- power consumption optimization,
- broken rail detection on the mainline
- fixed block train detection and signals at interlockings (for failure management), on the mainline and portion of the yard where the OC Transpo drivers operate.

As a minimum, the fixed block train detection layout shall include a block for each station / interlocking. Thales shall provide the proposed block layout in their technical response to this specification.

2.1.3.1 Maintenance and Storage Facility Operation

Thales shall provide fully automated control (driverless) of the MSF territory by the CBTC system, as implemented on the mainline, and integrated with the mainline System. The CBTC system shall ensure that trains are prevented from entering the mainline in UTO (driverless) mode.

The tracks leading into the vehicle maintenance shop shall be a manual operation area. Thales shall provide the necessary functionality to safely manage the transition between this manual area and the automatic tracks. Operation in the transition area shall be as per section 5.4.4.7 of Appendix 1.

2.1.3.1.1 Coupling and Uncoupling

Thales shall provide, fully automatic unattended coupling and uncoupling in designated areas within the MSF territory. This functionality is required to reconfigure trains for unscheduled

maintenance, etc. With automatic coupling and uncoupling, the final configuration of the Train(s) shall be established by the CBTC system without operator involvement.

Thales shall specify the Onboard CBTC-Vehicle interface requirements to accommodate automatic coupling and uncoupling functionality.

2.1.3.2 Simulation Training and Testing System

The CBTC system shall include a Simulation Training and Testing System (STTS). The STTS shall be used for operator training, timetable performance verification, and CBTC system testing. The STTS shall execute the actual CBTC system software (excluding vital I/O components) that will be used in the revenue System, in conjunction with a track and vehicle emulator. The track and vehicle emulator shall allow the STTS to simulate indications from trains and from the wayside devices.

The STTS shall provide functionality to simulate the following:

- the entire Line, including both the mainline and the MSF territory,
- movement of trains anywhere on the simulated track,
- all wayside devices to which the CBTC must interface (e.g. switches, signals, intrusion detectors, yard ESB and
- the revenue System functionality.

It shall be possible to execute predefined training / testing scenarios on the STTS including the injection of full or partial equipment failures. These equipment failures shall include, but not be limited to, the following:

- switch failures,
- Zone controller failures
- ATS server failures
- vehicle propulsion failures,
- communications failures, and
- trainborne CBTC system equipment failures.

It shall be possible for a trainer to prepare scripts for the training scenarios off-line and then load the scripts onto the STTS for execution via the Trainer's Workstation. The trainer shall be able to control the simulation, including injection of full or partial equipment failures via the Trainer's Workstation.

It shall be possible to manually operate a selected simulated train as per manual mode of operation.

All CBTC system displays available to the CROs in the revenue Control Room shall be available on the STTS. The STTS shall not communicate or interface with the revenue System in any manner.

The STTS shall provide a playback or rerun capability where it shall be possible to review the revenue or STTS operators' interactions, the operating state of the train(s), and the equipment working state in fast-forward, pause, stop, or real-time speed modes.

2.1.3.3 Communications Interface

The CBTC system shall provide train location, destination and routing information to the wayside and vehicle-borne Passenger Information and Passenger Announcement systems via the Communications System.

The CBTC system shall provide data to the Client's applications and systems. The CBTC system shall support periodic backup of operational data and logs to the City's central backup facility over a network connection that will be provided by Others.

Data requests and transfers to external systems shall occur over a network other than the CBTC network. The CBTC interface to external systems shall be provided with hardware and software security measures to block external access to the CBTC network.

The CBTC system shall provide such other information to the Communications Systems as may be identified by the Client during the detailed design review phase of the Project.

The CBTC system shall receive and react to information from the Communication System including, but not limited to, status of traction power sections.

The onboard CBTC System shall provide master clock time updates to the vehicle subsystems.

2.1.3.4 Vehicle Interface

Thales shall coordinate with the vehicle supplier to develop and agree on installation details for the trainborne CBTC system equipment and to ensure that all interfaces between the CBTC system and the vehicle shall function correctly. This shall include, but not be limited to, the function of spin/slide management.

Thales shall develop in collaboration and agreement with the vehicle supplier, a strategy for early integrated system testing of the trainborne CBTC system equipment and the vehicle at the vehicle supplier's premises.

Thales acknowledges that a CBTC System has never been integrated with a Low-Floor LRV. Furthermore the Vehicle Supplier acknowledges that the vehicle, including the Train Control/Vehicle interface must perform reliably in the extreme climate of the City of Ottawa. Thales shall be jointly and severally responsible with the Vehicle Supplier for all aspects of the interface between all vehicle and Train Control equipment. This includes, but is not limited to, detailed design, implementation, testing and demonstration, and performance of all vehicle and Train Control equipment interfaces.

As far as practicable Thales shall demonstrate all vehicle and Train Control equipment interfaces at the supplier's test track prior to the delivery of the first vehicle to the site. This shall include, but is not limited to, demonstration of the integration of the spin/slide control system with the Train Control system, as well as demonstration of the automatic yard functions of Unattended Train Operation with unattended coupling and uncoupling.

3.0 GENERAL REQUIREMENTS

3.1 Co-ordinated Installation Programme

There will be a number of other suppliers and sub-contractors (civil, E&M, etc.) involved in the Works. The Designer-Builder or its designate, in consultation with Thales and the other suppliers, will be responsible for the production of the Co-ordinated Installation Programme (CIP) for the Project. Thales' schedule must be coordinated with the Designer-Builder and these other parties as their respective contracts are awarded.

Thales shall co-operate with the Designer-Builder and other parties, including provision of details of Thales' schedule, in order to create an workable schedule and a CIP.

Thales shall comply with the following conditions in their co-ordination on the CIP:

- Thales shall not have exclusive access to any area except by specific written agreement from the Designer-Builder,
- Thales shall take note that when the same time allocation for certain areas has been given to more than one supplier, Thales shall co-ordinate their work in such areas with that of the other suppliers without detriment to the schedule, and
- the absence of a scheduled date or installation period for Thales in a specific area shall not prejudice the right of the Designer-Builder to establish a reasonable date or installation period for that area.

Thales shall provide a preliminary installation plan identifying the planned locations and equipment room sizes for the CBTC system equipment. Thales shall as far as possible maximize the use of equipment rooms in stations and the MSF building and minimize the use of Central Instrument Houses along the wayside.

3.2 Test and Commissioning

Thales shall be responsible for undertaking all necessary testing activities for the Train Control system.

Thales shall develop, organize and implement test and commissioning plans that verify that the CBTC system meets all its functional, safety, systems assurance, and performance requirements.

Factory and site tests shall be performed. Deliverables shall not be shipped until all required factory inspections and tests have been completed, test results and reports submitted and all deficiencies have been corrected to the Designer-Builder's satisfaction. Site testing shall ensure that the CBTC system has been correctly installed, and that the system satisfies all performance, safety, reliability, and functional requirements while in revenue service. Spare parts shall be tested in the identical manner as other equipment.

Thales shall provide on-site support during the CBTC system test and commissioning phases of the Project.

3.3 Training

Thales shall provide a training programme for the Designer-Builder's training instructors (i.e., train the trainers) and supervisory staff of sufficient quality and depth to permit satisfactory operation, servicing, and maintenance of the CBTC system.

Thales shall provide adequate training software, such as computer based training packages, videos, slides, drawings, printed materials, and training manuals to conduct the training effectively.

The requirements of the training programme shall include, but not be limited to, the following:

- establish training objectives and recommended training methods suitable for the Designer-Builder's operations and maintenance staff,
- define course attendee pass/fail criteria,
- develop and provide training through the use of classroom and hands-on instruction, simulators, mock-ups, models, manuals, diagrams, and parts catalogues, and
- provide initial training for designated Designer-Builder staff, to enable them to support testing and operational evaluation tasks and to a level proficient enough to enable them to conduct training of additional designated Designer-Builder staff in the operation and maintenance of the CBTC system.

Thales shall provide on-site management and co-ordination of the training programme to ensure continuity of classes and proper distribution of training materials, and to be responsible for interfacing with instructors.

4.0 PROJECT AGREEMENT

Please refer to the Project Agreement (as amended) and in particular Schedule 15 thereto and specifically sections 5.4.1, 5.4.4, 5.4.5, and 5.4.6 of RTG's technical response narrative and the drawings, diagrams and cut sheets referenced therein (see Appendix 1 below).

5.0 DRAWINGS

This section contains the following reference drawings:

Drawing Number	Drawing Title
TRK-1-CK-001	OLRT Project - Tunney's Pasture to Blair Road - Track Chart - Sheet 15 of 1609
TRK-2-CK-001	OLRT Project - Tunney's Pasture to Blair Road - Track Chart - Sheet 308 of 1609
TRK-3-CK-001	OLRT Project - Tunney's Pasture to Blair Road - Track Chart - Sheet 724 of 1609
TRK-4-CK-001	OLRT Project - Tunney's Pasture to Blair Road - Track Chart - Sheet 986 of 1609
TRK-5-CK-001	OLRT Project - Tunney's Pasture to Blair Road - Track Chart - Sheet 1279 of 1609
TRK-4-CK-460	OLRT Project - Tunney's Pasture to Blair Road - Yard Yard Track Plan I - Sheet 1058 of 1609
TRK-4-CK-461	OLRT Project - Tunney's Pasture to Blair Road - Yard Yard Track Plan II - Sheet 1059 of 1609
TRK-4-CK-462	OLRT Project - Tunney's Pasture to Blair Road - Yard Yard Track Plan III - Sheet 1060 of 1609
3030-48DK-SW-0300-FI	OLRT Project - CBTC System Context Diagram

6.0 SCOPE SPLIT

This section sets out the scope of work of Thales, the Design-Builder, and Others (for example, the City).[3]

Item	Description	Design	Supply	Install	Test & Commis.
1.	Central CBTC Hardware	Thales	Thales	Designer-Builder [4]	Thales
2.	Central CBTC Software	Thales	Thales	Thales	Thales
3.	Wayside CBTC Hardware	Thales	Thales	Designer-Builder [5]	Thales
4.	Wayside CBTC Software	Thales	Thales	Thales	Thales
5.	Equipment Rooms including A/C	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
6.	Control Room	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder

[3] Thales shall provide on-site CBTC equipment installation support and supervision for an 3-month period following commencement of CBTC equipment on-site installation. If and as circumstances warrant, Thales shall participate in bi-weekly or weekly installation teleconferences during the CBTC installation phases.

[4] Thales shall provide on-site installation supervision for Central CBTC hardware.

[5] Thales shall train Design/Builder on the installation and PICO testing of the 1st Zone Controller and its in-SER peripherals (e.g. relay racks). All PICO test results shall be reviewed and approved by Thales.

Item	Description	Design	Supply	Install	Test & Commis.
7.	CBTC Cables within Equipment Rooms	Thales	Thales	Designer-Builder	Thales
8.	CBTC Cables within Control Room	Thales	Designer-Builder	Designer-Builder	Thales
9.	CBTC Cable between Equipment Rooms and Wayside Equipment	Thales	Designer-Builder	Designer-Builder	Thales
10.	Control Room Desks, and Video Wall	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
11.	Cable Termination Frames	Thales	Thales	Designer-Builder	Thales
12.	Mounting Plinths for Switch Machines	Thales / Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
13.	Installation Fasteners for Wayside CBTC Equipment	Thales	Thales	Designer-Builder	Thales
14.	Earth Cables for Wayside CBTC Equipment	Thales	Designer-Builder	Designer-Builder	Thales
15.	Cables to ESBs (including Junction Boxes, Local Cables, and Connecting Hardware)Cabling Associated with Fixed Block Train Detection System, Wayside Signals and Indicators	Thales	Designer-Builder	Designer-Builder	Thales
16.	Switch Machines (including control and detection rods)	Thales	Thales	Designer-Builder[6]	Thales
17.	Portal Intrusion Dectors	Thales	Thales	Designer-Builder	Thales
18.	Switch Machine Earth Cables	Thales	Designer-Builder	Designer-Builder	Thales
19.	Switch Machine Control Cables	Thales	Designer-Builder	Designer-Builder	Thales
20.	Fixed Block Train Detection System (including all associated hardware and software)	Thales	Thales	Designer-Builder	Thales
21.	Wayside Signals and indicators (including all associated hardware)	Thales	Thales	Designer-Builder	Thales
22.	Uninterruptible Power Supplies	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
23.	Power Distribution Panels & Circuits & Earth Leakage Detection	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
24.	Power Cables to CBTC Equipment within Equipment Rooms	Thales	Thales	Designer-Builder	Designer-Builder
25.	Grounding	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder

6 Thales shall train the Design/Builder on the installation, PICO testing and set-up of the 1st two switch machines.

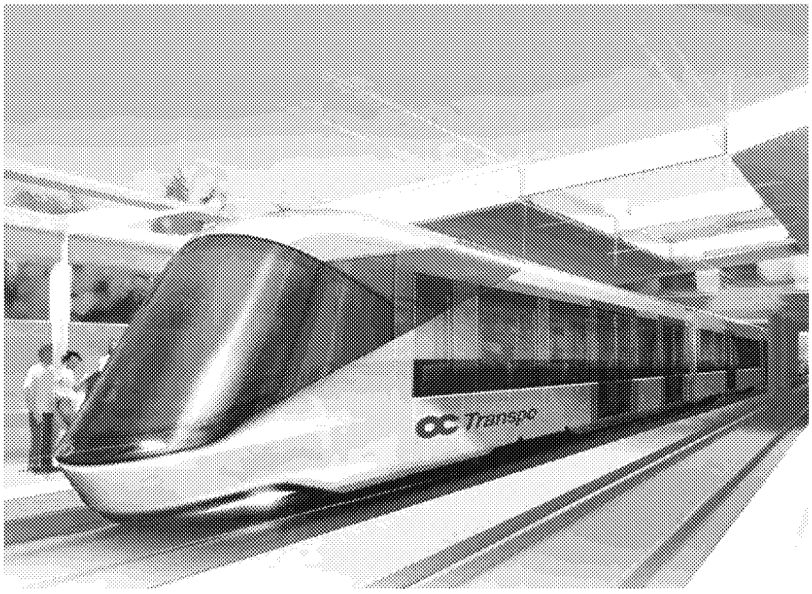
Item	Description	Design	Supply	Install	Test & Commis.
26.	Trainborne CBTC Equipment including Driving CBTC Panel Components	Thales	Thales	Alstom [7]	Thales
27.	Vehicle Testing Support at Vehicle Factory		Thales		
28.	Vehicle Testing Support at Site		Thales		
29.	Trainborne CBTC Software	Thales	Thales	Thales	Thales
30.	Trainborne CBTC Cables within Vehicles	Thales	Thales	Alstom	Thales
31.	Trainborne CBTC Cables within CBTC Cabinet	Thales	Thales	Thales	Thales
32.	Trainborne Rack for CBTC Equipment	Thales	Thales	Alstom	Thales
33.	Trainborne Cubicle / Cupboard for CBTC Equipment	Alstom	Alstom	Alstom	Alstom
34.	Trainborne Mounting Brackets (tachometers, antennas, etc.)	Alstom	Alstom	Alstom	Alstom
35.	Vehicle Driving Panel / Controls (including mode selector, bypass switch and manual release switch)	Alstom	Alstom	Alstom	Alstom
36.	Trainborne Conduits and Cableways for CBTC Cables	Alstom	Alstom	Alstom	Alstom
37.	Equipment Room Conduits and Cableways for CBTC Cables	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
38.	Wayside Conduits and Cableways for CBTC Cables	Designer-Builder	Designer-Builder	Designer-Builder	Designer-Builder
39.	Test & Commissioning Staff		Thales		
40.	Operational Support Staff for Test & Commissioning		Others		
41.	Special Tools and Test Equipment[8]	Thales	Thales	Thales	
42.	Equipment Spares[6]	Thales	Thales		
43.	Operations and Maintenance Documentation	Thales	Thales		
44.	Training Materials / Documentation	Thales	Thales		
45.	Training the Trainer	Thales	Thales		
46.	First Level Preventative and Corrective Maintenance of CBTC Equipment Prior to Warranty Period		Thales		

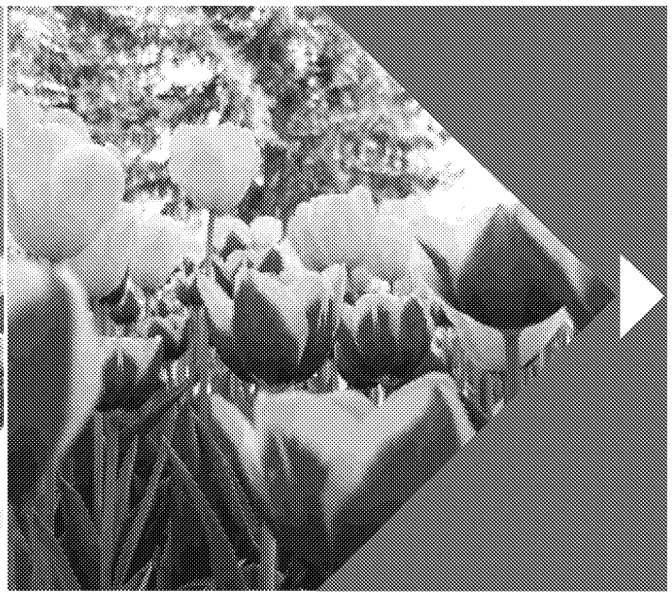
[7] Thales shall train Design/Builder on the installation and PICO testing of the 1st two onboard CBTC equipment sets and will perform static and dynamic PICO testing on same.

[8] Thales shall include this item in the Maintenance Contract scope of supply.

Appendix 1

5.4 LRT SYSTEMS AND VEHICLES





5.4 LRT SYSTEMS & VEHICLES

In accordance with RFP Schedule 3-1 instructions, this section describes the Rideau Transit Group solution for Vehicle and LRT Systems – a solution that brings together a world class light rail vehicle manufacturer with a state of the art supplier of Communication Based Train Control.

From the outset of the OLRT bid process, the RTG team was intent on finding the "right" solution for Ottawa's unique needs. We began by canvasing the globe in an international procurement process. For more than six months, the RTG team thoroughly reviewed submissions from the world's leading suppliers of rail vehicles and systems. We measured and evaluated their products and performance against the Ottawa challenges - cold climate operations, state of the art vehicles and train control but proven in service, modern low floor convenience plus 100 km per hour capability to name just a few – with a goal of putting the "best of the best" together in one integrated package.

Our selection of Alstom Transportation's CITADIS vehicle and Thales for train control and systems will place Ottawa's new light rail system at the head of the class, meeting the industry's highest levels of safety, comfort and reliability.

Worldwide, Alstom Transportation is a global powerhouse, having earned in excess of $8 billion in Revenue in the past operating year. The company also has significant experience in the North American rolling stock business. It maintains a large manufacturing plant in Hornell N.J (one of the largest in NA) and has produced more than 7000 transit vehicles for transit authorities and rail customers. In Canada the company has Transport division offices in Ottawa, Montreal and Toronto. Alstom is very experienced in technology transfer to meet both the letter and spirit of local content regulations as discussed in **Section 5.4.2**.

The Citadis vehicle is the ONLY 100 per cent low floor vehicle operating at 100 km in the world today. Its sleek urban design is the ideal solution for Ottawa's urban environment, offering the ideal blend of form and functionality in one vehicle. Its maintenance advantages are also proven. The Ixege pivoting bogie design (which utilizes conventional axels) has been shown to have lower life cycle and maintenance costs and better performance, particularly in the snow. The Ixege bogie allows the passenger interior of the car to have all of the accessibility and convenience of a 100% low floor LRV but many of the operational and performance advantages of a 70% low floor LRV. This will prove invaluable in winter operating conditions in Ottawa.

Thales is a global technology leader in the Transportation, Aerospace, Defense and Security markets. In 2011, the company generated revenues of $17 billion with 67,000 employees in 56 countries. With its 22,500 engineers and researchers, Thales has a unique capability to design, develop and deploy equipment, systems and services that meet the most complex security requirements. Thales has an exceptional international footprint, with operations around the world working with customers as local partners.

In Canada, Thales has been operating for more than 30 years, employing 1,300 people in its Transportation, Defense & Security, and Aerospace sectors. Canada is also headquarters to Thales Centre of Excellence in Signalling with offices are in Ottawa, Toronto and Vancouver that employ over 800 people. The CBTC signalling solution was first deployed by Thales on Vancouver's driverless metro in 1986. Today, CBTC technology has become the de facto standard for urban rail systems. Since then, with more than 35 systems equipped with its SelTrac CBTC solution and over 10 million

cumulative hours of operation to its credit, Thales has more experience with this solution than any other provider in the world. Successful projects in Beijing (1.2 million passengers a day on the two lines equipped by Thales), Shanghai (1.6 million passengers a day on the 5 lines equipped by Thales), Wuhan, Guangzou and Hong Kong have made Thales a market leader for transit signalling systems in mainland China. Thanks to SelTrac CBTC technology, the Docklands Light Railway – one of the busiest lines in the London transport system, with 70 million passengers a year – delivers over 98% availability – a remarkable achievement since it includes the availability of the fixed block backup system. The SelTrac CBTC installation on the Canada Line achieves over 99.95% availability (again including wayside components) even though it does not have as extensive redundancy as will be provided for the OLRT.

Thales' technologies and solutions are particularly well suited to the requirements of transit systems. Safety, reliability and cost effectiveness are fundamental to modern light rail system operations. Thales' systems control train speed and direction with great precision; this optimizes use of system assets and translates into enhanced performance and cost savings for the city. Thales' systems are in operations with major metro operators worldwide, including those of Vancouver, London, New York, Shanghai, Hong Kong and Dubai.

In addition to each company's independent success stories, Alstom and Thales have worked successfully together on several joint transit projects – the London Underground Jubilee Line and on Shanghai Metro Lines 6 and 8. The Shanghai installations employed 1500 VDC as is proposed for the OLRT. Throughout the design phase, Alstom and Thales will work closely with an engineering joint venture (EJV) comprising SNC-Lavalin Inc., MMM Group, and specialty consultants selected for their Project-specific expertise to deliver the best solution to the City.

5.4.1 LRT SYSTEMS DESIGN PROCESSES

RTG brings together the strengths, capabilities and expertise of ACS Infrastructure Canada Inc.; SNC-Lavalin Capital, a division of SNC-Lavalin Inc.; and EllisDon Inc. On announcement of Preferred Proponent these companies will form a special-purpose vehicle (Project Co) to contract with the City for the OLRT Project. Our team will use their combined experience on past projects to deliver the LRT Systems and Vehicles using the formal set of design processes explained below.

5.4.1.1 Design Methodology & Lessons Learned

Successful system integration starts with developing proper processes to validate requirements, implement them in a timely manner, and verify that the delivered system is safe and reliable. Over many years of experience on successful transit projects, RTG has developed a set of practical and results-oriented system engineering processes. These are documented in the plans and specifications defined in the following sections and incorporate the following key lessons learned:

- Perform a thorough Requirements Analysis to fully understand the City's requirements
- Use a formal engineering process through all Project phases to manage the work, track requirements and conduct comprehensive test and verification planning
- Thoroughly document interfaces and, in particular, vehicle interfaces (e.g. Train Control and wheel/rail)
- Choose proven suppliers and subsystems best suited to the City's requirements
- Emphasize off-site acceptance testing and maximize the use of simulators and test tracks
- Involve operations and maintenance staff in commissioning as early as possible

The design methodology is shown graphically in **Diagram 5.4.1 D2.1A** and the interaction with the overall Project is shown in **Diagram 5.4.1 D2.1B**.

Systems Engineering Plan

The Systems Engineering Plan described in this section will apply to each OLRT system in a manner commensurate with the safety level it is designed to provide. The Plan will ensure the tracking of system requirements and configuration

through Project design, implementation and test phases to support system assurance, quality, safety management and certification and to ensure a safe and reliable Maintenance Term.

The LRT Systems and Integration Manager will prepare the Systems Engineering Plan at the conceptual design phase, based on the current internationally recognized systems engineering standard: ISO/IEC 15288, Systems Engineering – System Life Cycle Processes.

The purpose of the Systems Engineering Plan is to define an integrated set of engineering processes, thus assuring the City that good engineering practices will be followed in the systems engineering of the Works, as follows:

- Establishing and evolving a complete and consistent set of requirements that will enable delivery of a feasible and cost-effective systems solution
- Satisfying requirements within cost, schedule, and risk constraints
- Providing a system, or any portion of a system, that satisfies the City over the life of the products that make up the system
- Satisfying Sustainability requirements including safe and cost-effective disposal or retirement of a system or part thereof

The Systems Engineering Plan will specify the following elements relative to engineering of the System:

- Agreement processes (e.g. product acquisition, product supply, subcontractor management and evaluation)
- Project management processes (e.g. planning, assessment, project control, and risk management)
- Technical processes (e.g. the City's requirements definition, requirements analysis, design, implementation, integration, verification, transition, validation, operation, maintenance, and disposal)
- Proposed technical review process
- Summary of documents required by the Plan

Design Planning

The LRT Systems and Integration Manager will prepare the Design Management Plan for System design activities at the conceptual design phase. The Plan will include the following elements:

- Organization of the Design Team
- System design activities:
  - Plan and schedule for managing the requirements, analysis, definition, and validation phases
  - Design review and audit schedule
  - Document submission schedule
  - Drawing submission schedule
- System design elements:
  - Document tree, illustrating the documentation hierarchy
  - Drawing tree, illustrating the drawing hierarchy

Design Reviews

There will be three design reviews for the OLRT System:

- Conceptual Design Review (CDR)
- Preliminary Design Review (PDR)
- Final Design Review (FDR)

In addition there will be a PDR and FDR for each major sub-system within the Works.

The formality and scope of these design reviews for the System or sub-system will depend on the complexity, size, and risk associated with the System or sub-system. In the following discussion, the term system (lower case) may refer to a system, sub-system, or component.

Conceptual Design Review

Senior designers from each discipline will prepare documentation for the CDR defining the theory of operation of the overall OLRT System, including major sub-systems, sub-system interfaces, interfaces to external systems, and any requirements the system may impose on external systems or equipment. Special attention will be paid to operator interfaces.

Preliminary Design Reviews

A primary goal of each PDR will be to validate system requirements to ensure that they are the complete, necessary, and sufficient set of requirements for the system, that they are consistent with the City's intent, and that the system supplier understands them. Typical documentation submitted for each PDR will include but not be limited to the following:

- Requirements analysis and other documentation to demonstrate that the proposed system meets the specified requirements
- Functional descriptions of the system and its major sub-systems
- Equipment layout and functional architecture
- Interconnection drawings
- Finalized interface specifications
- Mock-ups of operator interfaces
- Confirmation of the following:
    - Sub-system specifications have been defined appropriately
    - Enabling products have been defined adequately to initiate enabling product development, if required
    - Approaches planned for the next design phases have been appropriately planned
    - Project risks have been identified, and mitigation plans are feasible and judged to be effective
- System Assurance documents and checklists to confirm that the design conforms to quality safety and RAMS requirements (see also **Section 5.1.5.1**)

Open items from previous design reviews for the system will be addressed and/or resolved during the PDR.

Final Design Review

For each FDR, senior designers from each discipline will prepare documentation that confirms the following:

- Specifications, drawings, and/or software development files have been appropriately defined
- The end product designs satisfy system requirements
- The system meets one of these criteria:
    - Ready for continued design and development
    - Appropriately defined for purchase of products from an external supplier
    - Ready for manufacture/fabrication
    - Adequately defined such that off-the-shelf products and/or proven products can be used to fulfill system requirements and are available
- System Assurance documents and checklists to confirm that the design conforms to quality safety and RAMS requirements (see also **Section 5.1.5.1**)

For each FDR, detailed designs and other documentation will be prepared with sufficient information to confirm a complete design and allow manufacturing/construction to proceed. Typical submittals for an FDR will include, but not be limited to, final design and installation drawings, shop drawings, calculations and analyses to demonstrate that the system

will meet the specified requirements. All open items from previous design reviews for the system will be addressed and/or resolved during the FDR.

For each FDR, a System Verification Matrix (SVM) will document how each of the validated requirements will be verified, and the status of that verification. The SVM will be updated periodically to maintain the status of the requirement verification.

Other Reviews

Other types of reviews may be held on an as-appropriate and as-required basis:

- **Pre-System Definition Reviews** which, during the Project's conceptual phase, will consider all concepts analyzed and select a preferred concept for further development that has the potential for satisfying identified City requirements. In addition, this review may assess progress towards converging on a viable, traceable set of System Technical Requirements that are balanced with cost, schedule, and risk. This review will also ensure the design is optimized in terms of safety, operations reliability, availability, maintainability and lifecycle cost, service dependability, failsafe design and failure management of the system operation. OLRT system optimization is discussed in detail in **Section 5.1.5.1**.
- **Readiness Reviews** which, during the Project's integration and test phase, will demonstrate that delivered end products from lower layer systems have been validated, or that validation tests are adequately planned, and that each set of integrated products forming a composite end product is ready for end-product verification and validation, if required.
- **Audits** which, during the Project's manufacturing, integration and test phase, will demonstrate and confirm the following:
    - End products comply with their specified requirements and product verification outcomes compare favourably against configuration documentation (e.g. drawings, test procedures, authorized changes, software development files, as-built/as-coded documentation)
    - The as-built/as-coded configuration has been favourably examined against its configuration documentation (e.g. drawings, bill of materials, specifications, code lists, manuals, compliance test, compliance data)
    - Products have been built to drawings and satisfy specifications
    - The information database represents the work products of the system development
    - Required changes to previously completed specifications have been implemented
    - Enabling products for downstream associated processes are available, can be executed, and meet the City's requirements
- **Process Reviews** which, during the Project's integration and test phase, demonstrate that the development of enabling products for associated processes is on schedule, and that designs satisfy related end-product needs. Examples of Process Reviews are production readiness reviews and test readiness reviews.
- **Independent Contractor Evaluations, Reviews, and Audits** may occur as required throughout the Project

System Requirements Specification

A System Requirements Specification that captures the City's requirements and System technical requirements will be prepared by senior designers. This specification will be reviewed with the City to ensure that RTG completely understands the requirements. The Requirements Management Database will be created and maintained using the DOORS requirements management database tool.

The System Requirements Specification and Sub-System Requirements Specifications will be reviewed as part of the Preliminary Design Review.

Requirements Validation

As summarized in **Table 5.4-1**, requirements have been validated when it is determined that the subject set of requirements describes the input requirements and objectives such that the resulting system products can satisfy the requirements and objectives.

Table 5.4-1 | Requirements Validation

Stage	Objective	Methodology
General	The LRT Systems and Integration Manager will ensure that technical requirement statements are well formulated	▪ Analyzing and ensuring that each requirement statement is stated with: clarity, correctness, feasibility, focus, modifiability, removal of ambiguity, singularity, testability, and verifiability ▪ Analyzing and ensuring that technical requirement statements in pairs and as a set are stated with connectivity and without redundancy and conflicts
Requirements Validation	Defined System requirements will be reviewed against the City's needs and expectations	▪ Selecting methods and defining procedures for validating that the set of System requirements is consistent with the level of system structure, and the Validation Plan as appropriate ▪ Analyzing and comparing identified and collected requirements to the set of defined System requirements to determine upward and downward traceability ▪ Identifying and resolving variances, voids and conflicts ▪ Recording validation results
System Technical Requirements Validation	Defined System technical requirements will be reviewed against validated the City's requirements	▪ Selecting methods and defining procedures for validating that the set of System technical requirements is consistent with the level of systems structure and the Validation Plan as appropriate ▪ Analyzing and comparing identified and collected System technical requirements with the set of defined System technical requirements to determine upward and downward traceability ▪ Analyzing assumptions made with respect to defining System technical requirements to ensure they are consistent with the System being engineered ▪ Analyzing System technical requirements that have been defined as essential for the design effort where there is no parent requirement in the set of the City's requirements, to ensure they are consistent with the System being engineered ▪ Identifying and resolving variances, voids and conflicts ▪ Revalidating System technical requirements whenever a requirement change affects the City's requirements, or System technical requirements ▪ Recording validation results

Computer-Based Systems

Software

Tasks will be undertaken to ensure that System software complies fully with the following requirements:

- Operates without degradation during all date changes
- Uses a formal methodology for structured modular code design and implementation appropriate to the application and safety integrity of the System
- Uses open standards and non-proprietary protocols for all interfaces except where proprietary protocols are required to facilitate integration with legacy systems or to meet City requirements

- Ensures that configuration details are available down to the appropriate software configurable item
- Is capable of local loading and, where operationally required, remote loading

Formal documentation, change control, testing and verification processes will be appropriate to the application and safety integrity of the System for software quality control.

Software Development Management Plan

Where the System includes components of proprietary software development, a Software Development Management Plan for the System will be prepared at the conceptual design phase, to include, but not be limited to, the following:

- Organization including identification of Software Development Manager and key team members, as well as position descriptions (e.g. qualifications, training)
- Identification of subcontractors including their qualifications, how the Plan and other plans apply to them, and how they are assessed and evaluated during System development
- Software development philosophy
- Software lifecycle including phase input and output details, and phase entry and exit conditions
- Quality assurance and control activities and procedures
- Development schedule (e.g. critical activities, how key dates will be achieved, resourcing levels)
- Quality schedule including audits and reviews
- Strategies to accommodate contingencies and changes (e.g. software development schedule, resources)

The Software Development Management Plan and the software lifecycle processes documented therein will comply with internationally recognized standards.

5.4.1.2 Systems Interface Management

Interface Management Plan

At the conceptual design phase, an Interface Management Plan will systematically identify documents and provide a management tool for resolving technical interfaces between subsystems and between the System and external systems across all disciplines. This will include all System elements that have a direct or indirect interaction with systems or equipment external to the System. The Interface Management Plan will be updated as the interfaces evolve.

Interface Specifications

Each interface will be managed within a system of interface-control documentation (primarily interface specifications), which will include, but not be limited to, the following definitions:

- The organizational entities responsible for managing and engineering the interface and other entities involved
- Details of the agreed interface arrangement (e.g. physical installation, civil, power supply, signal levels, transfer characteristics, message formats, communications protocols)
- The functional, performance, reliability, maintainability and safety requirements of the individual elements forming the interface
- The proposed method and schedule for verifying interface integrity, individual element performance, and combined system performance

The interface control documentation will be reviewed in the process reviews and design reviews and will be updated as the interfaces evolve.

When interfacing to systems provided by others that are part of the Works, RTG will jointly prepare the interface control documentation with the third party.

Interface Communications

An organizational structure and corresponding procedures will be created for coordination and communication of interface data among the suppliers of systems and sub-systems within the system and interfacing to it. The City will be provided with design criteria that clearly define interface requirements between the System and systems provided by others, including any civil, structural, and fixed facilities that may interface to the System.

Configuration Data

During execution, Works suppliers will exchange configuration data (e.g. Station identification, track locations) using a structured, well-normalized record format. Project-wide configuration data guidelines will provide an overview of configuration data formats and structures specifying items such as abbreviations and Project-level identifiers.

The exact format and content of configuration data to be exchanged will be specified in configuration data control documentation (primarily Configuration Data Specifications). Such documentation will include, but not be limited to, the following:

- Detailed description of each item of configuration data, including how it is intended to be used
- Detailed description of the format of the configuration data, using examples if possible

Typically, there will be one set of configuration data control documentation for each configuration data interface with another entity (e.g. supplier, subcontractor). Subcontractors will prepare the interface-specific configuration data control documentation and comply with Project-wide configuration data guidelines.

Configuration Data Management Plan

A preliminary version of the Configuration Data Management Plan will be prepared for the System at the conceptual design phase, with the final Plan prepared at the preliminary design phase. It will include the following:

- Detailed description of the process and methods to handle configuration data
- Description of configuration data to be supplied to and by third-parties
- Description of configuration data formats to be used
- Configuration management procedures
- Change control management procedures
- Configuration data schedule (e.g. when configuration data is to be delivered to, or is required from, others)

5.4.1.3 Verification & Validation Strategy

The LRT Systems and Integration Manager will coordinate system verification and validation activities with the appropriate design phase as shown in **Diagram 5.4.1 D.1C**. The System Validation process provides a comparative assessment to confirm that the City's requirements are correctly defined. By assessing services presented to the City, validation demonstrates that the correct system entity has been created. Tasks include Requirements Validation and End Products Validation.

The System Verification process will be used to ascertain the following:

- System design solution generated is consistent with its source requirements and the specified design requirements are fulfilled by the system end product
- End products at each level of the system structure implementation, from the bottom up, meet specified requirements
- Enabling system development or procurement for each associated process is properly progressing
- Required enabling systems will be ready and available when needed to perform

Test and commissioning plans will be developed, organized, and implemented to verify the adequacy of the System to meet all functional, safety, systems assurance, and performance requirements.

All materials furnished (including spare parts) and all work performed as part of the Works will be inspected and tested. If specific hardware, software, or documentation does not meet specific requirements, it will be repaired, replaced, upgraded, or added by the responsible supplier as necessary to correct deficiencies. After correction of a deficiency, all tests necessary to verify the effectiveness of the corrective action will be repeated.

Factory and site tests will be performed. Deliverables will not be shipped until all required factory inspections and tests have been completed and all deficiencies have been corrected. Site testing will ensure that the System has been properly installed, and that the System satisfies all performance, safety, reliability, and functional requirements while in actual service. Spare parts will be tested in the identical manner as other equipment.

Before testing starts, the City will have approved all test plans and procedures for the test, and all relevant prerequisite testing will have been completed. Inspection and Testing will comply with ISO-9001:2008, clauses 8.2.4 "Monitoring and Measurement of Product" and 7.6 "Control of Inspection Measuring and Test Equipment".

Test Documentation Submittals

RTG will submit test documentation to the City including the following:

- A Validation, Inspection, and Test Plan for acceptance at the Conceptual Design Review. This Plan will demonstrate that the Contractor has considered all testing requirements and made adequate schedule provisions for testing in the overall schedule.
- A System Test Plan and a Test Plan for each sub-system for acceptance at the Preliminary Design Review listing the tests required to fully verify that the System meets functional, safety, and performance requirements.
- Detailed test procedures for acceptance for each test identified in the test plans identified above, no later than 90 days before testing.
- A Commissioning Test Plan for the System for acceptance at the Preliminary Design Review. These plans will list the tests required to fully verify that the System has been properly installed and to demonstrate that the System satisfies all performance, safety, reliability, and functional requirements while communicating with a full complement of devices under actual service conditions.
- A 90-day look-ahead schedule detailing all testing activities proposed for the period covered. The first schedule will be submitted 90 days before the first test scheduled and a revised schedule will be submitted periodically as required.
- Test Reports containing the results of all tests conducted at any factory or field location.
- Deficiency report(s), periodically or as required.

Test Documentation

Validation, Inspection, and Test Plan

The Validation, Inspection, and Test Plan will include at least the responsibilities of individuals and documentation of validation and test results and will include, but not be limited to, the following items:

- Flow diagram indicating the logical sequence of validations and tests, starting with materials receiving tests and inspections and concluding with system demonstrations tests
- Validation schedule
- Test schedule
- Responsibilities
- Record-keeping assignments, procedures, and forms
- Procedures for performing validation
- Procedures for monitoring, correcting, and re-testing deficiencies
- Procedures for controlling and documenting changes made to hardware and software after testing starts

- Coordination needed from the City

System and Sub-System Test Plan

Test plans will demonstrate that the System supplied is complete, safe and operable and will include at least the following items:

- Test schedule
- Responsibilities
- Block diagrams of the hardware test configuration including external data transmission interfaces, and detailed descriptions of test and/or simulation equipment
- Estimated duration of each test
- Coordination needed from the City
- Calibration and its traceability to known standards of hardware, software, simulation tools and test equipment to be used for testing

Commissioning Test Plan

The Commissioning Test Plan will include at least the following:

- Commissioning test schedule
- Responsibilities
- Recordkeeping assignments, procedures, and forms
- Procedures for monitoring, correcting, and re-testing deficiencies
- Procedures for controlling and documenting changes made to hardware and software after testing starts
- Coordination needed from the City

Test Procedures

Test Procedures will describe individual test cases and the steps comprising each case, with emphasis on the methods and processes to be followed:

- Objective of the test
- Requirement(s) to be demonstrated and verified
- Required setup and conditions, including descriptions of test equipment and required data
- Descriptions, listings, and instructions for test software tools and displays
- Step-by-step descriptions including inputs and user actions for each test step
- Expected results including the pass/fail criteria
- Techniques and scenarios used to simulate system field inputs and controlled equipment

Test Records

Complete certified Test Records of all factory and field acceptance test results will be maintained and delivered to the City. Test Records will be keyed to Test Procedures and will include the following:

- Reference to the corresponding Test Procedure
- Date the Test Procedure was executed
- Description of test conditions, input data, or user actions differing from that described in the Test Procedure
- Results for each test case including a passed/failed indication
- Name of test engineer and the City's Representative (if present for execution of the Test Procedure)
- Provision for comments by the City's Representative
- Copies of any deficiency reports generated as a result of the execution of the Test Procedure

- Copies of reports, display copies, and any other hardcopy generated by executing the Test Procedure
- Configuration data that fully describes the hardware and software that was tested, including software version and build numbers/identifiers for every software module

Failure Reporting, Analysis, and Corrective Action

Throughout the periods of System field testing, demonstration, and warranty, a closed-loop Failure Reporting, Analysis, and Corrective Action (FRACA) system will determine the cause of all test failures, unscheduled part removals, and other deficiencies. To identify failed parts and pertinent data and actions relating to each failure, failures will be classified and a cumulative summary of all failure analyses maintained. RTG will apply this process to all OLRT System and subsystem failures including performance failures.

FRACA data will regularly and systematically be evaluated to identify and monitor failure trends, no-trouble-found incidents, and new-failure effects.

End-Product Audits

During the Project's integration and test phase, end-product audits of the System will be held which, during the Project's integration and test phase, will demonstrate and confirm the following:

- End products comply with specified requirements and product verification outcomes compare favourably against configuration documentation (e.g. drawings, test procedures, authorized changes, software development files, as-built/as-coded documentation)
- As-built/as-coded configuration has been favourably examined against configuration documentation (e.g. drawings, bills of material, specifications, code lists, manuals, compliance test, compliance data)
- Products have been built to drawings and satisfy specifications
- The information database represents the work products of the system development
- Required changes to previously completed specifications have been implemented
- Enabling products for downstream associated processes are available, can be executed, and meet City requirements

Readiness Reviews

Readiness Reviews may be held for the System which, during the Project's integration and test phase, will demonstrate that delivered end products from lower layer systems have been validated, or that validation tests are adequately planned, and that each set of integrated products forming a composite end product is ready for end-product verification and validation, if required.

Tests on Completion

Tests on Completion will include all testing to be performed before Completion of the Works.

First Article Inspection

To ensure units are suitable in all respects for the purpose intended, a First Article Inspection (FAI) will be conducted on the first production unit of each sub-system prior to the first shipment of equipment for that sub-system from the factory. The FAI testing will include, but not be limited to, the following:

- Electrical and mechanical construction testing
- Vibration and impact resistance testing
- Temperature and humidity testing
- Functionality, performance, and timing testing
- Accelerated life testing
- EMC testing

Critical items of the System's equipment that do not have a proven history will be subject to qualification testing.

Equipment Tests

Sample units from production will be subject to routine and Quality Control inspections and testing.

Factory Acceptance Tests

Where appropriate and reasonably practicable, Factory Acceptance Tests (FATs) will be conducted on systems and sub-systems in a factory environment representative of the actual operating environment, to demonstrate that System items under test can perform in accordance with specifications, before being installed. The deliverable hardware and software will be tested. Upon completion of testing, a FAT review will confirm that the system or subsystem under test is fit to be deployed and installed.

Post Installation Checkout Tests

Post-Installation Checkout (PICO) testing will demonstrate that all system hardware (including spare parts) and software functions properly in the installed environment. The installed system will be verified against installation drawings to verify correct installation and that system equipment has not been damaged subsequent to shipment from the factory.

The field installation test will include a complete system inspection including but not limited to proper installation, grounding, cabling, conformance to plans and drawings, neatness, equipment access and installed versions of hardware and software. All cables will be tested for opens, shorts, grounds and high resistance.

Tests will be performed on each sub-system and group of sub-systems (using a bottom-up approach) to verify that they are operating correctly in the target environment. Tests will also be performed on groups of sub-systems using a bottom-up approach to verify that they are operating correctly in the target environment.

Site Acceptance Tests

After PICO Tests, Site Acceptance Testing (SAT) will be performed on installed System equipment and subsystems using the approved set of SAT procedures. These procedures will generally be a subset of those performed during FAT testing, but will also focus on requirements which could not be verified during FAT testing. SAT will be performed to verify that the System has been properly installed and to demonstrate that the System satisfies all performance, safety, reliability, and functional requirements while communicating with a full complement of devices under actual service conditions. The proper operation and performance of all System features and functions will be verified during this test.

Tests after Completion

Tests after Completion will include all testing to be performed after Completion of the Works.

Integrated System Testing

Upon successful completion of SAT on two or more related subsystems, these subsystems will be integrated to commence Integrated System Testing (IST). IST will concentrate on inter-subsystem functionality and performance under normal, abnormal, and emergency scenarios.

Trial Running

Trial Running of the System will demonstrate that the System meets specified performance criteria and is capable of safely operating in accordance with initial service plans, including specified travel times, headways, and availability.

Trial Running will exercise and confirm operating reliability of the System in simulated operating scenarios. A full regular scheduled service will be operated on the full Line using peak and off-peak schedules for an extended period. Passengers will not be carried, but appropriate dwell times will be observed. Trial Running will also include a variety of failure-management scenarios that could reasonably be expected to occur in regular revenue service.

5.4.1.4 Configuration Control Methodology

Configuration management and change control management procedures and techniques will be used in the engineering of the Works. Where appropriate (for example, in systems with software components), these procedures and techniques will comply with internationally recognized standards.

Configuration Management Plan

A Configuration Management Plan for the System will be prepared at the conceptual design phase and will include the following:

- Detailed description of the methodology and procedures to be used to control and document System configuration during the Contract period (e.g. from the preliminary configuration at the time of the proposal through the design phases to the as-delivered hardware and software configurations)
- Detailed description of configuration management processes, procedures, and techniques to be used with respect to any subcontractors
- Organizational structure with respect to configuration management

Change Control Management Plan

A Change Control Management Plan for the System will be prepared at the conceptual design phase and will include the following:

- Detailed description of methods and procedures to be used to handle change (e.g. functional changes, performance changes) during the Project Term
- Detailed description of the change lifecycle and statuses
- Detailed description of change control processes, procedures, and techniques to be used with respect to any subcontractors
- Change control organization

Configuration Control during the Maintenance Term

RTG will maintain all systems plans, maintenance reports, remedial actions, instructions and procedures in an Asset Management System. System plans include the conformed design plans reflecting as-built conditions at final acceptance of construction. Design plans, including typical installation drawings that document installation standards, will be controlled by the Maintenance Director through implementation of a configuration management process embedded in the asset management program.

A Configuration Management Committee, staffed with key personnel and chaired by the Maintenance Director, will control configuration management. All configuration changes of a system or equipment will include a request, an evaluation of the change, an approval process, and the final recording and documentation of the change. This will be managed and recorded within RTG's Asset Management System to provide traceability. Where life-limited or serialized components are changed in any equipment, the overall impact on future maintenance and lifecycle of the parent asset will be accounted for and adjusted within our Asset Management System.

Configuration Control during the Maintenance Term is described in detail in **Section 5.1.5.1**. A Regulatory Working Group is defined in **Section 5.1.6.2** to address the Safety Management System (SMS) by apply the appropriate configuration controls both prior to and during service commencement.

5.4.1.5 Systems Assurance Process & Methodology

As specified in the RFP, RAMS, including a narrative on management of the systems assurance process, is discussed in **Section 5.1.5.1**.

5.4.1.6 Climatic Performance

RTG will ensure that all systems and equipment subject to the external environment are designed for Ottawa's extreme climate by applying the following principles:

- Use suppliers with a proven track record of delivering systems in extreme climate
- Select major subsystems that are service-proven in similar climates
- Use NRC's environmental chamber for environmental qualification testing when necessary
- Verify system environmental performance during site testing.

A key factor in maintaining service during inclement weather is the proper response by both operations and maintenance and rehabilitation (M&R) personnel. RTG will address this factor as follows:

- Providing tools to manage weather extremes. For example, the CBTC System will include the ability to reduce braking and acceleration rates if low adhesion is experienced.
- Preparing maintenance procedures to deal with extremes of weather, and training M&R personnel in these procedures.
- Preparing operations procedures to deal with extremes of weather in cooperation with the City, and training operations personnel in these procedures.
- Providing snow removal equipment and procedures.

Examples of equipment and subsystems operating in similar environments are included in the cut sheets.

Methodology for Dealing with Extremes of Weather During Testing

RTG will implement the Maintenance and Storage Facility (MSF) early to provide a local test track to integrate all major subsystems. This early implementation will allow three seasons of environmental testing to experience a wide range of weather conditions. By proactive test scheduling, we will use inclement weather as a test tool.

Operations, M&R and testing and commissioning (T&C) personnel will be trained and qualified in all relevant procedures before the start of each T&C phase. A CBTC Control Operators Training Simulator will be provided to support this process.

When necessary, RTG will simulate extreme conditions (e.g. soaping rails for adhesion testing).

5.4.1.7 System Integration Methodology

To deliver an LRT system that meets or exceeds the City's performance expectations, RTG is committed to managing the Project's integration risk. System Integration is discussed in detail in **Section 5.1.5** and summarized here.

The past 30 years have seen significant improvements in Train Control System interfaces that decrease integration risk. These improvements can be seen in standardized interfaces resulting from supplier consolidation and technological advances, particularly in communication equipment and protocols. Modular hardware and software design technologies have simplified overall designs

Both Alstom and Thales are contractually required to ensure design visibility (including providing access to their key contractors) to RTG. Through this environment, RTG's LRT Systems and Integration Manager will manage the design process, ensuring that interface requirements are well understood and are properly implemented.

Processes and documentation to control interfaces will include but not be limited to the following.

- Interface specifications for each major interface
- First Article Inspections
- Qualification tests
- Factory Acceptance Tests and subsystem integration tests

- Vehicle/Train Control integration tests are planned in the MSF early in the schedule

As per lessons learned, particular attention will be paid to brake and propulsion interfaces, and the wheel/rail interface.

To ensure that proposed systems and equipment can perform as required in the Ottawa environment, RTG will carefully review supplier submissions. The process of choosing our Team's Vehicle and Train Control supplier included a detailed review of their proposed interfaces and interface management plan to verify that both suppliers understood the interface requirements and had the necessary knowledge and experience to implement them. We have chosen two experienced suppliers with demonstrated systems integration capability who have worked together and with RTG. We believe that Alstom and Thales are ideally suited to integrate the best solution for the City.

Test programs will be developed to demonstrate all aspects of the interfaces. This will include First Article Inspections, qualification tests, Factory Acceptance Tests and subsystem integration tests. Vehicle/Train Control integration tests are planned in the MSF early in the schedule. These tests will be a key milestone for ensuring that all Vehicle/Train Control interfaces have been properly addressed. On-site testing will be planned in stages that demonstrate functionality in a logical sequence and ensure that, as far as possible, only one function within one system is being tested at a time. Once multiple systems have been tested to an appropriate stage, they will be combined for integration testing (see **Drawing 5.4.1.D.1D & E**).

RTG will manage integration of other subsystems by applying the principles used for the Vehicle/Train Control interface.

Lessons Learned from Other Project Integrations

Integration of the Canada Line project was based on a similar strategy to that outlined herein, with the following lessons directly applicable to the OLRT Project:

- Agree early which parties will authorize major steps in the start-up of the OLRT Project, such as:
  - Traction Power Energization
  - First Train Movement
  - Multiple Train Movements
  - Trial Running
  - Revenue Service

  (Note that this is an example list, and not necessarily a comprehensive list for the OLRT Project.)
- Agree with each party on the list of documents and other activities required in support of their signature authorizing start-up. Document this list in a System Activation Plan.
- Agree with each party the processes and/or standards to prepare relevant documents and other activities.
- Prepare and sign certificates as early as possible.
- Combine items in one certificate where timing is similar and signatories match.
- Ensure that Revenue Service Operating procedures and training programs related to safe operations during the T&C phase (e.g. Train movements, traction power energization, hand signals) are prepared well in advance of the start of T&C.
- Ensure that sufficient operators are trained for the start of T&C.
- Ensure that System access requirements for the Driver training program are scheduled well in advance of the start of T&C and coordinated with testing activities on an ongoing basis.
- Use experts for key Project challenges and to identify latent issues based on experience on other projects.

Lessons learned are also discussed in **Section 5.4.1.1**.

5.4.1.8 Systems Branding Strategy

The OLRT System has been described as the most important infrastructure project in the City since the building of the Rideau Canal. This is the first leg of a legacy project that will shape the growth and liveability of the City for generations to come. Branding this iconic system creates a unique opportunity to enhance the reputation and quality of life of the City and her citizens. Systems are a key component of the new OLRT brand – the quality and performance of this 'product component' will serve to build the System's reputation for safety, reliability and efficiency. The more visible system components, including equipment that is visible to or interacts with the public (e.g. Passenger information displays, signage and announcements) take on an even greater role as the 'voice' of the brand. RTG will work closely with the City to ensure these brand elements are harmonized and consistent. The fact that Thales is a Canadian success story with key development activities taking place in Ottawa adds to the brand messaging. The Vehicle branding strategy is discussed in **Section 5.4.3.1**.

Item	Value
Estimated fire loading for an entire Vehicle	**161 GJoules**

Ride Quality

Thanks to its unique truck architecture, the proposed Vehicle features comfort levels in line with international standards for Passenger comfort:

- ISO 2631 associated with UIC 513 (Measurements will be performed as per UIC 518
- ISO 2631-1985: Evaluation of reduced comfort boundary for urban application

5.4.4 TRAIN CONTROL

RTG is pleased to offer the SelTrac Communication Based Train Control (CBTC) System from Thales Canada for the OLRT Project. SelTrac's proven CBTC architecture provides comprehensive Train Control functionality with the highest levels of performance, reliability, availability and safety. The SelTrac CBTC System provides the 21st century urban transit system operational capabilities required for the OLRT:

- Fully protected bidirectional operation over the entire alignment
- Moving block Train protection to maximize Passenger throughput
- Flexible Control Operator interface that supports fully automatic scheduled operation while providing tools to manage incidents
- Proven safety record – the longest in the CBTC industry
- Proven performance in severe climatic conditions
- A fully automatic maintenance yard with unattended coupling and uncoupling to promote Project sustainability

Thales has operated in Canada for more than 30 years employing 1,300 employees in Transportation, Defence & Security, and Aerospace sectors. Thales' centre of excellence for signalling is located in Toronto, with offices in Vancouver and Ottawa employing more than 800 people. These Canadian offices pioneered the development of CBTC Systems for the world market in the 1980s and continue to be leaders in delivering CBTC systems that exceed client performance expectations, and in defining CBTC industry standards (IEEE 1474). Thales' Software Defined Radio, which will provide network communications for the OLRT CBTC System, was developed in their Ottawa office.

Thales has 31 lines in revenue service totaling 900 line kilometres, with a total of 1100 line kilometres contracted, and has installed CBTC solutions around the world for more than 26 years. There are currently more than 900 transit track kilometres signalled with Thales SelTrac CBTC solution in over 35 cities including major transit centres such as London, New York, Hong Kong, Shanghai, and Beijing. Thales has never failed to successfully deliver a SelTrac CBTC project and, once delivered, the system has never been replaced. (See **Cut Sheets 5.4.1.C-1 & 2** for the full project list) RTG and Thales are excited to work with the City to bring this unique Canadian success story to the nation's capital.

5.4.4.1 Modelling & Results of Expected Systems Performance & Applicability to the OLRT

As the most experienced CBTC provider using the globally proven free-space radio technology, Thales' SelTrac CBTC System exceeds the City's operational and headway requirements, ensuring Passenger comfort and optimum travel times. All features specified by the City are either included as generic SelTrac functions or have been previously implemented as a site-specific function in another system. This section provides an overview of how the SelTrac CBTC System will be applied to the OLRT and describes the modelling that was performed to validate the CBTC System design as integrated with the chosen Vehicle and alignment.

Applicability to the OLRT

The SelTrac CBTC System proposed for the OLRT consists of the following major subsystems which are distributed as shown on **Diagram 5.4.1.D-SK-202**:

- The Automatic Train Supervision (ATS) system which provides the high level OLRT control functions such as Train schedule regulation, Control Operator interface and the interface to other OLRT systems (e.g. SCADA, Passenger Information, City systems)
- Zone Controllers (ZC) that ensure safe Train separation and provide the interlocking function on a section of guideway
- Vehicle Onboard Controllers (VOBC) that ensure Trains are operated at a safe speed and within the Movement Authority commanded by the Zone Controller
- The Data Communication System (DCS) which provides the fibre-optic backbone for communication between the fixed subsystems as well as the high-speed wireless data network for communication with the VOBCs
- Track Circuits that provide broken rail protection and tracking of maintenance equipment and non-communicating Trains[1]
- Track-mounted equipment including wireless Access Points, switch machines, signals at interlockings, Train location norming transponders, intrusion detection at tunnel portals and Stations, proximity detectors at Stations, and signage

RTG will also provide a training simulator to assist in the delivery of Control Operator training and certification programs. This system will be entirely independent of the revenue service equipment listed above.

All these subsystems will be supplied and integrated by Thales and are described in more detail in **Section 5.4.4.6** and **Cut Sheets 5.4.1.C-3 to 5.4.1.C-18**. The system configuration is based on the highly successful Canada Line in Vancouver, including a fully automatic storage yard. Unlike Canada Line, all major OLRT CBTC subsystems[2] will be fully redundant, thus providing even higher CBTC system availability.

Operating and maintenance procedures and training are an important factor in achieving high system performance. Canada Line operations personnel will coordinate the development of OLRT operating procedures with the City and will participate in developing and delivering operations training programs. Similarly Canada Line maintenance personnel have participated in the design of the CBTC System and will oversee the associated maintenance procedures, training, and participate in the testing and commissioning of the OLRT. This strategy will ensure that the CBTC System design is supported by well-trained personnel, thus ensuring high system performance.

Simulation Modelling Results

Thales simulated the performance of the CBTC System on the OLRT alignment using a simulator that has been validated against actual performance of Trains in other systems. The simulation used conservative values of braking and acceleration derived from actual Train performance characteristics provided by Alstom. Actual guideway civil speeds and CBTC System tolerances and processing delays were used. The Thales CBTC System uses a proven safety distance algorithm that applies a conservative safety distance based on the worst-case braking distance calculated for actual Train speed, which allows the System to safely maximize throughput.

The simulations confirm that RTG's proposed system for the OLRT meets or exceeds all of the City's operational requirements by achieving the following:

- Minimum design headway of 90 seconds

[1] RTG has chosen to provide track circuits because, although they are not required by the SelTrac CBTC System, we believe that they are the City's preferred option. We are open to exploring other options which may improve system availability at the Conceptual Design Review.
[2] Canada Line Interlockings are not redundant.

- Worst-case single tracking minimum headway of 14:52 minutes
- Maximum trip time of 23 minutes for ATO mode and 24 minutes for ATP mode
- System capacity for all operating scenarios

Simulation results are summarized in **Section 5.4.5** and details are presented in the Operation Performance Simulation. A narrative can be found in **Section 10.0.4**.

5.4.4.2 Interaction of the Train Control System with Vehicles

Revenue Vehicles

Using proven interfaces, the VOBC will control and monitor major Vehicle subsystems including propulsion, brakes, and doors. In general these interfaces will be Ethernet, MVB and discrete trainlines for safety critical functions. Vehicle networks and CBTC networks will be independent, and the CBTC Ethernet network will be redundant. The functional description of the VOBC can be found in **Section 5.4.4.6**.

Thales has successfully installed their system on Trains built by all major manufacturers. They have worked with Alstom on the London Underground Jubilee Line and on Shanghai Metro Lines 6 and 8. The Shanghai installations employed 1500 Vdc as is proposed for the OLRT. The preliminary Train network design prepared jointly by Alstom and Thales is shown in **Drawing 5.4.1.D-SK-201**.

Non-Revenue Vehicles

SelTrac protects non-communicating Trains (NCT - either failed Trains or unequipped vehicles such as maintenance equipment) with a Manual Route Reservation (MRR, which sets and locks a route from an origin to destination for an NCT move) and tracks the NCT using track circuit status.

The Zone Controller interfaces with the track circuits and monitors their status to determine block occupancy, which is reported to the ATS. The Zone Controller will use block occupancy to determine the location of the NCT and will release the route behind the Train based on a check-in/check-out algorithm using block occupancy status.

NCT tracking is performed automatically by the ATS function. The ATS operator can use the Occupancy Train Correlation command to manually associate an NCT with a block occupancy. The ATS Line Overview graphically shows all Trains in CBTC territory – equipped, unequipped, and non-communicating.

5.4.4.3 Interaction of the Train Control System with Operators

Train Driver

The Train Operator Display (TOD) in the Driver's cab of the Vehicles provides status and commands to the Driver in a clear and easily understood format. The TOD is ergonomically designed to present data in a clear and concise display. The VOBC will provide data to the TOD via an Ethernet interface (see **Figure 5.4-24**):

- Speed (Maximum permitted speed, Actual speed, and New target speed)
- Train operating mode (UTO, ATO, ATP, Coupling, Non-CBTC Territory, Manual Release, ATP Cut-out)
- Indicates direction of travel, distance to go (to the next stopping point, to a new target speed, and to the movement authority limit)

Figure 5.4-24 | Typical TOD Operation Screen

- Dwell countdown timer, Faults, Alignment at the Station
- CBTC Available modes
- Side of doors that open, overspeed indication
- Train doors status
- Train identification number
- Current Station
- Next Station
- Train destination/Headcode
- Ready-to-depart indicator (audio/visual)
- Local Time
- Station Overrun Message
- Indication of Station hold at (next) platform
- Indication of Station skip
- Open/Close Train Doors command
- Train operator ID, Rolling Stock ID
- Travel Direction, Emergency Brake Status

Mainline Operators

The mainline Control Operators (COs) are the command level of authority for the OLRT. The SelTrac ATS function provides COs with an interface where they normally run the railway in accordance with a prearranged schedule with minimal intervention, but which provides powerful tools to intervene as required to manage special circumstances such as Passenger emergencies, large crowds, system failures or severe weather. ATS workstations and overview displays provide real-time status of, and alarms for, the full rail network. Operational procedures will be developed in cooperation with the City to define the appropriate response to alarms and delays. ATS functions and screens are described in detail in **Section 5.4.4.6**.

COs are assigned a command Level of Authority (LOA) based on their training and certification. They are also assigned a Region of Authority (ROA) based on the portion of the railway they have been assigned to control. ATS command level authorization and territory control are controlled through the User Administration ATS function. ATS operators are required to log in with a defined user account to access ATS functions. Each user account is associated with one or more LOA user groups, which determine what commands are accessible to that user.

For those commands which perform a function in a specific territory of the railway, the logged-in ATS operator must acquire control of the ROA that includes that area before being able to issue the command. Only one CO may have control of an ROA at a given time. The user account specifies for what ROAs the operator is authorized to request control. Assigning ROA and LOA groups is restricted to authorized personnel.

All commands executed by an operator are logged in the archive server with the user account and workstation from which the command was issued.

Maintenance & Storage Facility (MSF) Yard Control Functions

The MSF Yard ATS workstations provide similar capabilities as the mainline, plus certain yard-specific functions such as the Train Wake-Up Command and a Train Park Command. The ROA function ensures that the yard Control Operator (YCO) cannot execute commands that affect the mainline. The yard control functions are described in **Section 5.4.4.7**.

5.4.4.4 Train Control System

The SelTrac CBTC Subsystems outlined in **Section 5.4.4.1** are further described here. Equipment location and interconnections are shown in high level architecture **Diagram 5.4.1.D-SK-202.** System hardware is described in **Cut Sheets 5.4.1.C-3 to 5.4.1.C-18**. System software, including development life cycle and configuration control are discussed below.

The CBTC product offered by Thales has an optimized architecture built around the integrated Zone Controller (ZC), which implements both CBTC and Computer-based Interlocking System (CIS) functionality.

The vital components of the system are the Vehicle On-board Controller (VOBC) on the Train and the Zone Controller (ZC) on the wayside. Together they provide the Automatic Train Protection functions of the SelTrac CBTC. The non-vital ATS provides the operator with a high-level set of operation management functions for Automatic Train Supervision. The Data Communication System (DCS) provides the communication means for all components to exchange data. A wayside Train detection system is implemented to track non-communicating Trains using track circuits.

Automatic Train Supervision (ATS) is the top-level system management and supervision component of the SelTrac CBTC, providing the ATS functionality:

- Schedule and headway automatic regulation, including energy-saving features
- Automatic and manual routing
- System status (e.g. status of Trains, switches, emergency-stop system) monitoring and display
- Operator control functions and user interface
- Data logging and report generation
- Interface with external systems, including Passenger information systems

The function of the ATS Server is to perform predictions, routing, schedule regulation, and to maintain the system status and alarm database. The ATS Server will write all log information (i.e. events, alarms) into the clustered database in the MSF. The Database Storage Unit (DSU) is the repository of the system databases. It is used to securely distribute application data to the system components remotely. The ATS is non-vital and performs no safety critical functions.

ATS Servers are redundant and implemented in a hot standby configuration. Redundancy of ATS workstations is achieved by providing multiple workstations in each control room and allowing any workstation to be configured for any function.

The **Zone Controller (ZC)** is the core Automatic Train Protection (ATP) component of the wayside vital Train control, which integrates the Limit of Movement Authority calculation with interlocking functionality. Each Zone Controller manages a section of the railway (zone) in accordance with various operation and configuration requests from the ATS. The ZC controls and monitors the following:

- All track-mounted equipment in its zone
- All Trains in its zone via continuous communication with the VOBC
- Trains entering or leaving its zone via continuous communication with the neighbouring Zone Controller(s)

The ZC is a vital subsystem and is configured as a 2 X 2oo2 (see **Section 5.4.4.9**) subsystem to achieve high safety and availability. Each ZC is equipped with a local ATS workstation to maintain basic ATS functionality in the unlikely event of loss of communication to the central ATS Servers. In case of complete loss of the ZC CBTC System process, the ZC will function as a conventional interlocking in a standalone fashion.

The **Vehicle On-Board Controller (VOBC)** is the core onboard train control system component which provides driver controlled operation (ATP Only mode), driver supervised operation (ATO mode), and driverless operation (UTO mode), by implementing Automatic Train Protection and Automatic Train Operation functionality, including safe automatic or manually driven Train movement, including Driverless turnback and accurate Station stopping, automatic door operation and protection.

The VOBC performs ATP and ATO functions in accordance with ZC and ATS commands, with which it maintains continuous communication over the CBTC wireless network. The ZC provides the Limit of Movement Authority (LMA) used by the VOBC to safely operate the Train in accordance with the maximum speed profile. The VOBC, using its sophisticated safe-braking model, calculates in real-time its safe braking curve, allowing the Train to stop very close to the end of its LMA, thus reducing the required overlap distance. The VOBC reports the position, speed and status of the controlled Train to the ZC.

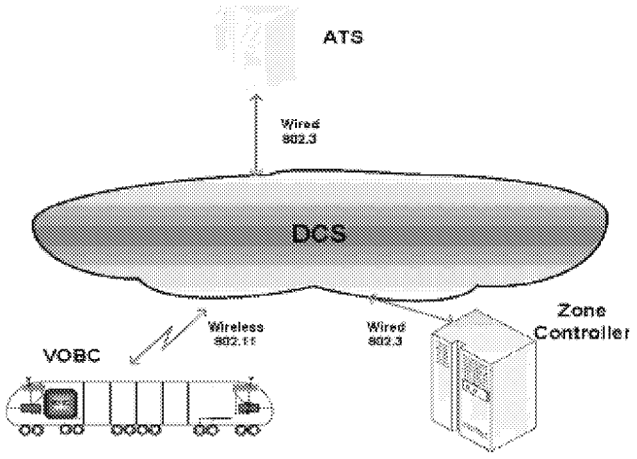
The VOBC is a vital ATP component of the SelTrac CBTC system and is designed and built redundantly for high safety and availability. Each 48.5 m Vehicle is equipped with a safety redundant (2oo3) VOBC (see **Section 5.4.4.9**). In addition to on-board tachometers and accelerometers, the VOBC uses transponders to maintain Train position and proximity plates which support accurate Station stopping in ATO mode.

The **Data Communications System (DCS)** is the SelTrac CBTC communication component. Its main function is to enable fast, bidirectional, secure and dependable communication between all subsystems (see **Figure 5.4-25**).

The radio component of the DCS is based on IEEE 802.11 successfully deployed over more than 300 line kilometres. The radio layout provides geographical redundancy (zones have overlapping coverage) and on-board redundancy (with a pair of antennae installed at each end of the Train to provide diversity).

DCS security devices ensure that communication between the wayside trusted network and the wireless trackside and on-board network is secure.

Figure 5.4-25 | Data Communication System Context



The modular system architecture provides built-in expandability to support line extensions and/or fleet expansions to realize the full capacity of the OLRT. The system architecture of the Train control system is supported by trackside equipment and three classes of software.

Trackside Equipment

The following equipment will be installed at the trackside:

- **Track Circuits –** Invensys PSO 4000 jointless track circuits - AREMA compliant and rated to -40°C. The PSO 4000's are service proven in North America on both mainline and metro systems.
- **Access Points (APs) –** The APs provide high-speed wireless communication between the VOBCs and the ATS and ZC. They are rated to -40oC, are being used in Asia and North America, and are currently being installed in Edmonton, Alberta.
- **Transponders -** Transcore AT5415 which are service-proven in many North American rail applications.
- **Switch machines –** Thales 910H switch machines which are service-proven in various countries including Canada, Finland, Portugal, Germany, Italy, Spain, Turkey, Switzerland, Austria, Slovenia, Britain, Malaysia, and Saudi Arabia. Over the past 10 years they have demonstrated reliable operation at temperatures of -40°C. Heaters will be provided for each switch – gas in the yard and electric on the mainline (**Cut Sheets 5.2.4-CS-101 & 102**)
- **Signals –** The signals at interlockings will be three-aspect LED signals designed for clear visibility and high availability. Two-aspect LED signals will be provided to control movements between the maintenance shop and the boundary of CBTC territory in the MSF (see **Drawing 5.4.1.D-SK-106**)
- **Intrusion Detection –** FibrMat optical fibre pressure sensitive mat for intrusion detection

- **Proximity plates –** The proximity plates used to ensure stopping accuracy at the Station are service-proven on many SelTrac projects.

Software Classification

The software for this Project falls into three classifications:

- **Vital Software –** Software which, if implemented incorrectly, may reduce System safety. The development and modification of vital software is subject to rigorous reviews and procedures (e.g. ZC and VOBC software).
- **System-Critical Software –** Software which, if implemented incorrectly, may reduce System day-to-day operational capability. The development and modification of system-critical software, although not required to meet the same standards as vital software, is subject to a complete design/review/test program to ensure that the functional requirements are met (e.g. ATS software).
- **System Support Software –** Software which, if implemented incorrectly, will not have an immediate effect on the level of System service but which is required to meet the overall System specification. The development and modification of System support software is designed with a less rigorous method, compatible with ensuring specified functionality (e.g. Training Simulator software).

Software Development Lifecycle

This section describes the software development process for producing software to meet functional requirements.

Software V-Model Life Cycle

The V-Model for the software development process is used to manage the relationship between each phase of the development cycle and testing, as indicated in **Diagram 5.4.1.D2.3A**. The model deploys a well-defined structure, in which each phase is implemented in accordance with the outputs from the previous phase. System requirements are input to the model.

Software Configuration and Control Management

Software configuration and all associated documentation will be controlled and managed according to Thales' proven Software Configuration Management work instruction. The software system will be segmented into Computer Software Configured Items (CSCIs) that will be version managed by use of the software tool ClearCase. Defects to these CSCIs will be managed through the accompanying software tool ClearQuest.

During the development, software configured items include the following:

- Software Requirements Specification (ClearCase)
- Software Design Documentation(ClearCase)
- Software Source Code (ClearCase)
- Software Test Plans (ClearCase)
- Software Test Specifications (ClearQuest/ClearCase)
- Software Test Source Code (ClearCase)
- Software Test Scripts (ClearCase)
- Software Test Results (ClearQuest)

When an anomaly is detected, a Software Change Report (SCR) report is submitted to the defect tracking system. This report is handled as per Thales' Change Control Process. Closure of this report will follow the documented development process complete with all reviews and checkpoints. Thales's Change Control Process ensures the following:

- Any perceived hardware, software or document fault is reported, recorded and resolved.
- Change instructions are represented in a clearly stated, structured and consistent manner.
- Proposed changes are fully evaluated (in a defined way, by all relevant parties), and are properly resolved.

- There is visibility on the status of all changes.
- All communication paths are well defined.

Hardware Configuration Control

All Line Replaceable Units (LRUs) that are identified as hardware configuration items are serialized during manufacturing. As part of final inspection, the configuration of each LRU will be verified and recorded.

Where items are procured from a subcontractor, the subcontractor will record the configuration and submit the configuration log with the item in accordance with the purchase order requirement. The configuration log will be verified as part of Thales' inspection procedures.

5.4.4.5 Key Functions and Modes

This section is divided into two major tables. **Table 5.4-16** defines key functions for both normal and abnormal conditions. Abnormal conditions are defined to be failure conditions or extreme weather. **Table 5.4-17** defines the interaction of operational modes and identifies how Drivers interact with the system.

Key Functions

Table 5.4-16 | CBTC System Key Functions

Key Function	CBTC System Condition	
	Normal	Abnormal
Automatic Train Supervision		
Automatic Train Regulation	Regulation method: ■ Schedule ■ Headway or ■ Energy Conservation	**Cause (of Abnormal Condition):** Loss of ATS Server, Loss of DCS **Fallback Operation:** Routing from Local ATS
Automatic Train Routing	■ Start of service launch ■ Dwell expiry ■ Turnback handling ■ Deadlock prevention ■ Bi-directional handling	***Cause:*** *Track blockage* **Fallback:** Single track "Fleeting" ***Cause:*** *Loss of ATS Server, Loss of DCS* **Fallback:** Routing from Local ATS
Automatic Train Protection		
Train Tracking	■ Train position determination ■ Train speed measurement ■ Station alignment ■ Train length determination ■ Train integrity supervision	***Cause:*** *Loss of all VOBCs, Loss of DCS, Loss of ZC, Unequipped vehicle* **Fallback:** NCT Tracking, Manual Route Reservation
Safe Train Separation	■ LMA enforcement ■ Rollback detection ■ Maximum speed enforcement ■ Train mode supervision	***Cause:*** Loss of all VOBCs, Loss of DCS, Loss of ZC. Unequipped vehicle **Fallback:** Limit maximum velocity (VOBC or propulsion system depending on failure), Signals at interlocking, line-of-sight operation
Route Interlocking	■ Route locking based on Train reservations, LMA, and speed	***Cause:*** Loss of all VOBCs, Loss of DCS, Loss of ZC CBTC function. Unequipped vehicle **Fallback** :Conventional I/L using track circuits and signals

Key Function	CBTC System Condition	
	Normal	Abnormal
Train door supervision	■ Verify stopped at Station & doors commanded open on platform side ■ Train position determination ■ Train speed measurement ■ Station alignment	***Cause:*** *Loss of all VOBCs* **Fallback:** Driver intervention – door open override
Monitor Driver Awareness	■ Deadman switch supervision (all modes except UTO)	***Cause:*** *Deadman switch failure* **Fallback:** CBTC Bypass Mode
Manage Track-side Anomalies	■ Temporary speed restrictions ■ Work zones	***Cause:*** *Loss of all VOBCs, Loss of Train/wayside communication* **Fallback:** CBTC Bypass Mode or Manual Release Mode, Line of Sight
Automatic Train Operation		
Automatic Speed Control	■ Control Train speed as per ATS commands and ride quality parameters ■ Monitor Train master controller	***Cause:*** *poor adhesion due to Extreme weather, debris (e.g. leaves)* **Fallback:** ASC feedback loop to adjust Train braking especially while approaching Station stop, ATS tools to reduce acceleration & braking rates in extreme weather, Maintenance procedures
Door Open/close requests	■ Doors open/close as per scheduled dwell	***Cause:*** *Loss of all VOBCs, Loss of Train/wayside communication* **Fallback:** Driver intervention – door open override

CBTC System - Operations Mode Interaction

Because of its large installation base, the Thales CBTC System supports all the features of each operating mode specified in the PA, generally as part of the generic product and in a few cases as site-specific functions implemented on previous projects. **Table 5.4-17** shows how the subsystems interact to manage the operations modes. Vehicle modes are further described in the **State Transition Diagram 5.4.1.D2.6**.

Table 5.4-17 | CBTC System Operations Mode Interactions

Mode	Description	CBTC Interaction (Key Functions)				Driver Interaction
Train Modes		**ATS**	**ATP - ZC**	**ATP – VOBC**	**ATO**	
ATO	Normal Mainline Operation	Full ATS: Automatic Train Regulation Automatic Train Routing	Full ATP: LMA Calculation CBTC Route Locking Mode Change Supervision	Full ATP: LMA Enforcement Rollback Detection Max Speed Enforcement Train Door Supervision Deadman Supervision	Full ATO: Speed Control Door Control Monitor master Controller	Driver Monitors via Deadman May operate doors (configurable option)
ATP Only	Work Zones Future extensions	Full ATS: Automatic Train Regulation	Full ATP: LMA Calculation CBTC Route Locking	Full ATP: LMA Enforcement Rollback Detection Max Speed	None	Driver Operates Train as per TOD

Mode	Description	CBTC Interaction (Key Functions)				Driver Interaction
		Automatic Train Routing		Enforcement Train Door Supervision Deadman Supervision		indications
Coupling	Manual Train Coupling (ATP)	Track & Display Train(s)	Full ATP: LMA Calculation CBTC Route Locking Operation Plausibility checks (Mode Change Supervision) Prohibit movement into I/L with signal at stop	Full ATP: LMA Enforcement Rollback Detection Max Speed Enforcement Train Door Supervision Deadman Supervision	None	Driver Operates Train as per TOD indications
CBTC Bypass	Operate Train in unlikely, case of total onboard CBTC failure	Track & display non communicating Train (NCT) Manual Route Reservation	Track NCT Conventional Route Locking	None – propulsion system enforces a max speed	None	Line of sight operation
Manual Release Mode	Train/wayside communication loss Reverse move required (Station overshoot) Re-establish Train position	Track & display Train (may or may not be comm-unicating)	If NCT: Track NCT Conventional Route Locking Mode Change Supervision	Enforce restricted speed	None	Get CO permission before activating switch Line of sight operation
Non-CBTC Territory	Exit/Enter CBTC territory	Track & display Train	Track Train Mode Change Supervision	Enforce restricted speed	None	Driver initiates
Off	Cab shut down before Driver exits at end of shift, or Terminus end change	Display Train Request change to UTO	Mode Change Supervision	Enforce zero speed	None	Driver initiates
Unattended Train Operation	Non-revenue Train activity in Yard	Full ATS: Automatic Train Regulation Automatic Train Routing Unattended coupling/	Full ATP: LMA Calculation CBTC Route Locking Mode Change Supervision Coupling/ Uncoupling	Full ATP: LMA Enforcement Rollback Detection Max Speed Enforcement Train Door Supervision No Deadman Supervision	Full ATO: Speed Control Door Control	No Driver Involvement

Mode	Description	CBTC Interaction (Key Functions)				Driver Interaction
		uncoupling	Supervision			
ATS Modes						
ATS Automatic Mode	Automatic Train Regulation Automatic Train Routing	Full ATS	Full ATP depending on individual Train mode	Full ATP depending on individual Train mode	Full ATO depending on individual Train mode	Depends on individual Train Mode
ATS Manual Operation	Used to operate during loss of Train to wayside communication or when operating unequipped Vehicles during nightly maintenance period	Partial ATS – some functions available	Partial ATP: Conventional Interlocking NCT tracking	Enforce restricted speed (MRM Train mode)	None	Get CO permission before activating switch Line of sight operation

5.4.4.6 Train Control System Functional Description

The functional description is organized by the classic categories (i.e. ATS, ATP and ATO), summarized as follows:

- ATS performs all signalling and control functions but has no responsibility for safety
- ATP is responsible for safe Train separation and routing in accordance with control requests from the ATS
- ATO is responsible for automatic operation of the Train in accordance with commands from the ATS and under the supervision of ATP

Automatic Train Supervision (ATS)

ATS for OLRT can be divided into two major modes: ATS Automatic Mode and ATS Manual Operation Mode. Both modes operate with minimal intervention and provide the CO with powerful tools to intervene as required to manage special circumstances such as Passenger emergencies, large crowds, system failures or severe weather. Any automatic operation can be manually overridden by the CO. A preliminary list of commands is shown in **Table 5.4-17**.

ATS Automatic Mode

This is the normal mode in which the OLRT will run. The CO loads a timetable at the beginning of the day. The timetable defines a set of runs for each level of service (LOS) and each run defines the schedule of operation for a Train in that LOS. ATS will wake up each Train at the required time, send it to a Driver pick-up platform, route it to the mainline, and assign it to a run. Trains are routed from Station to Station according to their assigned timetable run. Once the run is no longer required, ATS routes the Train back to the yard.

Automatic Train Regulation

This function regulates Train movements to either a schedule or defined headway. Schedule regulation minimizes deviations between the operating timetable and actual Train movements. Headway regulation ensures that the time between Trains is consistent.

ATS will modify a Train's acceleration rate, maximum speed and/or Station dwell time to address a difference (late or early) between its actual Station arrival time versus the target arrival time according to the active regulation strategy. ATS can also apply the following regulation functions in real time to provide significant energy savings:

- **Adaptive Slow Running** – Modify a Train's driving profile to reduce acceleration rate and limit speed to avoid stopping between Stations due to the preceding Train being behind schedule.
- **Arrival/Departure Coordination** – Coordinate braking and acceleration of nearby Trains to reuse energy from regenerative braking.
- **Constrain Peak Demand** - Limit the number of Trains departing simultaneously to reduce power spikes.

The timetable compilation tool provides Energy Efficient Planning capabilities similar to these three to optimize a timetable for energy efficiency.

Automatic Train Routing

This function sends route requests routes to the ZC for Trains on run or line assignments as required by the automatic Train regulation function. Route requests may also be sent in response to CO commands including Train Depart, Platform Hold Release, System Hold Release or point to point routing. This routing function ensures that deadlocking is prevented through the following:

- **Deadlock Prevention** – Use predictive routing to avoid interference with another route.
- **Terminus Station Handling** – Maximize throughput at terminus Stations using multiple Station platforms and coordinating arrival of a Train at the terminus with departure of the previous one.
- **Bi-Directional Handling** – Prevent conflicts in areas where routes would be opposing in a single track. This allows the CO to operate shuttle services that intersect or to initiate single-tracking operations without having to worry about Train movements deadlocking.

ATS Manual Operation Mode (Interlockings)

ATS Manual Operation Mode allows the CO to control the interlocking process of the ZC from an ATS workstation (either central or local). This mode may be useful in case of loss of CBTC Train-to-wayside communication or during the maintenance window when operating with unequipped vehicles. The ZC will operate as a conventional interlocking performing all the functions specified in the PA including allowing the CO to do the following:

- Set up routes by selecting entrances and exits or by selecting switch position for each switch
- Block and unblock switches
- Call, cancel and fleet signals
- Set the Interlocking to operate in an automatic turnback mode

ATS CO Interface

The ATS provides the human-machine interface (HMI) to the CO. The SelTrac HMI is powerful and flexible, again due to Thales' experience and large installation base. The CO uses the ATS workstation to issue commands and to monitor the state of the system. The ATS Line Overview provides a complete visual representation of the OLRT state including of the location of Trains, their routes and Movement Authority, the state of wayside devices, system alarms, and Traction Power status. **Cut Sheet 5.4.1.D2.2** shows typical ATS screens, and the NetTrac MT **Cut Sheet 5.4.1.C-4** provides further information. **Table 5.4-18** provides a preliminary list of ATC commands. The details of the ATS HMI interface will be developed at the CDR and will fully support the operating procedures that RTG will prepare in cooperation with the City.

Table 5.4-18 | Typical ATC Commands

Typical ATC Commands		
ATS Level		
Online timetable updates	Run assignment	Re-determination
Line assignments	Regulation mode	System hold
Train hold	Train stop / proceed	Shuttle operation
Platform hold	Platform skip	Server switchover
Train reset	UTO Train park	UTO Train wake-up
point to point Train routing	Region & Level of Authority	Occupancy Train Correlation
ATP Level		
Temporary speed restriction	Set/clear work zone	Emergency brake set/reset
Manual switch control	Interlocking mode control	Manual route reservation
Open/close track	Route blocking	Platform close
Signal block	Authorize UTO mode	UTO Train couple/uncouple
Switch block		
ATO Level		
Speed adjustments	Dwell adjustments	Door control
Acceleration rate adjustment	Brake rate adjustment	

Automatic Train Protection (ATP)

The heart of the ATP function is the ZC: it determines the Limit of Movement Authority (LMA) and provides route locking while supporting full bidirectional operation. The VOBC is responsible for enforcing the LMA and accurately reporting Train position. The ZC reserves a block (section of guideway) for the Train up to the end of the route (typically the next Station) unless there is an obstruction along the way (e. g. preceding Train). As the Train moves within this block the VOBC reports the Train's new position allowing the ZC to release that part of the block now behind the Train. If the LMA is restricted by a preceding Train, the ZC will advance the front end of the block as the preceding Train moves ahead, hence the CBTC term "moving block." These functions are described below.

Safe Train Separation and Interlocking

The ZC maintains an accurate database of the status of all obstructions within its zone. This database is maintained by cyclical communication with all relevant devices and includes the position of all Trains, interlocking device status (e.g. switches, intrusion detectors, conflicting routes), status of neighbouring ZCs, fixed obstructions such as end-of-guideway, and CO-imposed obstructions such as closed tracks and work zones. Upon receiving a route request for a healthy Train the ZC determines an LMA based on the route, direction, destination, nearest obstruction and maximum LMA required.

In the process of LMA determination, the ZC LMA process uses the ZC interlocking process to lock routes. Only if the route is set and locked will the LMA be advanced through the interlocking.

The VOBC ATP process is responsible for enforcing the LMA. It continuously supervises the Train's speed and position against both the maximum allowed speed and the braking curve required to stop the Train a safe distance before the LMA, and brakes the Train as required to ensure that the Train stops before the LMA.

The VOBC ATP process also monitors rollback, which is defined as Train movement against the commanded travel direction. The VOBC ATP process commands an emergency brake when it detects that the Train has moved against the commanded travel direction in excess of the rollback limit.

The LMA for all Trains in the system is calculated cyclically. For each controlled Train, the LMA is advanced only after it is validated that any preceding Train has advanced and that all other restrictions have been cleared. The function is failsafe in that any failure within the ZC, VOBC, or DCS which prevents the ZC from confirming that it is safe to advance the LMA will result in the LMA not being advanced.

The ATP function also supervises Train mode changes (see preliminary design in Mode State Transition **Drawing 5.4.3-SW-110**). RTG will develop details in cooperation with the City during operations procedure definition.

The ZC closes tracks under certain conditions such as a portal intrusion activated or as initiated by the CO. In addition, it will manage Temporary Speed Restrictions (TSR) and Work Zones (WZ) as specified in the PA.

Train Tracking

Using position reports from the Train and its known length, the CBTC system safely and accurately determines the location of both the front and rear of the communicating Train. The VOBC vitally determines Train length, using Vehicle length and coupler status. Vehicle length is defined by the Vehicle ID plug, and coupler status is used to determine if the Train is a single Vehicle or a coupled consist. Train position is maintained as described below.

Train Position Determination

Once it has detected two transponders, the VOBC knows the position of the Train. It compares the distance it has measured between two consecutive transponders, with the distance recorded in the guideway database. If the two values agree within a limited tolerance, the position for the Train has been established and the exact location of the Train will be known. Between the transponders, the position is determined based on the inputs from the speed sensors.

Positional uncertainty is dynamically calculated based on factors such as transponder footprint, distance travelled since last transponder, and wheel slip status. If the uncertainty exceeds the acceptable limit, the VOBC sets the position to unknown.

Train Speed Measurement

The VOBC uses speed sensors and accelerometers to determine distance travelled, train speed and travel direction. The VOBC processes inputs from each of the three tachometers installed on different axles as well as inputs from each of the three accelerometers in each processing cycle, and performs plausibility checks to dynamically estimate the speed determination error.

In extreme weather, wheel/rail adhesion is reduced and there is a risk of wheel spin/slide resulting in overshooting the stopping points. The Vehicle propulsion system will detect spin/slide and adjust propulsion and braking demand to mitigate. Similarly, the ATO function will adjust braking demand to compensate. Finally, the ATS will permit the Driver to select one of three wet-rail mitigation levels to reduce the ATO Train's acceleration and braking rates. Special attention will be paid to these systems during site testing to validate their performance. Thales has successfully integrated their system with more than a dozen different rolling stock suppliers on more than 30 different CBTC projects and will do so again on the OLRT project.

Station Platform Alignment

Proximity plates will be used at Station platforms to confirm correct alignment.

Train Integrity Supervision

The VOBC will continuously supervise a Train integrity signal supplied by the Train. If Train integrity is lost, the VOBC will declare position lost and apply the emergency brakes. The ZC will create a protection envelope around the Train to prevent other Trains from entering the area where the Train has lost integrity.

Tracking Communicating Trains

The ZC uses the position reported by the VOBC to track communicating Trains. As a Train approaches an area associated with a neighbouring ZC, the VOBC begins to communicate with this 'takeover' ZC. During the transition between zones, the VOBC communicates with both ZCs, which also communicate between themselves. The VOBC stops communicating with the handover ZC once the Train is completely inside the takeover zone.

Train Doors

If door status is lost when the Train is stopped, the VOBC will prevent the Train from moving. If door status is lost while the Train is moving, the VOBC will stop the Train and alarm the Driver and CO. Upon restoration of Train-door closed-and-locked status, the ATS Operator will reset the emergency brake and the Train will start moving.

The VOBC will provide a door-enable signal on the platform side (as determined from its guideway database and Train orientation) only when the Train is aligned with a Station and is stationary with propulsion disabled. Upon completion of the platform dwell, and once the doors have closed, the VOBC will remove the door-enable signal.

Automatic Train Operation (ATO)

SelTrac ATO governs mainline functions such as speed regulation, programmed Station stopping and automatic door operation. ATO commands are always subordinate to ATP supervision functions. The ATO component of the CBTC system is primarily designed to provide automatic Train operation, Train movement, door open/close, alarms and communications, and information transmission to the ATS. The ATO process will monitor the active cab's master controller to allow the Driver to assert control as per the PA.

Data Communication System

All communications between subsystems are via the non-vital Data Communication System (DCS). Vitality of the data transferred via DCS is ensured by incorporating sequence numbers and CRCs in each message, and using an authentication algorithm applied to each message. Algorithms for generating sequence numbers and CRCs are known only by the vital devices, to prevent corruption by non-vital components of the DCS.

The network uses an Open System IP standard that permits messages to be sent from any node to another node within the DCS as required. Fault Diagnosis of all hardware and software elements is aided by use of the DCS network which facilitates remote maintenance to determine unit level faults. It facilitates system-wide testing and deployment while achieving a high level of security. The DCS is a redundant, robust, dedicated communication system using various mechanisms to ensure protection against unauthorized access. Security devices control the interface between the wireless portion of the network (referred to the "untrusted' network) with the wayside "trusted" part of the network as described in **Cut Sheet 5.4.1.C-7** and preliminary network architecture **Drawings 5.4.1.D2.4 & 5.4.1.D2.5**)

Backup Methodology in Case of Communication Failure

The SelTrac CBTC System has a high level of availability due to a robust architecture. The equipment is configured fully redundantly to provide high availability (in addition to redundancy to provide vitality). This is implemented from the processor through to field Input/Output modules. In this way the system tolerates the failure of one component with no impact to system operation.

The redundant central ATS Servers installed at the MSF are configured hot-standby. Each ZC is provided with a redundant local ATS workstation connected to the DCS. This workstation can be used to display the overview of the line, and is used to provide local control in the unlikely event of a central ATS server failure. If both ATS Servers in the MSF go down, local ATS workstations will immediately and seamlessly take over control of the system.

A fixed-block secondary system will also be installed for tracking failed equipped Trains and non-equipped Trains. The Train position is expanded and contracted based on adjacent block occupancy report. Track circuits will be used for monitoring block occupancy status and will interface with the Zone Controller to report block occupancy status, so the Zone Controller will treat the occupied block as an obstruction to the Movement Authority of any approaching Train.

System redundancy is explained further in **Section 5.4.4.9**. The following sections explain the reaction to specific failures.

Non-Communicating Trains (NCT)

A Train will become non-communicating when the VOBC to ZC communication has been interrupted beyond a predefined timeout. Unequipped vehicles, such as maintenance equipment, will also be treated as NCTs. The system tracks NCTs using track circuits. The preliminary fixed block track circuit layout is shown in **Drawings 5.4.1.D-SK-101 to -106**.

The Zone Controller will use block occupancy to determine the location of the obstruction (NCO) and will release the route behind the Train based on check-in/check-out using block occupancy status.

If the Train is operating in a controlled mode and becomes non-communicating, the VOBC applies service brakes. If the Train regains communication before a timer has expired, the VOBC releases brakes and continues driving. This functionality allows for graceful handling of a temporary communication loss. If the timer expires without regaining communication, the Train is stopped.

The ATS Line Overview graphically shows all Trains in CBTC territory, including NCT.

Zone Controller Failure

The Zone Controller (ZC) has a 2 X 2oo2 configuration (see **Section 5.4.4.9**); one ZC is active, the other is passive. If the active ZC fails, the passive ZC will take over. This configuration ensures high ZC availability. If the CBTC process of the newly active ZC fails, the ZC interlocking process will still be available. However, in the unlikely case of multiple failures resulting in complete loss of a ZC, communication with Trains approaching or inside the failed ZC area will be lost. In this case, the VOBCs will maintain their position. Trains inside the zone will initiate service brake to a stop. Trains outside the zone will attempt to stop before the zone boundary. After the Train has stopped, the Driver can operate the Train in Manual Release mode until the Train reaches the next healthy ZC.

Upon restart the ZC will use track circuit status to confirm the location of all trains before allowing normal operation to resume.

Communication Failure

The Data Communication System is fully redundant at all levels, for both the wired and wireless components and is communication-gap tolerant, ensuring high availability. The system design includes geographical redundancy and Train reception diversity. The system reaction to the unlikely communication failures is described below.

ZC to VOBC Communication Loss

The ZC/VOBC communication is redundant, ensuring high availability. Each VOBC on-board the Train communicates with both on-board radios; one at each end of the Train (see **Cut Sheet 5.4.1.C-11**). Each radio has two pairs of radio antennas, one pair at each end of the Train, providing equipment and territory diversity (i.e. this strategy allows Train radios access to more wayside APs). Both pairs of antennas are used for maintaining communication with wayside equipment at all times.

Communication gaps of up to 3 seconds are tolerated by the system with no impact on the operation. Upon detecting the ZC/VOBC communication loss longer than 3 seconds, the VOBC will service brake the Train to a stop. If communication recovers, the VOBC will return to normal operation. If communication has not been recovered when the Train comes to a stop, the Train will need to be driven in Manual Release mode until communication is restored. The ZC will handle the Train as an NCT (see above). Once communication is restored, normal operation (ATO) can resume. The Driver will be notified of the mode availability via the TOD.

ZC to ZC Communication Loss

ZC/ZC communication is redundant. In the unlikely case that ZC/ZC communication is lost, this failure is generally caused by a multiple DCS network switch failure and is described under "Failure of DCS Network Switches" section.

If a controlled Train is approaching a ZC border where the two ZCs are not communicating, the Train will have its LMA set to the border. The Train will stop a safe distance from the border. To cross the border, the Train must be switched to Manual Release mode and driven under the supervision of the CO. Once the Train crosses the border, it will have a route on the takeover side and can be switched back to ATO mode.

Failure of an Access Point

Radio network coverage is designed such that failure of a single Access Point will not impact operation. The NMS will report the failure.

Failure of DCS Network Switches

If a network switch fails, the system ensures a full reconfiguration with no impact on operation. There are redundant network switches at the MSF and the ZC locations. The NMS will report the failure.

Failure of DCS Security Devices

There is redundancy in the configuration of the Security Devices (SDs) on the wayside. If an SD fails, another SD will take over with no impact on operation. The NMS will report the failure.

Transponder Failure

The VOBC will issue an alarm to the ATS indicating that it has failed to detect a particular transponder. The VOBC will continue to determine the position of the Train using the next transponder. If two consecutive transponders have not been detected, the VOBC will consider positioning lost and the Train will brake to a stop. The Train will then have to be driven in Manual Release mode to regain position.

VOBC Related Failures

There are two types of VOBC failures:

- **VOBC Loss of Positioning** - Loss of positioning can be caused by missing two consecutive transponders, a failure of multiple speed sensors or accelerometers, or excessive wheel spin/slide. Loss of positioning will cause the VOBC to become passive and apply brakes. In a two-car Train, if the other VOBC is healthy it will take over control of the Train and normal operation can resume. If there is not a second healthy Vehicle on the Train, the Driver will use CBTC Bypass to operate the Train.
- **Failure of the VOBC** - The VOBC has a 2oo3 configuration (**Section 5.4.4.9**) so if one processor fails the Train will continue to operate normally. If multiple processors fail the VOBC will apply the brakes. As mentioned above, in a two-car Train, if the other VOBC is healthy it will take over control of the Train and normal operation can resume.

ATS Failure

Failure of Single Server

The failure of a single active server causes the automatic activation of its passive partner. The typical failure scenario results in the failing active server “advertising” its failure to its partner as the last action it performs as it shuts down. This provides a fast (<100 ms) reaction by the passive partner to activate. The takeover server activates itself, and assumes a master role in its zone controller and Train communications. The failure is reported to the CO.

Failure of Both Servers

If both ATS Servers in the MSF go down, the local ATS workstations will immediately and seamlessly take over control of the system.

Methodology for Broken Rail Detection

Track circuits are proposed to detect broken rails. Anytime a track circuit indicates that the block is occupied when there is no Train present, there is a possibility that a broken rail is causing the occupancy. The CBTC System reacts to the broken rail detection with following Train protection:

- The ZC will report the broken rail status to the ATS
- The ATS will highlight the area with broken rail, and alarm the CO
- A Temporary Speed Restriction will be assigned to the corresponding tracks
- A warning will be presented on the TOD

RTG will develop an operating procedure to reset the alarm in cooperation with the City at the PDR stage.

5.4.4.7 Proposed Yard Control Strategy

RTG is pleased to propose Driverless (UTO) CBTC in the yard with a full complement of equipment compatible with the mainline CBTC, including a dedicated redundant Zone Controller. We are able to make this unique offer due to the exceptional service-proven performance of the Thales-equipped automatic yards on the Canada Line and the Vancouver SkyTrain, which have demonstrated safe operation in over 28 years of combined revenue service. This strategy will not only provide the safest and most efficient yard operation, it will also allow the Yard to be used as an LRT Systems and Vehicles test bed. This will reduce Project risk, increase the time available to validate system performance in severe weather, and provide the City with a test bed for future Vehicle purchases and/or line expansions.

Procedures for the OLRT MSF will be based on Canada Line procedures, which in turn were based on the Vancouver SkyTrain Driverless yard procedures. Canada Line O&M personnel have participated in MSF design and particularly the design of safety features to support Driverless operation. They will lead the development and initial rollout of the OLRT MSF O&M procedures. Safety measures will include the following:

- Full CCTV coverage of the MSF with 24/7 monitoring by the Yard Control Operator (YCO)
- Perimeter fencing with intrusion detection and access control
- Fencing and signage to restrict access and delineate different operational areas (e.g. auto/manual)
- Tunnels and walkways to ensure that OC Transpo personnel never need to cross operational tracks. This will also minimize the need for M&R personnel to cross tracks.
- Gates to protect vehicular level crossings. The gates will be monitored by the CBTC System which will interlock gate status with Train operation in the affected area.
- Stop buttons at track level which will suspend automatic operation in the associated area will be provided as required by the yard O&M procedures.
- All operational commands describe above in **Section 5.4.6** can be used by YCO to set routes, block tracks, define work zones and temporary speed restrictions.
- Proper procedures, training and recertification of staff to establish and maintain safe working practices.

UTO functions will include unattended Train coupling and uncoupling which will enhance sustainability by allowing the YCO to quickly and efficiently reconfigure Trains to match Passenger loads.

Yard Operations

The yard is divided into functional operations areas (see **Drawing 5.4.1.D-SK-106**):

- The area where the OC Transpo Drivers operate to pick up and drop off Trains will be equipped exactly as per the mainline to ensure common operating procedures. OC Transpo Drivers will pick up and drop off Trains as described below.

- The remainder of the yard will not be equipped with track circuits and signals. The YCO will control Train operation throughout the yard as required to support mainline operations and manage maintenance activities. Movement of unequipped Trains will be controlled by the YCO using Manual Route Reservations (MRR) in accordance with proven Canada Line procedures.
- The Transition Zone (TZ) is used to move Trains to and from the Maintenance Hall and to test Trains returning to service from maintenance. The TZ is within CBTC Territory while the Maintenance Hall and its approach apron are manual operation areas.
- The YCO will control moves between the Maintenance Hall and the TZ using an MRR to control the two-aspect signals which will be set to stop unless the YCO has set a route in response to an equipment move request (via radio) from an M&R hostler. Transponders in the TZ track will notify the VOBC that it is moving into or out of CBTC Territory and it will react as specified in the PA
- Similarly the YCO will control moves to and from the maintenance-of-way (MOW) storage track using an MRR. The MOW track is provides quick access to the mainline to maximize the usable nightly maintenance period.

Yard operations will not affect the mainline. The yard/mainline control boundary will be on the connector track between them. The precise location will be determined in conjunction with the development of operating procedures in cooperation with the City. The transfer of Trains across the boundary will be transparent to the CO, as is the transfer of Trains across any ZC boundary. To control the yard the YCO will use an ATS workstation which has full ATS functionally. The Region of Authority function will ensure that the YCO cannot execute commands that affect the mainline. Failure of the yard ZC will not affect the mainline. An FMECA will demonstrate that there are no credible CBTC yard equipment failure modes that can affect the mainline (including network failures).

Train Launch for Revenue Service

Prior to service start the mainline CO will select a timetable which defines the service level. The ATS will then:

- Select which parked Trains will be used to meet the service level (the YCO can edit this "launch list")
- Send each one a wake-up command at a configurable time before the Train is scheduled for service (to ensure that the interior temperature is comfortable)
- Route each Train as scheduled to one of the handover platforms for the OC Transpo Driver to board
- Route the Train onto the mainline upon Train mode changing to ATO (or ATP Only) and assign it to a run

Exceptions are as follows:

- The VOBC performs a start-up test upon receiving the wake-up command. The ATS informs the YCO if the test fails. The YCO will then route the Train to an inspection point or, if necessary, dispatch M&R personnel to manually drive the Train to the Maintenance Hall for service. The YCO will assign another Train to the launch list.
- If the OC Transpo Driver does not arrive in time the ATS will alarm the YCO to address the delay before service is affected.

Train Exit from Revenue Service

The ATS will select Trains to be taken out of service in accordance with the timetable as follows:

- Before arriving at the exit Station the ATS informs the Driver and the Passenger information system that the Train is being taken out of service.
- Upon completion of the dwell at the terminus Station the ATS routes the Train to one of the handover platforms in the yard.
- The Driver drives the Train to the handover platform, turns the cab off and exits the Train.
- Upon confirming that the Driver has left the Train, the YCO will normally command the VOBC to change to UTO mode and route the Train to a storage track where the Train will enter a low-energy-usage mode until commanded to wake-up. The YCO may also perform other actions as required:
- Route the Train to an inspection platform for inspection by a technician and/or cleaning staff.

- Route the Train to the wash and/or sanding facility.
- Route the Train to the Maintenance Hall. In this case the Train will come to a stop at the CBTC Territory boundary (see TZ in **Drawing 5.4.1.D-SK-106**) and wait to be boarded by an M&R hostler who will change the Train to Non-CBTC Territory mode and request a route into the Maintenance Hall as described above
- Uncouple a two-car Train to prepare for a timetable that requires shorter Trains, or to send one Vehicle to the Maintenance Hall.
- Couple to another Vehicle to prepare for a timetable that requires longer Trains.

5.4.4.8 System Safety Verification Standards

For the OLRT Project, Thales will adapt the System Safety Programme Plan (SSPP) plan that defines safety objectives, targets, and the required safety tasks for each of its projects. The OLRT SSPP will describe the methodologies and techniques to perform each safety task and address 'product' technical and management aspects. Other types of safety issues, such as site safety, will not be covered in this document.

This SSPP will describe the tasks and activities supporting application of the Thales generic SelTrac product safety case to the Project, building on the tasks and activities that have been performed in support of the product baseline. The tasks and activities within this scope, in many cases, take as inputs the artefacts produced in developing the product baseline, evaluating and updating based on the impact of the implementation details of the Project. The proposed solution is based on field-proven design which has been subjected to Independent Safety Assessment, the core of which remains intact for this Project. The existing safety artefacts will be confirmed and reused for this Project, where appropriate. In all cases, the existing artefacts are thoroughly reviewed to determine appropriateness and extent of reuse potential. The reuse of existing safety artefacts aids in building strong safety arguments for the OLRT Project.

The SSPP embodies the principles, methods, and best practices used in the transit signalling industry, and complies fully with PA safety requirements. It is based on the processes defined in EN 50126, EN 50128, EN 50129 and EN 50159 specifications. The SSPP also defines tasks and documentation per Thales' own ISO-9001 Manuals and Work Instructions (WI) as referenced.

This SSPP consists of eight sections which will describe each component of the Safety Programme for this CBTC Project:

- Section 1 defines the scope of this document and provides a brief description of each section.
- Section 2 (References & Terminology) identifies the standards and references that will be used to guide system design and implementation to achieve required safety targets. Abbreviations and acronyms used in this document are listed and definitions of safety terms are provided in this section.
- Section 3 (System Description) describes the proposed CBTC System with focus on system architecture and its interface with other systems.
- Section 4 (Safety Targets) describes the safety objectives required to be met by system design and implementation and the safety process used to demonstrate the achieved performance.
- Section 5 (Safety Management Organization and Responsibilities) describes the CBTC project team organization and their responsibilities with respect to the safety programme.
- Section 6 (Safety Engineering) describes the CBTC project lifecycle and the safety tasks corresponding to each stage. The process to control safety-related hazards and service affecting failures throughout the Project lifecycle is described in this section. This process ensures that the implemented CBTC system attains the required safety targets.
- Section 7 addresses the strategy and necessary activities of the safety assurance and certification process.
- Section 8 lists the Project safety deliverables and briefly describes their content and delivery milestones.

5.4.4.9 System Redundancy

The ZC is a vital ATP component of SelTrac CBTC, designed and built redundantly in a 2oo2 configuration for safety. Each zone is controlled by two ZC functional units, in an availability redundant hot-standby configuration. Thus, each ZC is a 2 X 2oo2 vital computer system, with high safety and availability. The 2oo2 configuration means that failsafe operation is assured by each unit operating on a two-out-of-two voting principle whereby its two independent central processing units (CPUs) cross-compare (and must agree upon) inputs and outputs. High availability is achieved by having a second failsafe pair (designated by 2 X) in a hot-standby configuration.

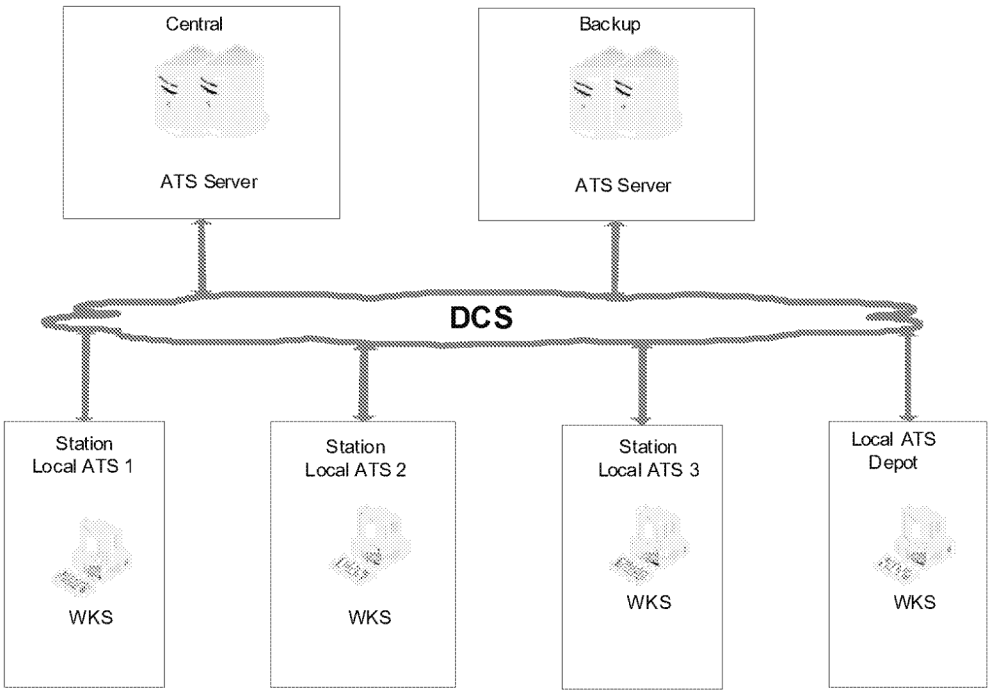
The ZC integrates the wayside ATP and interlocking functionality into each of the 2oo2 hardware vital computers, thus reducing the hardware component count. This minimizes the equipment to be deployed, increases the reliability and availability of the system and facilitates future extension of the system.

The VOBC is a vital ATP component of the SelTrac CBTC system, designed and built redundantly for safety and availability. Each 48.5 m Vehicle is equipped with a safety redundant (2oo3) VOBC. Failsafe operation is vitally assured by each of the VOBC's three independent CPUs cross-comparing inputs and outputs with agreement required by at least two CPUs to permit operation. High availability is achieved, since a single CPU failure will not affect operation. In normal operation, availability is further enhanced because either VOBC on a two-Vehicle Train has the capability of fully supervising and controlling Train movement regardless of the operational state of the other.

The redundant Central ATS Servers installed at the MSF are configured hot-standby. Workstation redundancy is obtained by any or all OLRT areas being controlled from any ATS workstation by appropriate Level of Authority assignment.

At selected Stations and in the depot, where a ZC is installed, a redundant local ATS workstation will be connected to the DCS (see **Figure 5.4-26**). This workstation can be used to display the overview of the line, and is used to provide local control in the unlikely event of a central ATS server failure. While in local ATS control, if an ATS server is available, the system status will continue to be sent to the central ATS.

Figure 5.4-26 | DCS and Redundant Local ATS Workstations



With all its servers being redundant, hot-standby configured, Thales ATS offers high availability through an architecture that accommodates two modes:

- Multiple users, with either central or local (Station) access
- Multiple types of operator responsibility configuration in terms of authority and area of control

DCS is a redundant network implemented using high-quality COTS components, distributed between control locations (TSCC, BCC, Stations, YCC), equipment rooms, trackside and on-board the Trains. The wired (802.3) and the wireless (802.11) components of the DCS use open-standard network protocols.

Redundancy of the Train-to-wayside radio network is discussed in the next section.

5.4.4.10 Train/Wayside Communications Reliability

In a Train Control environment, performance, reliability and mobility are key considerations. The Thales DCS ensures performance by providing a low mean message (IP packet) latency and a low packet error rate (PER) by providing a redundant on-board radio link and redundant wayside radio coverage. Each Train has a radio at both ends, and all VOBCs on the Train are connected to both radios. All messages between the VOBC and ATS or ZC are sent twice, and the IP addressing scheme transmits messages over two separate radio links. Only one message needs to be received for a successful transmission to occur.

Reliability is maintained by installing robust equipment in redundant configurations. There is no need for forward error correction on the DCS, only error detection. Packet errors are handled by a retransmission protocol within the DCS itself. This is transparent to the Train Control application. The DCS is designed to handle many types of single-point failures and some multiple failures without loss of communication. The DCS is also designed to protect applications against malicious attacks. Equipment redundancy and route diversity protect the system from "denial-of-service" attacks. An industry-standard IPSec security protocol, available at DCS security gateways, protects CBTC equipment from emulation attacks.

The on-board radio units (OBRU) of each Train communicate with the wayside radios (Access Points – AP) as the Train proceeds along the guideway. The IEEE 802.11 wireless standard uses its media access control (MAC) protocol for authorization, association and disassociation of the OBRUs that wish to communicate with the DCS wayside network.

This means that Trains can move between wayside coverage areas without losing their connectivity to the network. Trains can travel in excess of 100 km/h with minimal message loss during handover from one AP to another. Lost messages are simply retransmitted according to the 802.11 protocol. The wireless links can support multiple OBRUs associated with the same AP. Placement of the AP is determined by a radio route survey. This survey is conducted with a trolley equipped with RF instrumentation, although a Train may also be used. Instruments measure RF signal levels exactly as they would be seen by the Train antennas.

The DCS network includes all equipment needed for continuous uninterrupted communications between all elements of the CBTC System. The ring architecture is chosen because it is both cost effective and offers high availability. The network provides full redundancy for the backbone and AP feeder rings, as well as overlapping RF coverage and mobile radios at each end of the Train.

The communication system is designed to provide enough overlap between the wayside radios, such that the failure of a single radio does not degrade performance. APs are strategically located so that at any point on the guideway the OBRUs are capable of communicating with at least two APs. This maintains full coverage even if every alternate radio unit fails.

The DCS provides full overlapping RF coverage to each end of every Train at all points along the guideway, achieving CBTC System availability. To provide this coverage, a radio route survey is performed to determine the precise locations of all AP antennas (depicted in **Cut Sheet 5.4.1.C-12**) and to verify the choice of on-board antenna locations. After the survey and installation of the AP and the associated antennas, a full sweep of the guideway verifies the coverage of the actual installation and provides a baseline for later comparison during troubleshooting. While it is important to have full coverage, it is also important to recognize that signal levels can fluctuate in space and time due to objects near the propagation path (e.g. new wayside equipment, nearby Vehicles, people on platforms). To accommodate these effects, signal strength must be treated stochastically and a probability assigned to the strength being above the desired

threshold. In a typical installation, measurement of the signal strength over time and over the full length of the guideway has been found to take on a log-normal distribution (normally distributed in dBm). The methodology used for the design of a Thales DCS network is to arrange for a particular threshold level to be exceeded 98 percent of the time, based on a log-normally distributed signal. During a survey this threshold is used as the cut-off point for a given AP signal and sets the useful range of that AP. Note that there are four such propagation paths to any given Train, thus meeting the high availability of the network.

The important thing is not minimizing the number of APs but providing uninterrupted redundant coverage at a certain signal level. Anything less would not provide the availability needed for the network. As a starting point for all DCS designs, APs are located at the ends of each Station. These APs feed the antennas necessary to cover the two entrances pointing away from the Station and two antennas pointing into the Station. The number, location and type of antennas will be determined during the route survey. Between these antennas, additional APs are placed along the guideway at approximately 325 m spacing to allow for redundant RF coverage.

5.4.5 OPERATIONAL PERFORMANCE REQUIREMENTS

This section summarizes the results of simulations performed to demonstrate that the proposed system meets all the City's Operational Performance requirements. Simulation details are presented in the Operation Performance Simulation. A narrative can be found in **Section 10.0.4**.

5.4.5.1 Validation of Operational Capabilities & Capacity through System Performance Simulations

System Performance Simulation is performed using a software program known as Muesli Standard which simulates Train movement through the entire guideway. Numerous functions are incorporated into the simulation to model the characteristics of a modern transit system:

- Train data: acceleration, service deceleration, emergency brake rate, brake application delay
- Guideway data: grade, civil speed limits, Stations and switch locations
- System data: speed measurement errors, Train positioning errors
- Overspeed tolerance, safety distance calculation algorithm, process delays
- Routing data

To take into account the variations in travel times at different Station segments, stochastic simulations were carried out to estimate terminal-to-terminal trip time variances. These simulations confirm that RTG's proposed system for the OLRT meets or exceeds all of the City's operational requirements:

- Peak line capacity of 11,429 PPHPD in Operating Scenario 1 and 18,151 in Scenario 2, which can be increased to an ultimate capacity of 24,000 PPHPD in Scenario 3
- Average standee density of 3.33 Passengers/m^2 during peak service, with 40 percent of the capacity provided by seats, and average standee density of 0.80 Passengers/m^2 during off-peak service
- Minimum turnback headway of 79 seconds (Tunney's Pasture) and 88 seconds (Blair) in ATO mode and 86 seconds (Tunney's Pasture) and 90 seconds (Blair) in manual operation (ATP Only mode)
- Single-track outage headway of 14:52 minutes in the longest single-tracking segment
- Maximum trip time of 22:21 minutes including Dwell Time in ATO, and 22:46 minutes in Manual mode

5.4.5.2 Proposed Consist Arrangements

The proposed Train consist for peak service is a two-car configuration. Each Vehicle has a length of 48.5 m, with the distance between the farthest doors in the two units being 83.7 m (see **Drawing 5.4.1-SW-102**). The carrying capacity of the Vehicle is illustrated in **Table 5.4-19.**

Table 5.4-19 | Vehicle Capacity

Passenger Capacity	Scenarios 1 and 2 3.33 standees/m²		Scenario 3 4.0 standees/m²		Off-Peak 0.8 standees/m2	
Seated Passengers	120	40.13%	120	35.82%	120	73.62%
Standing Passengers	180	59.87%	216	64.18%	43	26.38%
Total Passengers per Vehicle	300	100%	336	100%	163	100%

Each Vehicle is capable of carrying 300 Passengers at 3.33 standees/m^2 in Scenarios 1 and 2, and 336 Passengers at 4.0 m^2 in Scenario 3 during peak service. In off-peak service the average standee density of 0.8 standees/m^2 provides an even higher degree of Passenger comfort. Seated Passengers account for 40 percent of the total capacity in Scenarios 1 and 2, and over 35 percent in Scenario 3, thus meeting the comfort level requirement outlined in PA Schedule 15-2, Part 1, Article 2.6 (c).

5.4.5.3 Terminal Operations

To optimize for lower Driver hours and tighter headways, the double-platform turnback is preferred during peak periods for the following advantages:

- Shorter minimum turnback headways, especially for Scenarios 2 and beyond
- Fewer Drivers required
- Longer dwell time at the terminus for Drivers to travel to the opposite cab to reverse direction

Under the double-platform turnback, the terminal dwell is set to be identical to the operating headway. Terminal dwell during Peak Period is illustrated in **Table 5.4-20**. Under all scenarios the terminal dwell offers more than enough time for Passenger loading and unloading, as per PA Schedule 15-2, Part 1, Article 2.6 (f).

Table 5.4-20 | Terminus Stations - Peak Period Dwell

Peak Terminal Dwell	Scenario 1	Scenario 2	Scenario 3
Tunney's Pasture and Blair	189 seconds	119 seconds	105 seconds

To comply with the Article 2.6 (f) (iv) requirement to demonstrate the ability to reliably meet terminal time requirements, we undertook performance simulations to verify the minimum turnback headway at both Tunney's Pasture and Blair. The result (see **Table 5.4-21**), confirmed that the minimum turnback headway at both termini is well below the shortest operating headway in Scenario 3.

Tunney's Pasture is not expected to be a terminus Station in Scenarios 2 and 3, as per the AM Peak boardings and alightings data for Service Levels 4 to 9 in PA Schedule 10. Nevertheless the proposed solution shows that the Tunney's Pasture Station can meet the strictest turnback headway requirements, should the City choose to use Tunney's Pasture as a terminus in Scenarios 2 and 3. **Section 10.0.4.3** describes terminus operations.

Table 5.4-21 | Terminus Stations - Minimum Headway

Terminus	Turnback Headway (ATO)	Turnback Headway (Manual Operation)
Tunney's Pasture	79 seconds	86 seconds
Blair	88 seconds	90 seconds

5.4.5.4 Station Dwell Time Analysis

As per PA Schedule 15-2, Part 1, Article 2.6 (e), nominal dwell times at all Stations were determined based on directional peak hour boardings and alightings provided in the Schedule. Factors taken into account for the determination include boardings and alightings, number of doors per Train, operating headway, Passenger throughput per door, system communication factors etc. As per Article 2.6 (e) (iv), an absolute minimum Dwell Time of 20 seconds is applied at all Stations. Dwell Times are then included in calculating the maximum terminal-to-terminal travel time, as per Article 2.6 (e) (i). **Section 10.0.4.4** fully describes the analysis.

5.4.5.5 Capability to Reliably Support Headway Requirements

To demonstrate the capability to reliably support headway requirements, RTG carried out two simulations. First, the minimum turnback headway was determined and compared against the peak headways of the System in Scenarios 1, 2 and 3. Second, the design headway of each inter-Station section of the guideway was also determined and compared against the peak headways.

The first step involves determining the minimum turnback headway. This is illustrated in **Section 5.4.5.3**, where minimum turnback headways at Tunney's Pasture and Blair are calculated to be 79 seconds and 88 seconds in ATO, and 86 seconds and 90 seconds in manual operation. All minimum turnback headways are comfortably below the tightest requirement of the105 seconds headway in Scenario 3. The second step involved determining the design headway of the guideway by performance simulation. Results of the simulation are presented in **Table 5.4-22**, where design headways in all guideway sections meet the 105 seconds headway. Combining the two steps demonstrates compliance with PA Schedule 15-2, Part 1, Article 2.3 (a): the System can reliably support a sustained operational headway of 2 minutes or less.

Table 5.4-22 | Design Headway at each Inter-Station Section

Inter-Station Section	Design Headway (Eastbound)		Design Headway (Westbound)	
	ATO	Manual	ATO	Manual
Tunney's Pasture – Bayview	59	61	36	36
Bayview - LeBreton	57	59	58	60
LeBreton – Downtown West	71	74	57	60
Downtown West – Downtown East	82	85	77	79
Downtown East – Rideau Centre	74	77	81	83
Rideau Centre – Campus	62	63	70	73
Campus – Lees	72	75	68	70
Lees – Hurdman	63	66	67	67
Hurdman – Train Station	62	65	69	72
Train Station – St. Laurent	57	60	55	57
St. Laurent – Cyrville	61	63	71	73
Cyrville – Blair	31	32	58	60

5.4.5.6 Single-Track Operation Headway

As per Schedule 15-2, Part 1, Article 2.3 (b), the System is designed to support a sustained operational headway of 15 minutes during a single track outage. To comply with this requirement, RTG simulated performance to determine the sustainable headway in all single track outage scenarios in the System. **Figure 5.4-25** illustrates the single-tracking

scenarios. This calculation of the single-track operation headway takes into account the track length, number of Station dwells, and allowable speed between the switches used to bypass the failed track. The result of the simulation is presented in **Table 5.4-23**.

The worst-case single track outage headway is 14:52 minutes. System design thus complies with the Article 2.3 (b) requirement. The SelTrac CBTC System also supports "fleeting" of Trains through a single tracking section whereby multiple Trains can be sent through the section in alternating directions. This function has proven to significantly increase single tracking Passenger throughput on the Canada Line. RTG will recommend single0tracking fleeting when preparing OLRT operational procedures in cooperation with the City.

Figure 5.4-25 | Single-Tracking Scenarios

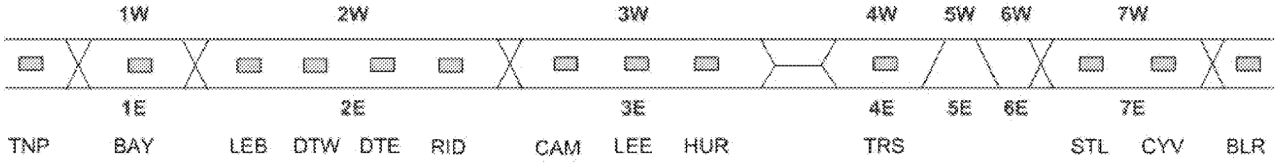


Table 5.4 -23 | Single-Track Operation Headways

Segment with Outage	Bypass Route	Minimum Headway (minutes)
1E	1W	5:10
1W	1E	5:03
2E	2W	14:43
2W	2E	14:52
3E	3W-Pocket	10:43
3W	Pocket-3E	10:02
4E	Pocket-4W-5W	4:37
4W	4E-Pocket	3:12
5E	5W	0:51
5W	6E-5E-4E-Pocket	4:59
6E	5W-6W	2:09
6W	6E	1:41
7E	7W	9:09
7W	7E	9:01
Pocket Section	4E-3E	13:53

5.4.5.7 Project End-to-end Trip Times

With all Inter-Station Travel Times and Station Dwells determined for Year 2021 and 2031 in both ATO and Manual operation, the End-to-End trip times are presented in **Table 5.4-24**. All scenarios meet the maximum terminal-to-terminal trip time requirement of 24 minutes in Manual mode and 23 minutes in ATO mode, as defined in PA Schedule 15-2, Part 1, Article 2.7.

Table 5.4-24 | End-to-End Trip Times

Direction	Year	Operations Mode	Trip Time
Eastbound	2021	ATO	22:17 minutes
Eastbound	2021	Manual	22:44 minutes
Westbound	2021	ATO	22:21 minutes
Westbound	2021	Manual	22:55 minutes
Eastbound	2031	ATO	22:15 minutes
Eastbound	2031	Manual	22:46 minutes
Westbound	2031	ATO	22:10 minutes
Westbound	2031	Manual	22:44 minutes

5.4.5.8 Validation of Operating Scenarios 1 and 2

With the relevant data presented in the above sections, **Table 5.4-25** presents the System capacity for Scenarios 1 and 2.

Table 5.4-25 | System Capacity

	Scenario 1 (Year 2021)	Scenario 2 (Year 2031)
Peak Headway	189 seconds	119 seconds
Terminal Dwell	189 seconds	119 seconds
Cycle Time	3052 seconds	2903 seconds
Capacity per Train	600	600
AM Peak Capacity	**11,429**	**18,151**
Capacity Requirement (Schedule 15-2 Part 1 Article 2.5)	**11,360**	**18,040**

5.4.5.9 Approach to System Expansion for Operating Scenario 3

At-grade Station platforms will be built to accommodate Scenario 2 (90 m) and designed to be expandable to 100 m to accommodate Scenario 3. The Underground Stations will be built to accommodate Scenario 3. The MSF site will be built to accommodate the LRVs required to meet Scenarios 1 and 2, as well as any non-revenue and specialty maintenance vehicles. The MSF Building will be designed to be expandable to accommodate Scenario 3. **Table 5.4-26** shows the headway for Operating Scenario 3 with the proposed Vehicle operating as a two-Vehicle Train, as well as options to achieve the compliant headway of 105 seconds.

Table 5.4-26 | Scenario 3 Operating Headway

Line Capacity	Vehicle Capacity	Passenger Density (p/m^2)	Percent Seated (%)	Proposed Headway (s)	Specified Headway (s)	Total Vehicles[1]
24,000	336	4	35	101[2]	105	58
For Compliant Headway:						
23,040[3]	336	4	35	105	105	56
24,000	351	4.27[4]	34.3	105	105	56

Line Capacity	Vehicle Capacity	Passenger Density (p/m²)	Percent Seated (%)	Proposed Headway (s)	Specified Headway (s)	Total Vehicles[1]
24,000	351	4	29.7[5]	105	105	56
24,000	Average 351[6]	4	35	114	105	10+46

Notes:

1 Not including spares

2 The system design will accommodate the 101s headway. A shorter headway is achieved regularly on by the Thales CBTC System on Vancouver SkyTrain between Broadway and Waterfront Stations

3 Non-compliant capacity by 4%

4 Non-compliant Passenger density by 7%

5 Non-compliant seated% by 5.3%

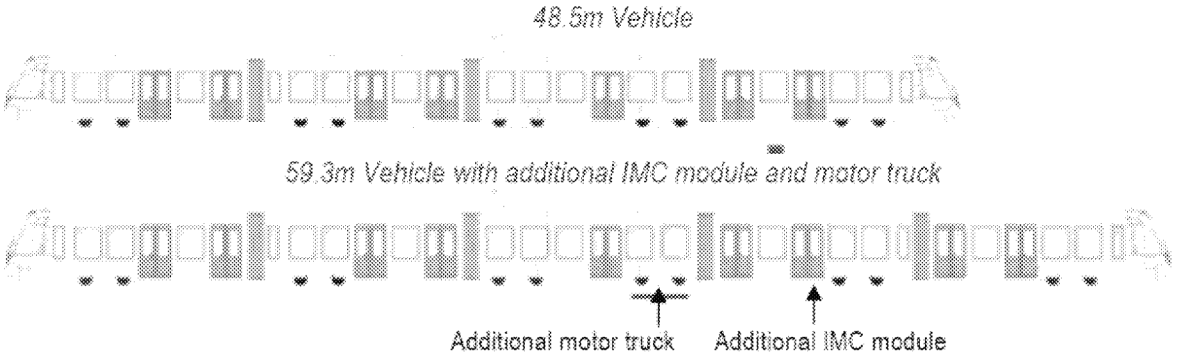
6 Average capacity of a mixed fleet of 48.5 and 59.3m long Vehicles (see below)

RTG will procure the Vehicles to accommodate the opening year. This will be accomplished with a two-Vehicle Train, each Vehicle being 48.5 m long (including the coupler the overall Vehicle length is 98 m). The distance between the outside faces of the end doors is 83.7 m. The Vehicles will allow for future fleet expansion to accommodate Scenarios 1, 2 and 3.

A headway of 114 seconds for Scenario 3 can be achieved with a mixed fleet of 48.5 m and 59.3 m long Vehicles as follows:

- The 59.3 m Vehicle is obtained by adding a new IMCx module to a 48.5 m Vehicle to increase Passenger capacity to 419 (see **Figure 5.4-26**).
- Coupling a 59.3 m Vehicle with a 48.5 m Vehicle will result in a 108.8 m long Train. The distance between the outside faces of the end doors is 94.5 m. The Underground Station platforms are sized to accommodate this and the At-grade Station platforms will be extended to 100 m to accommodate the longer Train. The MSF Building will be designed so that it can be expanded as required. Additional storage tracks will need to be built as shown on the drawings. The City can elect whether a storage shed is needed for these Vehicles.
- To comply with the specified peak hour headway, the average consist capacity should be 752 Passengers. This can be achieved with ten 108.8 m Train plus eighteen 98 m Trains. Therefore, 10 of the longer Vehicles are required.

Figure 5.4-26 | Addition of New Modules



The proposed timing of the changeover to the longer Vehicle is as follows. For Scenario 2 in 2031, 50 Vehicles (25 Trains) are required. This fleet will be increased to 58 Vehicles to handle Service Level 9 in 2046.

Once the City elects to initiate Scenario 3, the 10 additional IMCx modules will be manufactured and added to 10 of the existing 48.5 m long Vehicles. It will take six weeks to extend each Vehicle. To limit service impact, we propose to modify

one Vehicle every three weeks, so only two Vehicles will be out of service at any one time. However, since two extra Vehicles are required for Service Level 9 the fleet will be fully operational even when two Vehicles are being extended. The total retrofit duration will be less than 1 year.

However, there are other options to achieve a 105 second headway which are more economical for the City:

- Slightly increasing Passenger density from 4 Passenger/m^2 to 4.3 Passengers/m^2 OR
- Nominally reducing the percentage of seated Passengers from 35 to 30 percent (a difference of approximately 10 seats)

5.4.6 NON-REVENUE VEHICLES

This section examines non-revenue vehicles, their specific tasks and lessons from other projects about purchasing vehicles.

5.4.6.1 Vehicles for Specific Maintenance Activities & Tasks

The non-revenue equipment that RTG proposes to use for maintenance of the system will consist of both Hi-Rail and Rail-Bound equipment (see **Table 5.4-27**). The strategy is to use Hi-Rail (road/rail equipment) wherever possible to maximize work time and accessibility to the system. Because much of the OLRT will be at grade, access points can be provided at various points on the system where Hi-Rail equipment can be driven to by public roadway. This will maximize available work time as this equipment can be ready to access or clear the system immediately at the start and end of the work window, and typically much closer to the work location. Because Rail-Bound vehicles are confined to rail movement, they have to be driven on the rails between the MSF and the work location, and typically after all Trains have cleared the system or before Trains have launched onto the system. This significantly reduces the amount of productive work time that is available for Rail-Bound equipment. Despite this disadvantage, there are numerous operations where Rail-Bound equipment is more capable; thus, RTG intends to use both. For specialized equipment that will not be used on a frequent or consistent basis, RTG intends to contract this work out rather than purchase and maintain equipment that would be vastly underused. Examples of such equipment would be production tampers, stabilizers, track geometry measurement equipment, and ultrasonic rail flaw detection equipment. All these services are readily available in the Ottawa area.

Table 5.4-27 | RTG Non-Revenue Equipment List (RB = Rail Bound, HR = High Rail)

Description	Type	Qty	Primary User	Anticipated Specifications
Train Shunter	RB	1	Shunt and position Trains in the MSF where no overhead power is available	Rechargeable battery-powered electric
Utility Maintenance Vehicle	RB	1	Crew transport, materials handling, track and OCS maintenance, Train rescue.	Requires towing capacity, deck, crane, crew compartment, bucket, hydraulic circuits, and Train couplers on both ends.
Trailers	RB	3	To be towed behind utility maintenance vehicle. One for general materials handling, one for cable handling, and one for tunnel wash equipment.	10 tonne useful load, air brakes, 7.0 m x 2.5 m decks.
Large Hi-Rail Trucks	HR	2	One for welding and heavier track maintenance One for OCS inspection and work	Ford F-750 or equivalent. One with complete welding set-up, one with double buckets for OCS work.
Smaller Hi-Rail Trucks	HR	2	One for guideway inspection and light repair One for signal system inspection and light repair	Ford F-350 4x4 crew cabs or equivalent
Ballast Regulator	RB	1	Regulating ballast in summer, snow clearing in winter	Industry standard ballast regulator with snow fighting attachments
Rail Grinder	RB	1	Rail grinding to address corrugation and rail	Minimum 8 stone, programmable

Description	Type	Qty	Primary User	Anticipated Specifications
			profile	rail profiling, sealed pressurized cab, dust collection.
Multifunction road/ rail Loader/ Excavator	HR	1	Multi-function materials handling, excavating, loading, rail handling, snow fighting, vegetation control.	360° road rail excavator with attachments
Spot Tamper	RB	1	Spot surfacing of slab to ballast sections, switches, low spots	Spot utility 16 tool tamping machine

NOTE: All motorized equipment will be diesel powered and equipped with scrubbers to reduce emissions and be tunnel safety compliant.

5.4.6.2 Lessons Learned about Non-Revenue Vehicle Purchases from Other Projects

Purchase Equipment that is Industry Proven when Needed

Purchasing hi-tech equipment/vehicles (requiring specialized training to operate and maintain) at the start of an operation usually means that this equipment is not used as intended when required. The employees trained to operate and maintain the equipment are usually not the ones around when the equipment or vehicle is needed to perform maintenance or repairs. Technology changes and, in most cases, the equipment becomes obsolete.

Purchase Vehicles and Equipment that Fit your System

Purchase vehicles and equipment that can negotiate the track geometry in the yard and main line. On transit systems, smaller vehicles and equipment work better in the tighter clearance areas. Also, the hi-rail vehicles can manoeuvre better in urban environments and access the track easier.

Purchase Equipment that can do Multiple Tasks

A bucket truck can replace a platform truck for OCS maintenance and be more flexible in low-clearance areas. It can also be used by facility maintenance to support lighting maintenance and platform maintenance.

5.4.7 TRACTION POWER

5.4.7.1 Traction Power Supply Design Process

The design methodology of the traction power supply employs a computer simulation technique, computer-based "traction load flow modeling". The model used for this Project is Train Operation Model (TOM) comprising two parts: Train Performance Simulation (TPS) and Electric Network Simulation (ENS).

TPS requires accurate Train and guideway data as well as Train loading, Station dwell times and speed restrictions for inputs. TPS modeling results should provide the following information:

- Train power profile output
- Train trip distance shown in TPS output summary
- Train trip time shown in TPS output summary
- Train energy consumption in each trip shown in TPS output summary
- Train energy consumption per km per car in TPS output summary

The computer ENS modeling requires accurate traction power electric network data, Train operation data as well as the Train power profile from the output of the TPS. ENS simulates a fleet of Trains based on Train operation data and

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-1 Thales Installation

ISSUED FOR PROPOSAL
10/09/2012

THALES

URBAN RAIL AUTOMATED SIGNALLING PROJECTS

Location	Revenue Service	System Solution	Rolling Stock
Ankara RT – Line 1	1997	SelTrac CBTC – DTO	Bombardier
Beijing Metro		SelTrac CBTC/R – STO	Siemens / Sisang
Line 4	2009		
Daxing South Extension	2010		
Berlin			
Metro	1982	SelTrac ZB – DTO	Siemens
BVG Line U6	2006	LockTrac Electronic Interlocking	
Bundang – Sin Bundang Line	2011	SelTrac CBTC/R – UTO	Hyundai Rotem
Busan – Busan-Gimhae Line	2011	SelTrac CBTC/R – UTO	Hyundai Rotem
Canadian Pacific – BC North Line	1990	ATCS Radio-based Train Protection	
Detroit – Downtown People Mover	1987	SelTrac CBTC – UTO	Bombardier
Dubai RTA		SelTrac CBTC – UTO	Kinki Sharyo
Red Line	2010		
Green Line	2011		
Duisburg Metro	1992	SelTrac ZB – DTO	Siemens / Vossloh
Dusseldorf Metro	1988	SelTrac ZB – DTO	Siemens / Vossloh
Guangzhou Metro		SelTrac CBTC – DTO	Siemens
Line 3	2009		
Line 3 Extension	2010		
Hong Kong MTRC			
MTRC lines	1992/5/6	NetTrac MT – Train Regulation	
West Rail	2003	SelTrac CBTC – DTO	Kawasaki
Ma On Shan Line	2004	SelTrac CBTC – DTO	Kawasaki
Disneyland Resort Line	2005	SelTrac CBTC/R – UTO	Cammell
Kowloon Southern Link	2009	SelTrac CBTC – DTO	Kawasaki
Incheon – Line 2	2014	SelTrac CBTC/R - UTO	Hyundai Rotem
Istanbul – Kadiköy-Kartal Line	2012	SelTrac CBTC – DTO	CAF
Jacksonville ASE	1998	SelTrac CBTC – UTO	Bombardier
JFK Int'l Airport APM – Airtrain	2003	SelTrac CBTC – UTO	Bombardier
Kuala Lumpur – Kelana Jaya Line	1998	SelTrac CBTC – UTO	Bombardier
Las Vegas Monorail	2004	SelTrac CBTC/R – UTO	Bombardier

URBAN RAIL: AUTOMATED SIGNALLING PROJECTS

London Docklands LR	1995	SelTrac CBTC – DTO	BN / Bombardier
Lewisham Extension	1999		
London City Airport Ext.	2005		
Woolwich Extension	2009		
Stratford Extension	2010		
London Underground			
Jubilee Line	1998	NetTrac MT – Central Control	
Jubilee Line	2010	SelTrac CBTC – DTO	Alstom
Northern Line	2014	SelTrac CBTC – DTO	Alstom
Piccadilly Line	2014	SelTrac CBTC – DTO	Alstom
Mecca Al Mashaaer Al Mugaddassah Metro	2011	SelTrac CBTC – UTO	CRCC
Mulheim / Ruhr Metro	1999	SelTrac ZB – DTO	Siemens / Vossloh
Newark Int'l Airport APM	1996	SelTrac CBTC – UTO	Von Roll / Bombardier
Northeast Corridor Ext.	2001		
New York City Transit			
Bergen Street	2006	LockTrac MT – Electronic Interlocking	
Canarsie, Phase III	2006	SelTrac CBTC/R STO – Interoperability Program	
Flushing Line	2016	SelTrac CBTC/R STO	Bombardier / Kawasaki R142/A
Paris – Line 13	2012	SelTrac CBTC/R – DTO	SFB / Alstom
Quebec Cartier Railway	1992	NetTrac MT – Dispatch System	
San Francisco MUNI – Market Street Tunnel	1997	SelTrac CBTC – DTO	Boeing / Ansaldobreda
Shanghai Metro			
Line 6	2011	SelTrac / CBTC/R – STO	Alstom / Changchun
Line 8	2011	SelTrac / CBTC/R – STO	Alstom / Changchun
Line 9	2011	SelTrac / CBTC/R – STO	Bombardier
Line 7	2010	SelTrac / CBTC/R – STO	Bombardier
Line 11	2010	SelTrac / CBTC/R – STO	Siemens
Stockholm SL		IDTS – Passenger Info System	Svenska / ABB
Line 2	1988		
Line 3	1992		
Line 1	1996		
Tampa Int'l Airport APM	1992	SelTrac CBTC – UTO	TGI / Bombardier
Toronto Transit			
Scarborough RT Line	1985	SelTrac CBTC – DTO	Bombardier
Streetcar lines	1986	IDTS – Track Switch Control	
Spadina Streetcar Line	1996	IDTS – Track Switch Control	
Sheppard Metro Line	2009	SelTrac SS&S	Cancar / Bombardier
Yonge University Spadina Metro Line	2010	SelTrac SS&S	Cancar / Bombardier
Vancouver			
SkyTrain Expo Line	1986	SelTrac CBTC – UTO	Bombardier
SkyTrain Millennium Line	2002	SelTrac CBTC – UTO	Bombardier
Canada Line	2009	SelTrac CBTC – UTO	Hyundai Rotem
Walt Disney World Monorail	1989	SelTrac ATP	Disney / TGI
Washington Dulles Airport APM	2009	SelTrac CBTC/R – UTO	Sumitomo / MHI
Wuhan LRT		SelTrac CBTC – DTO	
Line 1	2004		Changchun
Line 1 Extension	2010		ZhuZhou

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-2 SelTrac Installation

ISSUED FOR PROPOSAL
10/09/2012

SelTrac Automatic Train Control Systems

Operating Mode	Project Type	Interlocking	Kilometers	Revenue Kilometer - years	Project
S	N	I	6	173	Toronto SRT
U	N	I	29	680	Vancouver - Expo Line
U	N	I	5	118	Detroit DPM
U	N	I	2	40	Tampa APM
D	R	I	38	256	London DLR
U	E	I	8	98	Newark APM
S	N	I	14	210	Ankara
D	R	I	11	154	San Francisco MUNI
U	N	I	4	56	Jacksonville ASE
U	E	I	46	406	Kuala Lumpur Kelana Jaya Line
U	E	I	20	210	Vancouver - Millenium Line
S	E	I	35	290	Hong Kong West Rail
U	N	I	13	117	JFK APM
U	N	I	6	51	Las Vegas Monorail
S	E	I	29	119	Wuhan LRT
S	N	I	11	80	Hong Kong Ma On Shan
S	E	I	67	278	Guangzhou - Line 3
S	O	E	6	33	Bundang Commuter
U	N	I	3	19	Hong Kong Disney Resort Line
S	E	E	36	142	Shanghai Metro Line 8
S	E	E	60	256	Shanghai Metro Line 9
S	P	E	33	166	Shanghai Metro Line 6
P	O	E	65	195	Toronto Speed Enforcement
U	N	I	4	11	Dulles APM
U	N	I	52	156	Dubai Metro Red Line
S	N	E	29	87	Beijing Line 4
U	N	I	18	54	Vancouver Canada Line
S	R	I	37	74	London Tube Lines - Jubilee
S	E	E	44	88	Shanghai Metro Line 7
S	E	E	68	90	Shanghai Metro Line 11
S	P	I	20	40	Mecca - Al Mashaaer Al Mugaddassah Metro
S	P	E	22	44	Beijing Daxing Line
U	E	I	23	23	Dubai Metro Green Line
U	N	I	24	24	Korea Busan-Kimhae Line
U	E	I	31	19	Korea Sin Bundang Line
S	O	E	23	-	Paris RATP Line 13
D	N	I	22	-	Istanbul Kadikoy-Kartal
S	R	I	58	-	London Tube Lines - Northern
D	R	I	12	-	Edmonton North LRT
U	N	I	29	-	Korea Incheon Line 2
U	E	I	4	-	Hong Kong APM
S	R	I	63	-	London Tube Lines - Piccadilly
U	P	I	18	-	Sao Paulo Line 17
S	O	E	8	-	New York Culver
U	R	E	46	-	Singapore North-South Line
S	R	E	15	-	New York Flushing Line
U	R	E	57	-	Singapore East-West Line
			1,269	4,854	Revenue km-years as of end-of 2012

Operating Mode		
Manul Driving with Automatic Train Protection	ATP	1
Automatic Operation with Attendant in the Cab	STO	21
Automatic Operation with Attendant on-board	DTO	4
Automatic Operation without a Driver	UTO	21

Project Type	
New	17
Extended	12
Phased	4
Overlay	4
Realignal	10

Interlocking	
Integrated	33
External	14

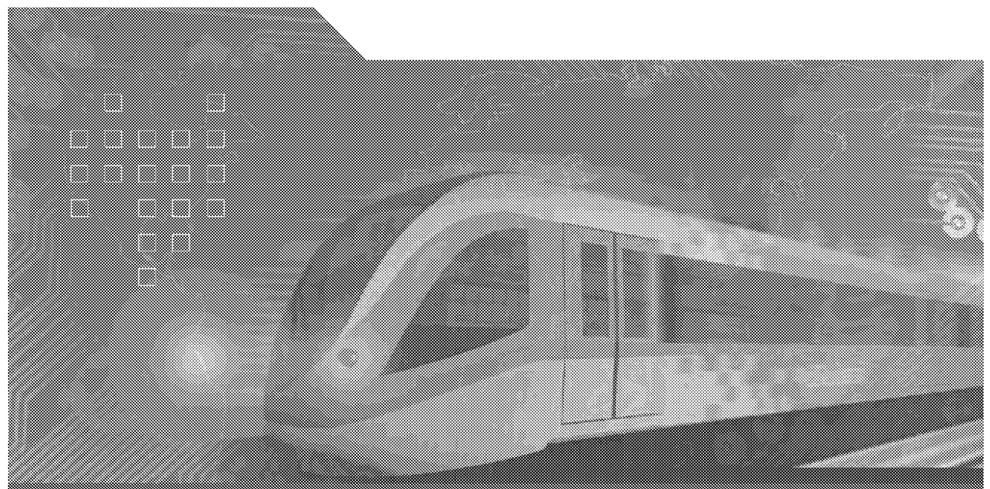
Communications	
Loop	25
Radio	21
Extension(s)	

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-3 SelTrac Cutsheet

ISSUED FOR PROPOSAL
10/09/2012

THALES

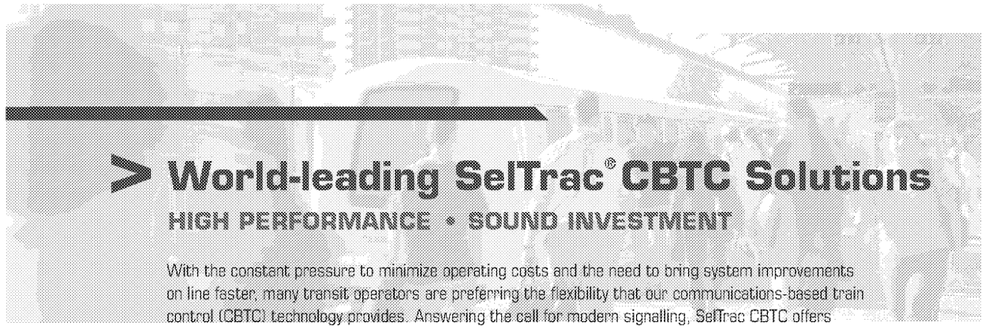


SelTrac® CBTC

Communications-Based Train Control For Urban Rail

RAIL SIGNALLING SOLUTIONS

www.thalesgroup.com/security-services



> World-leading SelTrac® CBTC Solutions

HIGH PERFORMANCE • SOUND INVESTMENT

With the constant pressure to minimize operating costs and the need to bring system improvements on line faster, many transit operators are preferring the flexibility that our communications-based train control (CBTC) technology provides. Answering the call for modern signalling, SelTrac CBTC offers the opportunity to enhance performance and safety and lower life-cycle costs. SelTrac systems are installed on transit networks around the world. Our methodology and technology has been proven in use for thirty years.

From fully automated, integrated solutions to upgradeable solutions and overlay re-signaling techniques to reach beyond the limitations of conventional fixed-block designs, SelTrac system solutions readily meet your needs to move more people more quickly and increase revenue potential.

Applicable to any type or size of rolling stock and dedicated guideway, SelTrac system solutions are flexible and adaptable enabling customers to employ a complete, high-end system or incrementally upgrade functionality over time, without disrupting operation. Transit operators retain the value of their original investment as they expand and grow their systems. SelTrac can be configured easily to meet the specific functionality needs of the operation. With built-in flexibility, SelTrac addresses the diverse requirements of operators needing basic Automatic Train Protection (ATP), cab-signalling, or CBTC-based operations. From simply replacing existing signalling, to improving the headway performance of an existing fixed-block system, SelTrac is the convenient and cost-effective solution.

Our premium SelTrac solutions include "moving block" technology for unattended/driverless operation. These systems offer excellent operational flexibility under even the most demanding of conditions. And, to meet high or increasing capacity situations, SelTrac has proven that it can deliver headways of under sixty seconds, better than normally required.

SelTrac system solutions readily meet your needs to move more people more quickly and increase revenue potential.

METROS, LIGHT RAPID TRANSIT, APMs

ENHANCED SAFETY • GREATER THROUGHPUT • SIGNIFICANT COST SAVINGS

> The Business Case for SelTrac CBTC

Optimising capital investment

- Shorter platforms due to shorter, more frequent trains
  - > MTR West Rail saved 384 million USD for nine stations
- Avoidance of building new tunnels (re-signalling)
  - > San Francisco MUNI doubled their existing tunnel capacity from 23 to 48 trains per hour with installation of SelTrac saving 1.3 billion USD

Equipment minimisation

- No traditional ancillary equipment required if mixed-mode is not part of normal operation
  - > No need for new "fallback" system
- Less equipment
  - > On the track
  - > Due to integration of functions

Ease of expansion

- Once SelTrac is installed, headways can be reduced and system capacity increased with no additional capital expenditure for the wayside, up to the physical limits of the guideway and trains
  - > Kuala Lumpur PUTRA, Vancouver SkyTrain and SF MUNI have increased their fleets without changes to wayside hardware or software
- System expansion is not tied to the initial vehicle supplier, competitive bid on new vehicles is possible
  - > SelTrac allows for different vehicle types with different performance and from different suppliers to operate on the same guideway, without overall system performance degradation or the need to update wayside equipment.
  - > Vancouver SkyTrain runs two generations of vehicles; San Francisco MUNI supports three vehicle types

Capacity enhancement

- Aging metro infrastructures can be modernized and operational capacity increased with SelTrac:
  - > San Francisco MUNI
- London Underground, one of the world's oldest & largest metros:
  - > Jubilee (2009): 35 km, 63 trains
  - > Northern (2011): 57 km, 106 trains
  - > Piccadilly (2015): 71 km, 92 trains

  20% capacity improvement due to signaling; Minimum impact to ongoing revenue operations

Energy Savings

- Energy-optimized driving profiles (e.g. coasting, reduced speeds, and reduced acceleration curves) can be based on time of day
- Schedule synchronization for regenerative power saving
  - > Hong Kong saves an estimated 2 Million USD per year in energy due to Automatic Train Operation
  - > Vancouver SkyTrain: "Energy consumption per passenger-kilometer is just less than half the average of the other systems." (BC Transit Fact Sheet – "SkyTrain Performance", October 1991)

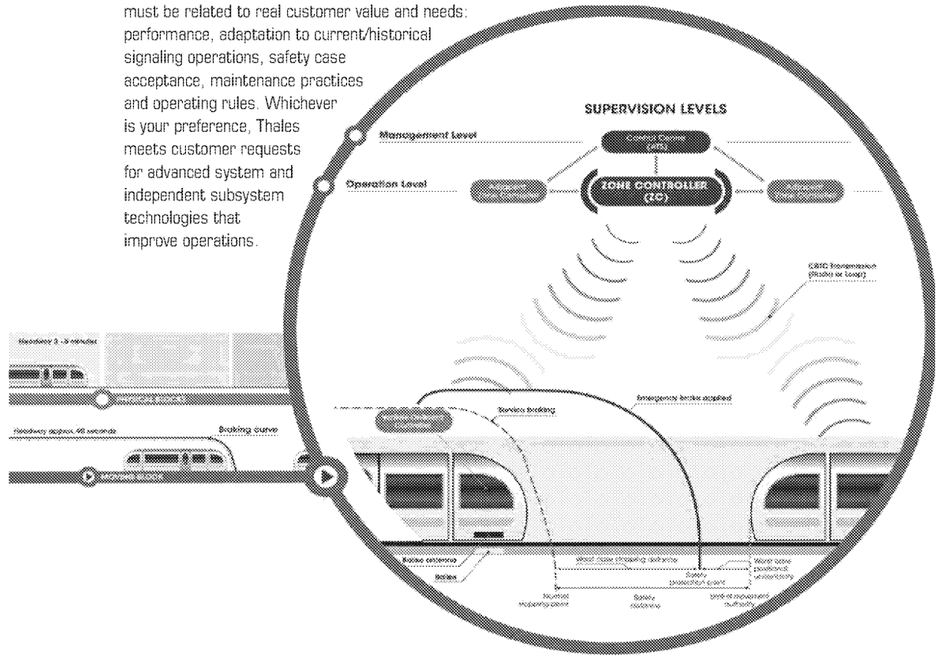
Flexible Operations

- Automatic Junction Management
- Remote diagnostic and centralized fault management capabilities
- Automatic incident management
  - > Bi-directional same-track operation
  - > Schedule recovery

> SelTrac is unique!

CHOOSE INTEGRATED OR OVERLAY ARCHITECTURE

Movement Authority and interlocking can be integrated within wayside Zone Controllers to reduce equipment and potential interfacing issues, while allowing faster response times and more tightly controlled movements. However, you might prefer separated interlockings. Both integrated and overlay architectures can be used together on the same line. Choice between the two is usually customer/application driven. The technology must be related to real customer value and needs: performance, adaptation to current/historical signaling operations, safety case acceptance, maintenance practices and operating rules. Whichever is your preference, Thales meets customer requests for advanced system and independent subsystem technologies that improve operations.



SELTRAC SOLUTIONS FOR ANY TRAIN TYPE OR STYLE

Specializing in quality signalling and train control technology, we can apply our solutions to any rolling stock. Examples include:

Dubai Metro
Kinki Sharyo

Guangzhou's Line 3
Siemens

KoRail's Seoul Bundang
Rotem

Las Vegas Monorail and many others
Bombardier

London's Jubilee, Northern and Piccadilly Lines
Alstom

MTR's Disneyland Resort Line
Cammell

Washington Dulles Int'l Airport
MHI's Crystal Mover

Wuhan
Changchun Car Co.

SelTrac can run different trains from different suppliers on the same line.

THE COMPLETE INTEGRATED SOLUTION

The fully integrated SelTrac CBTC provides maximum performance in terms of headways, passenger throughput, and energy conservation.

Integrating the management of the interlocking with the train location information, as communicated through the CBTC system, allows faster response times, more tightly controlled movements, and easier expandability and adaptability. Interfaces within the Zone Controller are more easily designed than those between subsystems.

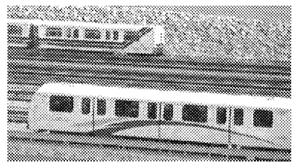
The integrated SelTrac CBTC system knows the position of each train to a high degree of accuracy. It can control the behaviour of the train at all times and, in response to changing conditions, can modify the behaviour to ensure the safety of the system while offering maximum service. It can adapt its algorithms to take advantage of individual train behaviour, and change parameters to ensure optimum use of resources, such as platform availability and traction power. It can coordinate train movements with a high degree of precision to move passengers efficiently through the system.

The Limit of Movement Authority (LMA) setting logic has a high impact on the end system performance, i.e. managing the interlocking in an integrated manner. Interlocking and switch control logic is optimized using the position reports of communicating trains.

By integrating the system design as a single entity, not as a collection of individual products, it is possible to more fully coordinate the interaction between functions, taking advantage of all information available to the system to optimize system performance.

The SelTrac integrated design includes:

* UTO, DTO and cab-signalling modes
* Moving block technology
* Automatic performance modification (including speed and station dwell)
* Fully redundant train-to-wayside configurations
* Data Communication option:
* High availability
* Automatic route setting
* Quick-start reset
* Solid-state interlocking and remote point machine control
* Automatic coupling/uncoupling (option)



Benefits

- Time proven solution
- Cost effective; best price to performance ratio
- High performance – no constraints from external interlocking
- Minimum trackside and wayside equipment
- Low life-cycle cost
- Fully protected bi-directional operation (requiring no additional hardware)
- High availability and reliability
- Automatic route setting

THE PROGRESSIVE OVERLAY SOLUTION

Existing fixed-block systems can be upgraded to SelTrac cost effectively to provide greater reliability and shortened headways. Installation is performed as an overlay in parallel with the existing system. Our cut-over strategy allows operators to phase in the new system with the least amount of disruption.

For those operators specifying an upgradeable solution for new lines, or to overlay on an existing or a new interlocking infrastructure, SelTrac offers progressive levels of automation from Speed and Signal Safeguard (S&SS), to continuous ATP, to ATO.
More advanced SelTrac configurations bring additional functionality and features into play, enabling operators to significantly enhance performance and service frequency with shorter headways and automated operation. These solutions incorporate a moving-block design -- the system is not dependent on, or restricted by track circuits. The operator can safely run two trains closer together to improve throughput (i.e. two trains can occupy the same physical block). This technology is especially effective in resolving interoperability and mixed-mode requirements faced by some transit operators.

Benefits

- Upgradeable up to any level of automatic operation including driverless
- Upgrade with no disruption to revenue service
- Allows phased operation and minimum time to service
- Allows phased investment towards improved safety, automation and operation efficiencies
- Maintains traditional signaling principles

Speed and Signal Safeguard

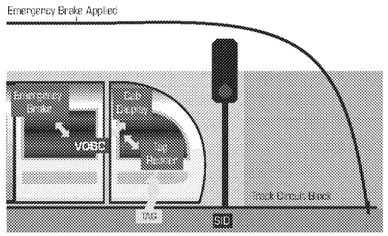
The SelTrac SS&S solution vitally supervises speed profiles and signal adherence and provides all the functions of an intermittent ATP. It provides an entry-level computer based train protection mechanism that enhances operational safety by supervising driver actions. Monitoring and interfacing with conventional signals, it 'emergency brakes' trains passing red signals and/or operating at speeds higher than mandated by civil speed limits. Information is regularly transmitted to the train at specific locations. This basic SelTrac solution is an ideal overlay enhancement for existing conventional signalling systems.

Signal status and permitted speed information is sent through transponder tags to the Vehicle On-Board Controller (VOBC) at key locations along the track. The advantage of this concept is its simple interfacing technique to the existing interlocking. It can be installed and brought on-line quickly and easily without complicated tie-ins to the signal circuitry, and operators do not require new skills to use and benefit from the system.

When the VOBC detects an over-speed condition, whether due to signal status or track restrictions, it alerts the driver and monitors the driver's reaction to the alert. Should the driver fail to respond properly, the VOBC vitally activates the braking system.

Operating data is fed to a high definition Driver Display Unit, allowing the driver to confidently monitor train performance and status. By providing speed and signal information to the driver in the cab, the system allows minimized headway while ensuring safety.

- Determines permitted and actual train speed
- Determines travel direction vs. expected travel direction
- Provides compensation for wheel slip/slide
- Provides automatic wheel size calibration to maintain accurate speed and position determination
- Allows for travel direction reversal
- Provides braking profile supervision and enforcement
- Records events in real time
- Can display distance traveled and distance to go



SelTrac's proven ability to operate safely in mixed mode with unequipped trains makes it ideal for a suburban railway that must share tracks with mainline operators.

Automatic Train Protection

Enhancing SelTrac SS&S capability with continuous ATP functionality provides the added value of improved headway while maintaining safe train separation, without depending on axle counters or track circuits. The system will automatically generate movement authorities based on the actual locations of moving obstacles (i.e. trains) and fixed obstacles such as switch protection signals. It is used in conjunction with existing interlockings and provides a replacement for automatic separation signals between the interlockings. It can operate seamlessly with existing track circuits which provide an inherent mechanism to operate mixed-mode traffic (communicating and non-communicating trains). A display in the cab shows information about the operating conditions ahead of the train. Information is continuously transmitted to the train by means of a radio-based Data Communications System (DCS).

Progressive functionality:

- Improves headway with moving-block technology
- Provides continuous ATP and cab-signal
- Provides high availability
- Allows multiple trains per physical track circuit
- Allows fully protected bi-directional operation (requiring no additional hardware)
- Reduces track-side equipment
- Provides integrated, redundant communication capability between wayside and train

In this solution, the wayside Zone Controller (ZC) generates override commands to external interlockings. This includes signal and route-release overrides. These commands are based on CBTC train position reports. Thales is offering external independent electronic interlocking designed to work efficiently with the SelTrac CBTC using standard IP interface.

Automatic Train Operation

The SelTrac solution can include automatic train movement control offering the driver the opportunity to operate "hands off" and thereby improve running performance. From one station (or predetermined operational stopping point) to the next, the train will follow the required speeds of the track and the operating conditions ensuring safe operation. The additional functionality is considered non-vital, with the continuous ATP features providing the safety net.

ATO functionality plus...

- Provides automatic train movement control functionality
- Governs automatic speed control to traffic and track conditions
- Can provide additional functions such as coordinated train and platform door control
- Driverless or unattended operation (optional)

Overlay designs facilitate cost-effective system cut-over and deployment, allow mixed-mode operation, and provide an easy evolutionary path to higher level functionality.

> Fully Automated Operation and Management (UTO/DTO)

Moving to Fully Automated Operation (FAO) provides an excellent means to match train supply to passenger demand both economically and commercially. It enables operators to improve the quality of service, reliability and availability of trains while breaking the constraining link between service offered and personal management requirements.

For light or heavy rail applying unattended (UTO) or driverless (DTO) operation for optimal headway, along with a high degree of safety, SelTrac CBTC is offered with a high level of automation and functionality all at once, or in progressive, scalable designs.

SelTrac's unique capacity for remote health-status monitoring and for control of all vehicle systems -- including doors (both train and platform), couplers and auxiliaries -- also makes it an attractive choice. All train control operations are self-supervising.

	Operating Cost	Availability	Driver	Door Control	Guideway Intrusion Detection
FAO	Lower	Higher	Not Required	Included	Included
STO*	Higher	Lower	Required	Not Included	Not Included

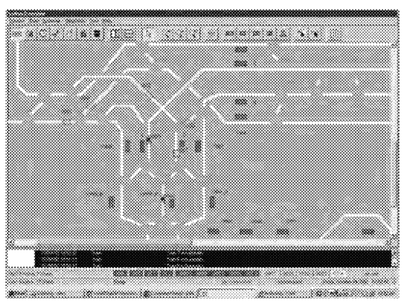
*STO: Semi-automated operation -- Driver initiates departure from station

NetTrac MT Central Control

Through our advanced NetTrac MT platform, based on commercial off-the-shelf PC and LAN technology, the System Management Center supervises the automatic, cab-signaling or manual operation of the entire rail fleet. NetTrac MT is designed to provide automatic control of all train operations under normal conditions without operator intervention. It is easy to use and enables operators to handle system disruptions quickly. Standard features include sophisticated failure management capabilities, high system availability, redundancy, complex alarm handling, and data logging.

Workstations display the track layout together with icons individually identifying all elements under SelTrac control. At a glance, central controllers monitor the location and schedule adherence of each train within the system. Icon color changes alert dispatchers to changes in the status of trains, platforms, track switches and tracks. Situations requiring urgent attention trip visual and audible alarm messages. Dispatchers use pull-down command menus, drag-and-drop, and point-and-click options to perform numerous functions, including:

- Assigning and launching a schedule
- Monitoring status
- Routing trains to a specific track location or station
- Assigning trains to a 'line' or 'run' or to shuttle service
- Holding trains at specific locations or by-passing platforms
- Diverting trains around an impassable area
- Changing train velocity
- Triggering automatic announcements in stations and on trains
- Interfacing with third-party subsystems



> ComTrac® DCS Open-Standards Radio Communications Technology:

SelTrac CBTC solutions incorporate high bandwidth, secure and protected radio communication technology to deliver the most advanced, most efficient Automatic Train Control solution available today.

Advanced signaling technology reached a new milestone in 2004 with the inauguration of the Las Vegas Monorail, the USA's first fully automated, wireless rapid transit system, and the first of many SelTrac projects worldwide to apply reliable and secure open-standards radio CBTC with its automatic train control solutions.

The driving force behind the advancement in applying broad-band radio technology to rail transit has been the need to move train control to a more sophisticated infrastructure while maintaining constant communication as trains move along the track.

The communication technology follows an open-system philosophy that complies with well-recognized industry standards and protocols, which provide a stable future migration path.

Thales advocates the use of open-standard data communication technology, believing that rail transit operators should have the flexibility to buy future components from any supplier that supports IEEE standards (802.3 Ethernet, 802.11, etc.), and software for future purposes. Meeting this demand allows the customer more supplier options primarily at less cost than that of proprietary systems.

The implementation of "free space" wireless communication incorporates full redundancy through the use of overlapping radio coverage.

Benefits

- Allows any subsystem to communicate with any other subsystem
- Allows for clear division of ATP and ATO functions
- Ease of installation and maintenance
- Faster recovery times due to single component failure detection and replacement
- Low susceptibility to vandalism. Less trackside equipment
- Facilitate cutover on resignalling projects
- Reduce LCC

SelTrac technology incorporates open architecture, system modularity, standard interfaces and commercial off-the-shelf data communication components based on Open System network solutions that facilitate subsystem interchangeability strategies. Safe train control functionality is specifically designed to be independent of the communication subsystem.

> Thales, enviable track record

Thales is the leading global supplier in the design, manufacture and implementation of advanced technology systems for urban rail mass transit .Continually evolving to meet the changing needs of operators around the world, SelTrac technology has provided safe, reliable, revenue-efficient operation over two decades. SelTrac sets the quality and performance standards that all others strive to reach.

- SelTrac® -- the world's most widely adopted CBTC system
  - > Proven with over 10 million train operating hours of revenue service
  - > More revenue CBTC km than any other supplier (over 1000km)
  - > Selected by 27 metro, light rapid transit and automated people mover operators around the world
  - > The latest technology underpinned by core systems and adapted to meet customer specific operations
- Re-signalling experience – Thales has experience on more than 215 km of urban rail track
- Market Firsts
  - > Fully automated CBTC in revenue service – Vancouver SkyTrain (1986)
  - > 1st revenue service of 'free space' radio CBTC for fully automated operation – Las Vegas Monorail and Hong Kong DRL
  - > CBTC UTO of the longest metros in the world – Vancouver SkyTrain and Dubai Red and Green lines
  - > 3 lines at once into revenue service – Shanghai lines 6, 8 and 9
  - > 1st re-signalling to CBTC – Docklands Light Rail (1995)
  - > Most challenging re-signalling project – San Francisco MUNI
  - > World's largest re-signalling project – London's Jubilee, Northern and Piccadilly lines
  - > Automated depot including driverless coupling/uncoupling – Vancouver SkyTrain

SOLUTION EXCELLENCE FROM THE CBTC SPECIALISTS

Real mass transit solutions begin with people. We assemble the right teams with the right skills to address the unique challenges and complexities of your project. Our people listen and respond, tailoring our proven technology to your special needs and helping you make the right decisions now and for the future. With more experience in advanced communications-based train control technology than anyone anywhere, your Project team offers exceptional expertise and integrated solutions for maximizing capacity, minimizing cost and enhancing safety in partnership with your engineering, operations, and maintenance departments. Our support is wide-ranging; our commitment is long-term.

Thales
Security Solutions & Services

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THALES

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-4 NetTrac Cutsheet

ISSUED FOR PROPOSAL
10/09/2012

THALES

NetTrac MT

Modular Central Control System For Urban Rail

RAIL SIGNALLING SOLUTIONS

www.thalesgroup.com

NetTrac MT

THE CENTRAL CONTROL SYSTEM SOLUTION THAT GROWS WITH YOUR NEEDS

Whether you are operating a simple fixed-block network or a sophisticated communications-based train control (CBTC) system, our LAN-based NetTrac MT system management control technology is right for you. And because you can add functionality as your needs change, why consider a less flexible system? In its task-rich configuration, NetTrac MT is integral to SelTrac CBTC systems in operation around the world. In its simplest form, NetTrac MT is still a very cost-effective stand-alone solution.

NetTrac MT supervises the automatic or manual operation of the entire rail fleet. It is an advanced open architecture solution for signalling control and integration of SCADA, including traction power and tunnel ventilation, passenger information, fare collection, maintenance management and access security management. NetTrac MT operates on a Windows® platform with distributed architecture on a TCP/IP network.

NetTrac MT provides a high degree of reliability and availability. Its streamlined Human-Machine Interface (HMI) is familiar, easy to learn and use. Basic functionality includes interlocking control, train tracking and scheduling. To meet the needs of a demanding train operation, the system can be built to higher levels of capability including automated functionality, automatic fail switch-over with no loss of data, sophisticated alarms, both timetable and headway regulation, junction management and conflict detection.

NetTrac MT also offers configuration flexibility – you have a choice in the number and layout of workstations using off-the-shelf PCs. Smaller systems can be created with less hardware. Much larger systems, supporting several workstations, can be created and distributed to meet higher capacity requirements.

Open architecture reduces the cost of system configuration, and makes it easier and more cost-effective to further evolve the product with the addition of new and improved features. The system is designed using the latest generation of object-oriented tools and a development process that provides high levels of capability, efficient traceability between architecture, design and testing. NetTrac MT remains evergreen, so you retain your original investment!

BUILT TO YOUR FUNCTIONALITY NEEDS

Start with a base system or elect comprehensive functionality – or choose somewhere in between! NetTrac MT can be configured to support either stand-alone Centralized Traffic Control (CTC) or highly integrated Control Center applications. Thales can build various levels of availability into your system.

SIGNALLING AND COMMUNICATION CAPABILITIES	NetTrac MT CONTROL FEATURE BUILD-UP
Vehicle load sensor	Advanced power optimization
Other vehicle monitoring	Advanced dwell control
	Sophisticated Diagnostics
	Maintenance Monitoring
Vehicle signs and PA	Predicted train arrival and destination
	Audio visual messages
2-way communication between trackside and vehicles	Automatic Movement Control
Departure control	Skip stop (platform bypass)
	Power optimization
	Regulation of velocity
	Complex regulation models
Station departure indication (countdown signal)	Automatic Regulation of dwell Holds at stations
Bi-directional train movements (signals)	Automatic Failure Management
	Diversion around obstacles
	Shuttle Line (between 2 points)
Passenger signs and PA at stations	Predicted train arrival
	Audio visual messages
Control centre of depots	Junction management
	Turnback control
	Deadlock prevention
	Holds at stations (i.e. ahead)
Intermittent train ID	Line assignments
	Schedule monitoring
Bus signaling	User access and control alarm handling
	Line planning and scheduling
	Logging and reporting
	Manual route request and cancel
	Switch move
	ADD FUNCTIONS STEP-BY-STEP

> MOVING UP THE LINE

WITH ADVANCED CENTRAL CONTROL FUNCTIONALITY

NetTrac MT can be configured to provide automatic control of all train operations under normal conditions without operator intervention. Automatic train routing functionality with high system availability is applicable to any type of signalling.

To reduce operator workload and further ensure passenger service reliability, Thales has adapted sophisticated routing concepts and features within the NetTrac MT Central Control System.

With conventional route-centric control, train routes are directly associated with the interlockings. The process involves arranging a path through one interlocking and then allowing the train to move through that route until it clears the interlocking. The route is then released. There may or may not be a route established through straight track (ABS) areas. If "fleeting" is set, the route is reset for the next train regardless of its desired targeted end-point.

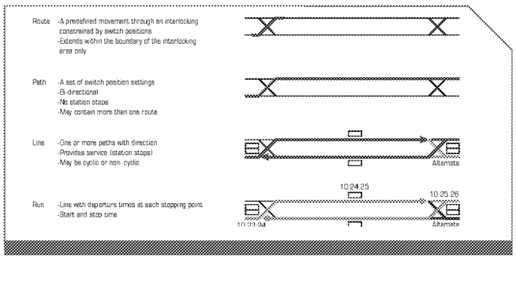
Our advanced train control technology allows operators to manipulate train behavior, instead of manipulating the track by simply setting routes for trains to follow. Thales derived this technology from three specific high-level, layered building block concepts above basic "route" control – they are PATH, LINE and RUN.

PATH

Our definition of Path reflects the full range of train movement and includes route level information, stopping points, alternate turn-back locations, changes in service pattern, entry and exits to the yard, and more.

The train's Path through the system is associated directly with the train – the Path defines its movement through the system. The train is assigned to a line that allows commanded movement without stopping until the desired destination is reached. This can be any location in the system.

The NetTrac MT system regards each train's movement as independent and determines progress step-by-step using associated bi-directional Paths (a group of interlocking routes). The system uses the train's Path to request appropriate routes through the interlockings taking into account conflicts such as other trains or regulation. Conflicts are resolved by logic using each train's current and future situation. Deadlocks (trains safely stopped head-to-head but causing train reversal) can be avoided.



LINE

The second tier concept is that of a Line which is the main area of superiority in the NetTrac MT system – all train movements are assignments.

- A Line consists of a group of one or more paths and directions with stopping points.
- Dwells are not specified as part of the line information.
- Each Line has a start point and end point (may be the same in the case of a loop).
- Each Line has at least a single direction; two are common but more are possible.
- A Line is used to define all train movements through the system and is directly associated with the train.
- A train can be assigned to a Line and will use fixed nominal dwells at each stopping point (specified as part of each platform's information). Unscheduled operation then refers to the case where trains are assigned to lines.
- Each Line can have zero or more turn-back locations where the train reverses direction, or platform alternates without direction change. If the location has a set of crossover switches or other more complicated track geometry, alternate turnback locations can be specified. These alternate locations will be used automatically by the train if the primary is not available due to current circumstances.

RUN

The highest level concept is that of a Run which completely defines a train's pattern of service for the duration of a schedule. Trains on Runs are regulated according to timetable. A Run consists of a line with a table of departure times at each stopping point. When a schedule is loaded, normally all trains are assigned to Runs (automatically on entry into the system or manually by the operator).

HUMAN INTERFACE

System Management Control workstations display the track layout together with icons individually identifying all elements under CBTC. At a glance, central controllers monitor the location and schedule adherence of each train within the system. Changes of icon color alert dispatchers to changes in the status of trains, platforms, track switches and tracks. Situations requiring urgent attention trip visual and audible alarm messages. Dispatchers use pull-down command menus, "drag and drop" and "point and click" options to easily perform numerous functions, including:

- Assigning and launching a schedule
- Monitoring status
- Routing trains to a specific track location or station
- Assigning trains to a line or run assignment, or to a shuttle service
- Holding trains at specified locations or by-passing platforms
- Diverting trains around an impassible area
- Changing train velocity
- Triggering automatic announcements in stations and on trains
- Interfacing with other suppliers subsystems
- Simplified screens show overall system status at a glance
- Continuous variable zoom in features provide increasing levels of detail

NetTrac MT Central Control offers significant advantages

- Better automatic regulation using very sophisticated algorithms
- Sophisticated optimization features such as:
  - Junction management
  - Automatic turn back handling including alternate platform selection based on sets of rules
  - Prevention of deadlock situations
  - Comprehensive methods for handling failures and disruptions through adjustments to service

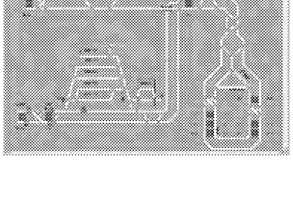
The flexibility of the advanced train control concept allows the operator to assign individual trains to unscheduled lines, or order point-to-point moves when necessary during scheduled operation, e.g. when a train's removal from service is required unexpectedly. It is not necessary to insert these unexpected movements into the timetable. Trains on Runs still will be regulated automatically.

> OPERATING EASE & SOPHISTICATION

With its automatic function control capability, NetTrac MT provides the operator with the ease and flexibility to handle a variety of minor or major disruptions to service with significantly reduced operator interaction. This functionality, inherent with Thales' advanced train control approach, greatly facilitates operating a transit system normally or under adverse conditions. Very little of this capability would be possible without the concept of Paths, Lines and Runs.

REGULATION MODES

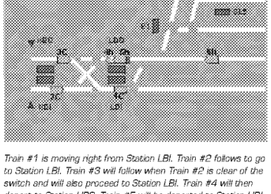
MT's automatic train regulation feature assigns an entry line that will take the train from storage to the first station where its service is to begin, adjusts to the departure schedule and normal service pattern, and manages changes seamlessly, e.g. other desired patterns of service, or a change in exit line that will take the train from its last station of service to the storege location. The regulation can very dwell within limits specified per station per block of scheduled time, the velocity to the next station, or both in different modes which alters the order in which the changes are applied. For example, an "energy conservation mode" could be used for off-peak periods where an early train's maximum velocity would be decreased, rather than increasing the station dwell in order to reduce power consumption. The regulation is applied automatically on arrival at the station for each train using the run information.



AUTOMATIC TURNBACK/ ALTERNATE PLATFORMS

A Line defines turnback locations where the direction is reversed. Most systems have two single crossovers or a double crossover near terminus platforms, however more complicated track layouts may have more than two possible turnback locations and more than one possible set of crossovers. The lines, therefore, can have one or more alternate turnback locations specified in the definition. This allows the system to automatically select the alternate turnback location based on a set of rules that include platform availability, closed platforms, etc. The selection of alternates is not predefined but is based on preference and current circumstances. This allows considerable flexibility and optimization of turnback handling so that delays are minimized.

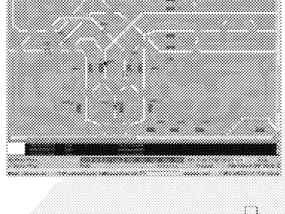
The same concept can be applied to alternate platforms in the same direction of travel.



Train #1 is moving right from Station LB1. Train #2 follows to go to Station LB1. Train #3 will follow when Train #2 is clear of the switch and will also proceed to Station LB1. Train #4 will then depart to Station HB0. Train #5 will be departed to Station HB1 when Train #4 is clear of the switch. (The red bar indicates that this train is waiting.)

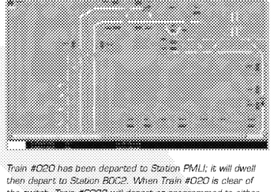
JUNCTION MANAGEMENT

For locations where tracks merge, conflicts will arise over which train goes first. Because each train has a Line and may or may not have a Run, the relative priority of each train through the junction is determined by a set of rules that take future movement into account. These rules can be very sophisticated considering train variance (late or early) including limits on waiting, recoverable time on each Line due to regulation, first-come-first-served, unscheduled versus scheduled, etc. The rule sets can be changed for different junctions and can vary depending upon the time of day. More complicated junctions with competition between a large number of trains can be handled with the same basic concepts.



AUTOMATIC DEADLOCK PREVENTION

The simplest example of a potential deadlock is a situation at turnback where one train is ready to depart to a turnback location occupied by another train. Instead of repeatedly calling the route to the terminus location, the NetTrac MT system will determine that there is a potential deadlock situation. It prevents issuing the route request until the train at the terminus is at a location where it will clear the interlocking just before the second train requires the route to be set. This functionality is more effective and efficient than simpler methods that depend upon the local interlocking to prevent the deadlock. The feature also prevents deadlocks in a bi-directional single-track travel area. And because of the Line concept, it is also possible to determine deadlocks that could occur over much larger areas.



Train #020 has been departed to Station PML1, it will dwell then depart to Station BDC2. When Train #020 is clear of the switch, Train #3022 will depart as programmed to either Station PML1 or Station PML2 and then on to STR4. Train #3022 will be prevented from departing to Station BDC2 until a bi-directional area is clear.

AUTOMATIC FAILURE MANAGEMENT

To aid in service recovery, it is possible to incorporate very sophisticated commands for handling a variety of failures and more severe disruptions. They include:

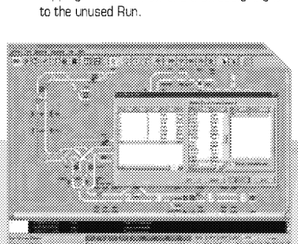
MANUAL ASSIGNMENT TO PATH, LINE OR RUN

Any train can be assigned to a Path to move it nonstop from one place to another. This is done to remove a train from service due to an unexpected problem, or to handle special movements to work through a disruption such as backing up a train to the previous station. Any train can be assigned to a Line, which will allow it to follow predefined stopping points with nominal dwells. This feature can be used to short-turn a train and reassign it to a Run on the other side of the turnback. Moving a replacement train into service is as easy as slipping it into the flow and then assigning it to the unused Run.

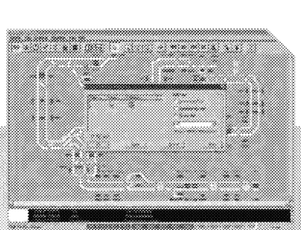
VARIANCE ADJUSTMENT

Manual adjustments can be used on one or more trains. Command features are designed to handle situations where a disruption has essentially stopped all trains. To regain a schedule, all departures need to be moved later in time to allow the system to recover and subsequently regulate in a reasonable manner.

A "schedule slide" is used to slide all departures by a fixed amount of time. It can be set to automatically update the slide based on the latest train in the system.



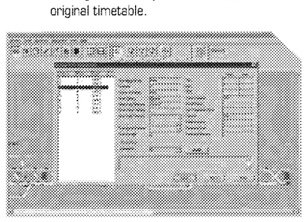
The operator can "left click" on the train icon and drag it to the desired stopping location which can be a station, track section or marker (anywhere that the train can travel to, moving in one direction). The system will show a dialogue box that lists route possibilities, highlighting the currently selected route on the screen.

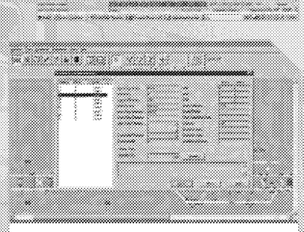


The dialogue box shows Train #1, 7030 seconds late and Train #2, 405 seconds early. The operator can apply a correction of 120 seconds, for example, to all trains and the system will automatically move each train to the adjusted schedule. The feature also allows individual train correction.

RE-DETERMINATION

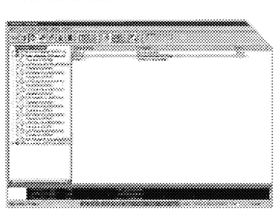
A "re-determination" is used to recover from a severe disruption. This command will automatically change the trains to new Runs following the same Lines. Train order is changed in the schedule so that all trains are reassigned in a way that best reclaims the original timetable.





ASSIGNMENT OF ANOTHER SCHEDULE

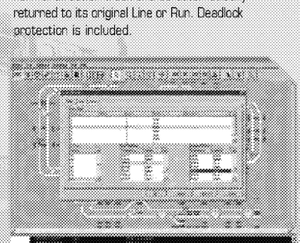
In the event that the schedule is not recoverable after a severe disruption, it can be removed and a new schedule can be designated. The trains can be assigned and activated manually to follow the revised schedule.



The most powerful, yet simple feature of NetTrac MT
In seconds an operator can remove a schedule and reassign a different one that matches current situations, i.e. to handle special events or unexpected service pattern changes or in response to a failure when the original schedule is not recoverable. There is no limit to the number of schedules that can be defined and created. Operators have a variety of means to transfer trains to the new service pattern.

ASSIGNMENT OF A DIVERSION

A "diversion" is used to automatically assign one or more trains to a different line before the obstruction, moving it on a bi-directional track until it can return to the normal direction track and be automatically returned to its original Line or Run. Deadlock protection is included.

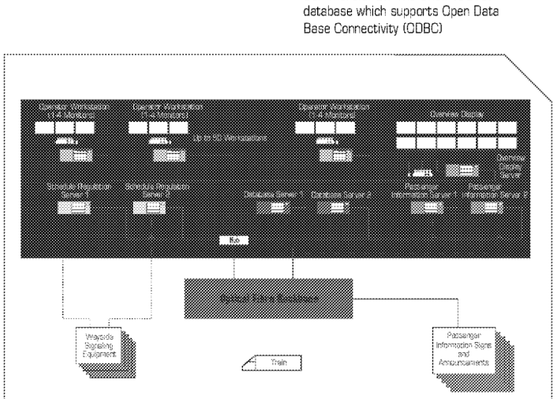


KEY CUSTOMER BENEFITS

- Meets a wide variety of transit system types and sizes
- Supervise the manual or automatic operation of the entire train fleet
- Better automatic control and regulation
- Flexible train operation management
- High availability and reliability
- Easy to use
- Fast response to system disruptions; easy communication
- Reduced operator workload
- Easily extended /upgraded – add levels of enhanced functionality later
- Low life cycle cost

FEATURES

- Modular – offered in levels of functional sophistication
- Commercial off-the-shelf PCs; LAN and Windows® NT technology
- Pull-down command menus; "drag & drop" "point & click"
- Workstations display track layout and element icons
- Scalable, flexible and configurable
- Connects to a single or dual (redundant) high-speed TCP/IP based LAN
- Interfaces with other subsystems
- Optional dual LAN backbones, multiple printers and workstations – no single point of breakdown can cause system failure
- Primary and backup server sets: automatic regulation, fully automatic switchover with no loss of data, optimization and information storage facilities
- Complies with a Cenelec prEN 50128 Standard for Level 1 software
- Data logging is supported to any Commercial Off-The-Shelf (COTS) database which supports Open Data Base Connectivity (ODBC)



> SOLUTION EXCELLENCE FROM SIMPLE TO COMPLEX, NetTrac MT CENTRAL CONTROL PERFORMS

LONDON'S DOCKLAND LIGHT RAILWAY

The DLR is one of the most complex and challenging people movers in the world. Today it consists of 27 km of double track with 54 stations, 94 fully automatic trains and two depots. DLR retains an attendant on board for train door operation.

DLR's track layout includes a complicated junction area where the major lines of the system converge. The signalling system consists of an arrangement of three vital interlocking train control subsystems, data transmission equipment, 65 trackline point machines, VHF bi-speed communications for ATP/ATO operations and 75 passenger information displays.

Key to our applied SelTrac CBTC with moving-block technology, NetTrac MT provides central operators with flexible and comprehensive control functionality.

NetTrac MT ensures automatic handling of incident management and single-track operation requiring multiple service patterns. Passenger displays are provided with accurate train arrival time predictions for multiple trains. The Control Center at Poplar station is equipped with a multi-workstation LAN-based system for train regulation and traffic management. Remote workstations are distributed at various locations providing detailed system status in color graphic format to train depots, operations management, security offices and neighboring transit authorities.

JFK INTERNATIONAL AIRPORT'S AIRTRAIN

AirTrain is the Port Authority of New York and New Jersey's fully automated, advanced rapid transit system that functions as the JFK Airport access service and circulator. It serves six terminals and ten stations along a 13km (8mi) predominantly elevated dual guideway and links the central terminal area to two major intermodal hubs.

SelTrac® CBTC with moving-block technology is applied for 24-hour fully automatic driverless operation of 32 vehicles as single units or in trains of up to four cars. 10 vehicles are outfitted with redundant ATC equipment. The other 22 are to be operated as coupled cars. The system controls 9 distributed solid-state interlockings and one fully automatic storage and car wash facility. SelTrac benefits include precise stopping accuracy and expandability for long-term growth.

Integral to the SelTrac system, NetTrac MT Central Control allows for both automatic train control and emergency manual operation. As a cost efficiency benefit, Thales has included a unique quick-start feature to allow vehicles to be reset from Central Control in the event of a systems halt. This eliminates the need for a maintainer to be dispatched to vehicle locations. The Central Control is capable of fully automatic launch, automatic skip-stop operation and turnaround and 24-hour continuous scheduled operation.

AROUND THE WORLD...IT'S NetTrac MT CENTRAL CONTROL

Hong Kong KCRC
West Rail
Ma On Shan Line

Hong Kong MTRC
ATR
Disneyland Resort Line

Jacksonville ASE

JFK International Airport APM

Kuala Lumpur LRT II

Las Vegas Monorail

London Docklands Light Railway

London Underground Jubilee Line

Newark International Airport APM

Quebec Cartier Railway

San Francisco Municipal Railway

Tampa International Airport APM

Toronto Scarborough RT Line

Vancouver SkyTrain
Expo and Millennium Lines

Wuhan Metro

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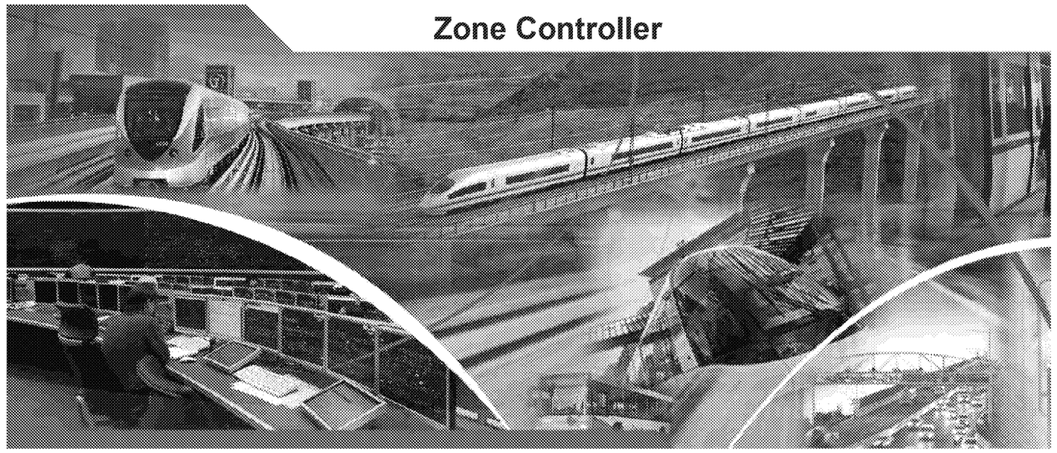
THALES

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-5 Zone Controller

ISSUED FOR PROPOSAL
10/09/2012

Zone Controller



The **Zone Controller** (ZC) is the core component of the wayside vital train control, which integrates Automatic Train Protection (ATP) and interlocking functionality including Movement Authority determination, route reservation, setting and switch control.

Each Zone Controller manages a section of the line called a "zone". The ZC controls and monitors:

- All the field devices in its assigned guideway area using its capabilities,
- All the trains in its area via continuous communication with the CBTC on-board equipment, and
- Trains' access coming into or leaving its area via continuous communication with the neighbouring Zone Controllers.

The Zone Controller is a vital ATP component of SelTrac CBTC designed and built redundantly in a 2oo2 configuration for safety: Each interlocking area is controlled by two ZC functional units, in an availability redundant hot-standby configuration. Thus, each Zone Controller is a 2 times 2oo2 vital computer system, with a very high level of safety and availability.

The Zone Controller integrates the wayside ATP and interlocking functionality in one 2oo2 hardware vital computer, thus reducing the hardware component count. This minimises the amount of equipment to be deployed, increases the reliability and availability of the system and facilitates future extension of the system.

For the field device interface, the Zone Controller uses I/O modules which are installed locally (for the interlocking stations).

The I/O modules support discrete input and output functionality.

The distributed architecture of the system provides full flexibility for testing & commissioning and optimises the track possession.

Zone Controller Configuration

At each Signalling Equipment Room, each of the Zone Controllers will be arranged in one rack enclosure (ZC Rack).

The ZC is made of two identical parts in a 2 x 2 out of 2 configuration (2oo2) in a hot standby configuration (one ZC is active and one is passive); if the active ZC fails, the passive ZC will take over). Each 2oo2 unit consists of the following parts:

- The Main Processor Unit subrack (MPU subrack)
- The Interface Board subrack(s) (IFB subrack)

The MPU is the brain of the ZC and consists of two Pentium based processor boards with embedded Thales Extended Operating System software with dedicated power supplies, arranged in a 2oo2 configuration.

It communicates with the ATS, the VOBCs and the neighbouring ZCs. It controls and monitors the field devices via the IFB subracks (which provide the I/O functionality).

The IFB subrack is the peripheral unit that links the wayside devices (switches, emergency stop system, etc.) to the MPU.

Up to 3 IFB subracks are used to connect the MPUs to wayside devices. There are a maximum of 12 interface cards in each IFB subrack.

The IFB subrack(s) are responsible for vitally reporting all changes in field status to the MPU and for executing and supervising all output commands from the MPU.

The ZC monitors and control field elements of a zone that consists of several stations. To provide full flexibility for Testing and commissioning and track possession, each ZC will consists of up to 3 or 4 stations.

Main Processing Unit (MPU)

Each Main Processing Unit (MPU) contains two computers operating in a 2 out of 2 safety configuration. Each computer communicates over a dedicated internal Controller Area Network (CAN) bus to an Interface Controller (IC) located on each I/O board.

The ZC uses 2 identical microprocessor-based "computing elements", with the following characteristics:

- Intel 600 MHz Celeron M Processor and supporting chipset
- 256 MB of SDRAM (for program execution)
- 128 MB of Compact Flash (for program storage)
- 32 KB of (non-volatile) FERAM (for event log storage)

The ZC application runs on top of the Thales TAS Platform vital operating system.

Both the Interface Controllers and the interface card I/O channels contain an 'A' and a 'B' section - with the 'A' channels of each interface card being controlled by the 'A' section of the Interface Controller and the 'B' channels being controlled by the 'B' section of the Interface Controller.

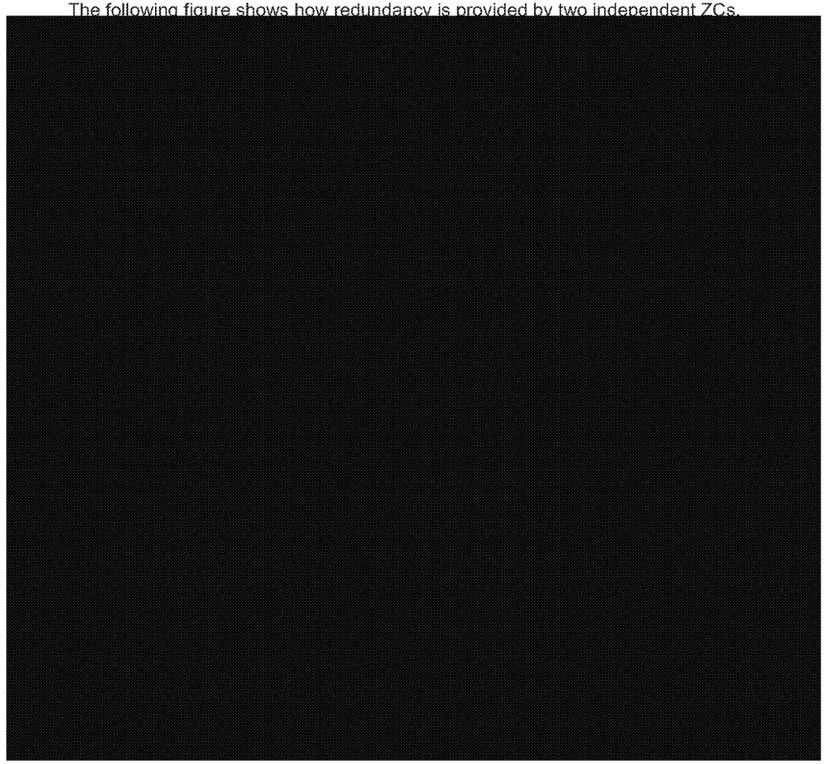
Within each ZC, hardware is duplicated for safety purposes and all information passing through the ZC is processed separately by each replica.

This arrangement allows the vital comparison of interface information processed by the two independent hardware paths and is key to the safe operation of the ZC. After reading status data, the input messages from the "A" side and from the "B" side of a IFB channel are exchanged and compared (2oo2 voting) by the MPU's to ensure that the messages are identical. Output messages (from the MPU to the other subsystems or to the IFB) are also compared before being sent. If the I/O information from side "A" and side "B" matches, the message is transmitted. However, a mis-comparison leads to the isolation of the failed ZC from the active system.

Hardware redundancy of the ZC is also used to improve system availability. All I/O channels are driven (output) or monitored (input), by two different ZCs.

Any failure causing loss of a single ZC has no operational impact because of the availability of the redundant unit.

The following figure shows how redundancy is provided by two independent ZCs.



Interface Boards (IFB)

The ZC supports interface boards (IFB) for a general purpose discrete input/ output card with the ability to energise vital relay coils (output) and to sense the presence or absence of voltage due to contact closures.

All outputs have a separate monitoring circuit that provides feedback to the IFB subrack regarding the ability of the ZC to control and maintain control of the outputs.

All inputs have "Latent Failure Detection" circuitry. The circuits periodically short-circuit each input that has a "high" state and checks that the resulting change in status to "low" is detected by the electronics on the I/O card. These checks, which do not interfere with the normal operation of the inputs, provide assurance that electronic failures resulting in an input channel being sensed high irrespective of its input ("stuck high fault") will be detected.

The IFBs under the same MPU control are configured to operate at the same location as the MPU (and are installed at the interlocking stations, along with the MPU, in the same rack) or at remote locations.

ZC Rack

The ZC can be packaged in three different types of rack depending of the number of IFB required for the zone which is determined by the number and type of field elements to be controlled and monitored in the ZC's area.

Each rack houses:

- Two MPUs (each in 2oo2 configuration) and
- One, two or three IFB sub-rack(s) depending on the Type

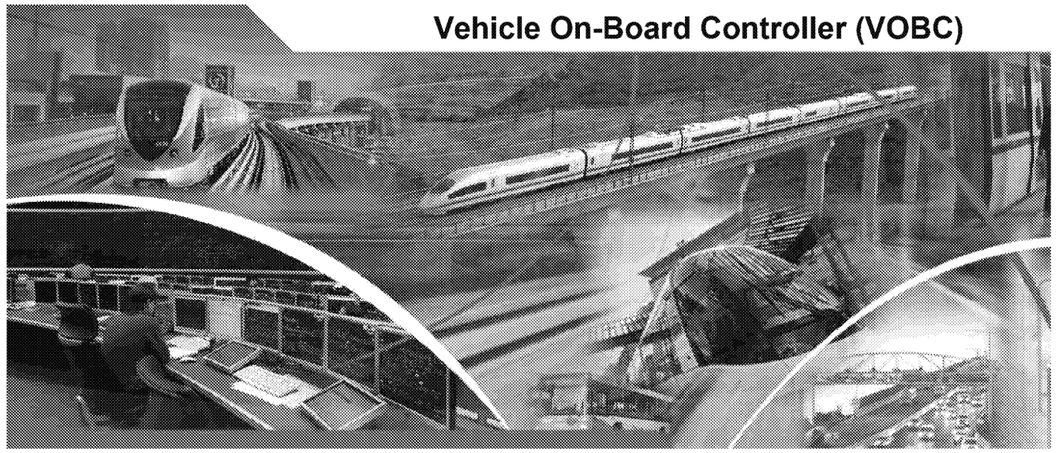
The ZC racks are mounted to the wayside room floor, using an appropriate under-floor mounting bracket that will secure the ZC racks to the equipment room floor and allow adequate space for cable entry via the bottom of the equipment rack.

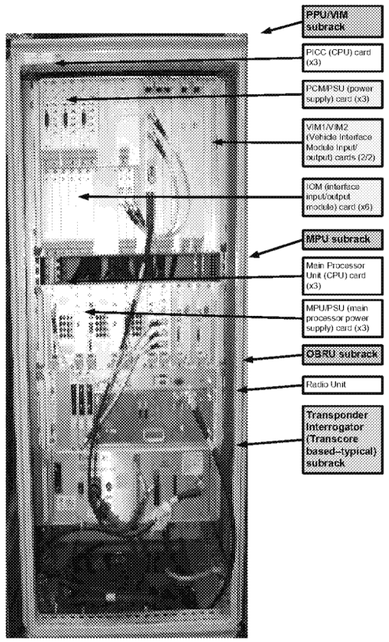
5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-6 Vehicle On-Board Controller

ISSUED FOR PROPOSAL
10/09/2012

Vehicle On-Board Controller (VOBC)





Typical VOBC Rack

- Designed in Toronto, Canada
- Proven Solution
- Availability 99.998%
- On-board Diagnostics
- Safety Integrity level CENELEC SIL 4

The **Vehicle On-Board Controller** (VOBC) is the core on-board component of the vital train control which allows Driverless Train Operation, by implementing Automatic Train Protection (ATP) and Automatic Train Operation (ATO) functionality, including safe automatic or manually driven train movement, including accurate station stopping, automatic door operation and protection.

The VOBC performs its ATP and ATO functions in collaboration with the Zone Controller and the ATS, with which it maintains continuous communication. The Zone Controller provides the Limit of Movement Authority (LMA) used by the VOBC to safely operate the train. The VOBC, using its sophisticated safe braking model, calculates in real-time its safe braking curve, allowing the train to stop very close to the end of its LMA and reducing the required overlap distance. The VOBC reports to the Zone Controller the position, speed and other parameters of the controlled train. The ATS allows the operator to issue various operation and configuration commands.

The VOBC is a vital ATP component of the SelTrac CBTC system designed and built redundantly for safety and availability. Each vehicle is equipped with a safety redundant (2oo3) VOBC. When the vehicles are coupled together the VOBCs will be in a hot-standby configuration, ensuring a high level of availability.

In its operation, the VOBC uses transponder tags (which provide train relocation reference) and proximity plates (which support station stopping), all of which are installed along the running tracks.

Vehicle On-Board Controller

The VOBC consists of a Main Processor Unit (MPU) and a Peripheral Processor Unit (PPU). The PPU handles the vital and non-vital input/output required on-board the train.

Both the MPU and PPU units consist of duplicated sets of hardware (2oo3 vital configuration). The two Pentium-based CPUs in the MPU interface individually via a high speed serial link to one of the two PICC units in the PPU.

Main Processor Unit

The MPU consists of a Pentium based processor board with embedded Thales Extended Operating System software with dedicated power supplies. In the 2oo3 implementation, there are three Pentium processor boards and Pentium power supplies installed. The Pentium processors exchange and compare peripheral data received from their respective peripheral interface controller replicas and decide and vote on control commands that are issued to the peripheral interface controllers via CAN bus.

The VOBC uses 3 identical microprocessor-based "computing elements", with the following characteristics:

- Intel 600 MHz Celeron M Processor and supporting chipset
- 256 MB of SDRAM (for program execution)
- 128 MB of Compact Flash (for program storage)
- 32 KB of (non-volatile) FERAM (for event log storage)

PPU/VIM Sub-rack (Peripheral Processor Unit/Vital Interface Module)

This sub-rack functions as the main interface to the rolling stock subsystems and to the Thales peripheral equipment signals (Digital I/O, Sensors, etc). The main function of the PPU/VIM sub-rack is to collect information from various on-board peripherals and to provide this information to the Main Processing unit.

The following are the main elements of the PPU/VIM Sub-rack:

- The **Peripheral Interface Control and Communication** (PICC) card is based on a Digital Signal Processor (DSP) with enhanced Peripheral Interfaces for motion control applications. In addition to the Controller Area Network, which is used for communications between the PICC and MPU, a single RS-232 Diagnostics Port and two high-speed configurable serial communications ports are provided. The PPU/VIM sub-rack is connected to the Transponder Interrogator using one of the serial ports.
- Vital Interface Module 1 (VIM1): This is the input interface (digital Input) used in the on-board controller. It can support 16 discrete inputs.
- Vital Interface Module 2 (VIM2): This is the digital output interface used in the on-board controller. It can support 16 outputs.
- Vital Interface Module 3 (VIM3): Processes analogue inputs (such as from speed sensors, accelerometers), connects to the transponder interrogator and interfaces to the vehicle identification plug.
- Process Cycle Monitor and Power Supply (PCM/PS) card: is used for process cycle monitoring, to check the life and function of the PPU, as well as supply the necessary supply voltages to drive the remaining cards.
- Disconnect board: is used to vitally disconnect the outputs of the PPU from the vehicle.

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-7 ComTrac Cutsheet

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10/09/2012

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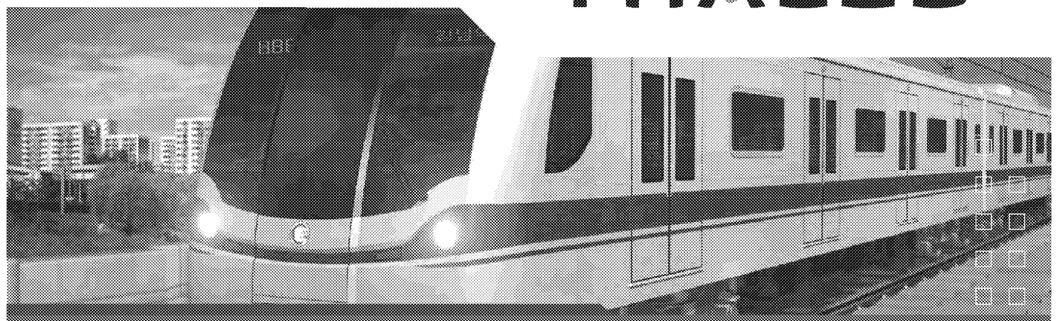


ComTrac 6753
DATA COMMUNICATION SYSTEM

Thales' ComTrac Data Communication System (DCS) is an autonomous mobile communication system forming a single seamless Ethernet network. It is used with SelTrac® Communications-Based Train Control (CBTC) solutions allowing for data communication between all train control applications inherent with central and wayside controllers and trains. ComTrac DCS has both a wired and a wireless component; the wired component links all centralized and decentralized systems, while the wireless component forms a link to all trains in the system. The DCS employs a security system that meets today's highest possible standards.

The DCS is entirely comprised of open-standard components, from its Commercial-Off-The-Shelf (COTS) equipment to its Internet Protocol Security (IPSec). All interfaces are via 802.3 Ethernet connections. The wireless component is IEEE 802.11 compliant, using the standard network Layer 2 Medium Access Control (MAC) protocol and a spread spectrum technique within the unlicensed ISM bands.

There are numerous reasons and benefits, for both rail operators and Thales, to using open-standards, the most important being a stable future migration path and cost containment through COTS equipment economies of scale
and a competitive market.

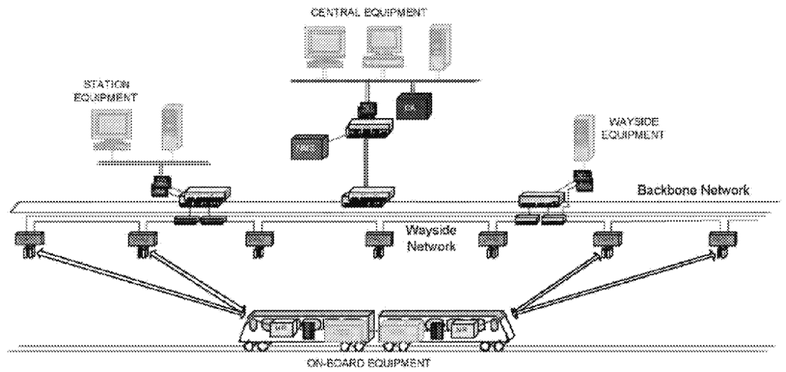
IEEE 802.3 and 802.11 benefits also include:

- Standard and consistent message formats for all train control applications
- No message fragmentation at the application layer
- Independency of train control application from the data communication system
- Applications isolated from the network, data link and physical layers
- Standards to provide a modular architecture that allows for independent application upgrades
- Standards are published, freely available, and provide a fully documented architecture
- Use of standard and well recognized interfaces and protocols, which encourages vendors to create compliant products

Network Architecture

The wired portion of the RMN network is a fibre optic Ethernet backbone delivering Ethernet services that support data transfer rates of 100 megabits per second (IEEE 802.3u) or 1 gigabit per second (IEEE 802.3z). This backbone uses Ethernet switches, and fibre optic cable that is configured using a redundant ring topology, such that a failure of any single component does not adversely affect communication and overall system operation. Security Gateway devices are installed between all train control subsystem applications and the Ethernet switches, in order to secure these applications from unauthenticated traffic.

The Ethernet switches are also used to connect wireless Access Point (AP) radios to the backbone in a secondary redundant ring. Backbone switches are customarily located in racks at central control, as well as in the equipment rooms of most stations, while APs are dispersed at measured intervals along the side of the railway track to ensure complete redundant radio coverage. Similarly, trains are equipped with Mobile Radios (MRs) that are connected to the Vehicle On-Board application equipment



through gateways, and serve to communicate messages between trains and the wayside train control applications. The entire network, including both the wired and wireless portion, is a single Ethernet network, such that all communication is conducted through standard Ethernet IP message formats, a major benefit of using open-standards.

Radio Technology

Besides the desire to use radios compliant with open-standards, Thales has chosen to use IEEE 802.11 FHSS radios for their technical distinction beneficial in a train control environment where mobility, interference and multipath propagation are factors. Comprehensive and systematic laboratory testing, as well as several field trials have confirmed that IEEE 802.11 radios support high speed mobility. FHSS radios can operate in the unlicensed ISM bands and apply a frequency hopping spreading technique that offers protection against interference through the use of pseudo-random hopping sequences. Frequency hopping provides effective throughput rates of up to 1 megabit per second while operating over 79 frequencies ranging from 2.402 GHz to 2.480 GHz. Each of the frequencies is GFSK modulated, with a channel width of 1 MHz. Antenna diversity offers proven mitigation against multipath propagation typically found in urban rail environments where tunnels, obstacles and other trains are common.

Because the APs are subjected to either the harsh conditions of tunnel environments or variable weather conditions of open space, these radios are housed in NEMA enclosures qualified to withstand punishing thermal and vibration conditions according to that required by railway standards such as AREMA.

Security

The main objective of the ComTrac DCS is to provide communication between all train control subsystems. This communication needs to be extremely secure relative to potential unauthenticated access attempts via the wireless component. Preventing this, the DCS incorporates a security system comprised of a Certificate Authority (CA) and numerous Security Devices (SDs). The SDs perform as gateways wherein all wired and wireless data is encrypted and authenticated as it passes through. The DCS also applies dynamic key management through open-standards such as IPSec, IKE and PKI.

Key Customer Benefits

- Scalable and extensible architecture
- Use of commercial-off-the-shelf (COTS) equipment
- Stable future migration path
- Interoperability and interchangeability
- No specialized skill sets required
- Commercially available technical support
- Freely available professional published documentation

Features

- Open-standards content throughout
- Single Ethernet IP network
- FHSS radios well suited to railway environment due to interference, noise and multipath propagation avoidance
- Leading edge technology
- Standard and consistent interfaces and message formats
- Impregnable security system
- autonomous and independent of train control applications

Rail Signalling Solutions
1235 Ormont Drive • Toronto, Ontario, Canada • M9L 2W6
tel: 1.416.742.3900 • fax: 1.416.742.1136

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

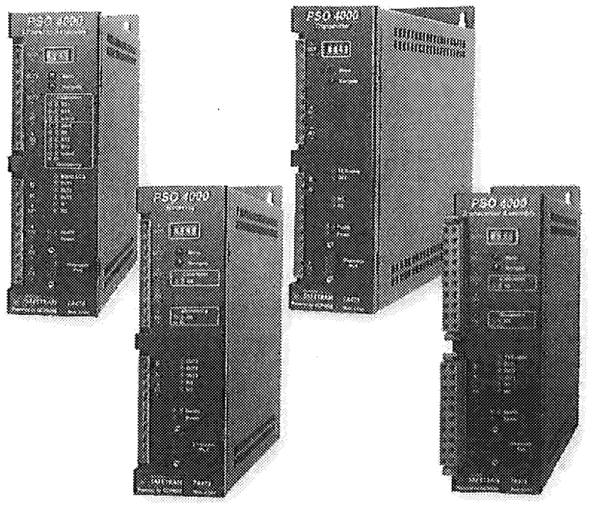
5.4.1.C-8 Track Circuit

ISSUED FOR PROPOSAL
10/09/2012

invensys
Rail

Phase Shift Overlay 4000 Track Circuit

User configurable, overlay track vacancy detection



- Each unit configurable to all frequencies
- Available as Transmitter, Receiver, Transceiver and Crossing
- Functionally & electrically compatible with PSO-II and PSO-III
- Transfer vital data with up to five different codes
- Suitable for electrified and non-electrified territory
- Generally operates without Insulated Rail Joints
- Overlays on most track circuits
- Uses the same couplers as PSO-II and PSO-III

New, Improved Design

Modern, reliable track circuit with new electrical design built on proven principles. Backwards compatible (functionally and electrically) with PSO-III and PSO-II. You can even mix versions on the one track.

Low component count, high flexibility

Separate Transmitter, Receiver, Transceiver and Crossing (two receivers plus an integrated island track circuit and stick logic) supplemented with a transceiver module.

No need to stock specific frequency variants. Modules can be used anywhere as all frequencies, modulation codes and levels are user configurable from the front panel codes.

Fully compatible with PSO-II and PSO-III transmitters, receivers and couplers.

Ideal to add track circuits in conjunction with other track circuits, level crossings and in difficult situations.

Description

PSO 4000 is a modular, audio frequency overlay, train vacancy detection system.

Each track section uses a transmitter that feeds a coded signal to the track and a receiver that validates both frequency and code to determine that the track section is clear. One intermediate receiver location can optionally be used.

The PSO 4000 couples to the track with a bandpass, low impedance connection–you don't have to have insulated rail joints on the track and you can mix PSO, GCP, ac and coded track circuits all on the one section.

PSO 4000 modules include:

- **Transmitter** (stand alone)
- **Receiver** (stand alone)
- **Transceiver** (combination of a transmitter and receiver for applications such as cut sections)
- **Crossing** (two receivers, an island circuit and integrated stick logic and timers for ready made level crossing protection)
- **GCP 4000**: Plug in module that programs to Transmitter, Receiver and Crossing functions and used for train detection or DAXing.
- **Couplers**:
  - receiver–tuned
  - line (used to couple transmitter or receiver to a cable)
  - track joint bypass–untuned for dc track or tuned for ac track

Features

Configurable **anti bob timers** on all tracks.

PSO 4000 is functionally and electrically **backwardly compatible** with PSO-II and PSO-III track circuits–you can even mix components on one track.

Choose from **16 standard** (compatible with PSO-III) and **31 alternative** frequencies with over half suitable for ac and dc electrified territory.

Choose from standard A & C codes (compatible with PSO-III) or three new codes: D, E & F.

Choose from **14 standard** or **10 alternative island frequencies** (crossing module), all suitable for electrified territory.

Transmitters can **dynamically swap between A and C codes** in response to an input state change: corresponding receivers can provide different outputs for three different codes.

Simple level crossing control with two transmitters and a crossing package with two receivers, an island circuit and stick logic (including configurable stick reset timers).

Configure and calibrate from front panel push buttons–no tools required.

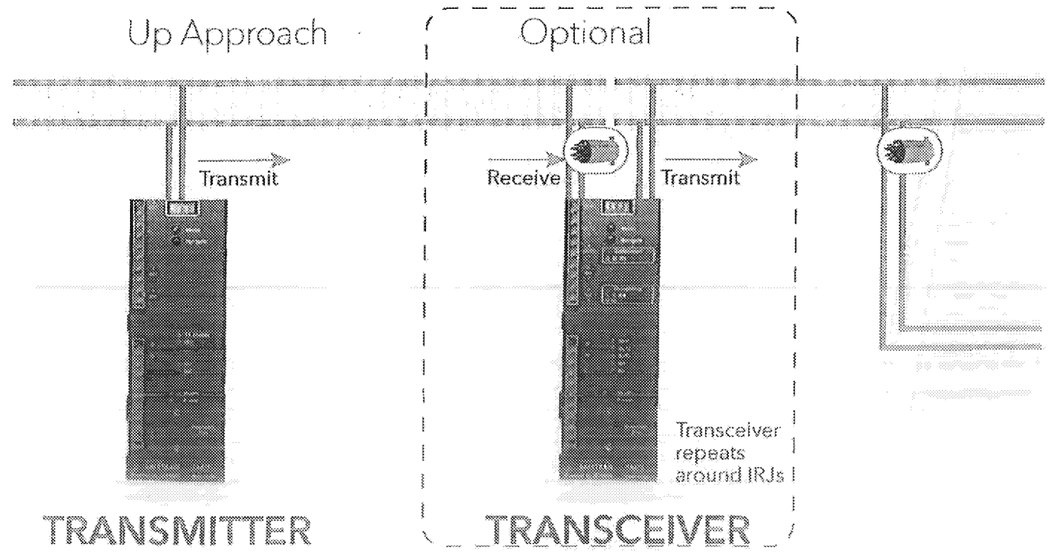
LEDs and 4 character displays for easy status identification and diagnostics.

Diagnostic history downloadable with DT or dumb terminal.

Configurable **Out of Service** setting.

Inputs and outputs on each module for control, output and health status.

Example Layout



Specifications

PSO Frequencies								
156 Hz	**211 Hz**	**285 Hz**	**348 Hz**	**430 Hz**	*500 Hz*	**525 Hz**	**645 Hz**	*700 Hz*
790 Hz	*900 Hz*	**970 Hz**	*1000 Hz*	*1100 Hz*	*1125 Hz*	**1180 Hz**	*1250 Hz*	*1300 Hz*
1375 Hz	**1450 Hz**	*1500 Hz*	*1600 Hz*	*1640 Hz*	*1750 Hz*	**1770 Hz**	*1875 Hz*	**2140 Hz**
2175 Hz	*2300 Hz*	**2630 Hz**	*2675 Hz*	*2800 Hz*	*3100 Hz*	**3240 Hz**	*3500 Hz*	**4000 Hz**
4000 Hz	*4900 Hz*	*5400 Hz*	*5900 Hz*	*6400 Hz*	*7100 Hz*	*7700 Hz*	*8300 Hz*	*8900 Hz*
9500 Hz	*10200 Hz*							

Island Circuit Frequencies								
2.14 kHz	*2.3 kHz*	**2.63 kHz**	*2.8 kHz*	*3.1 kHz*	**3.24 kHz**	*3.5 kHz*	**4.00 kHz**	**4.90 kHz**
5.4 kHz	**5.90 kHz**	*6.4 kHz*	**7.10 kHz**	*7.7 kHz*	**8.30 kHz**	*8.9 kHz*	*9.5 kHz*	**10.0 kHz**
10.2 kHz	**11.5 kHz**	**13.2 kHz**	**15.2 kHz**	**17.5 kHz**	**20.2 kHz**			

Legend:
Bold text Standard frequencies
Italic text Alternative frequencies. Used with existing track equipment from other suppliers.
Frequencies suitable for use in electrified territories

Refer manual for compatibility.

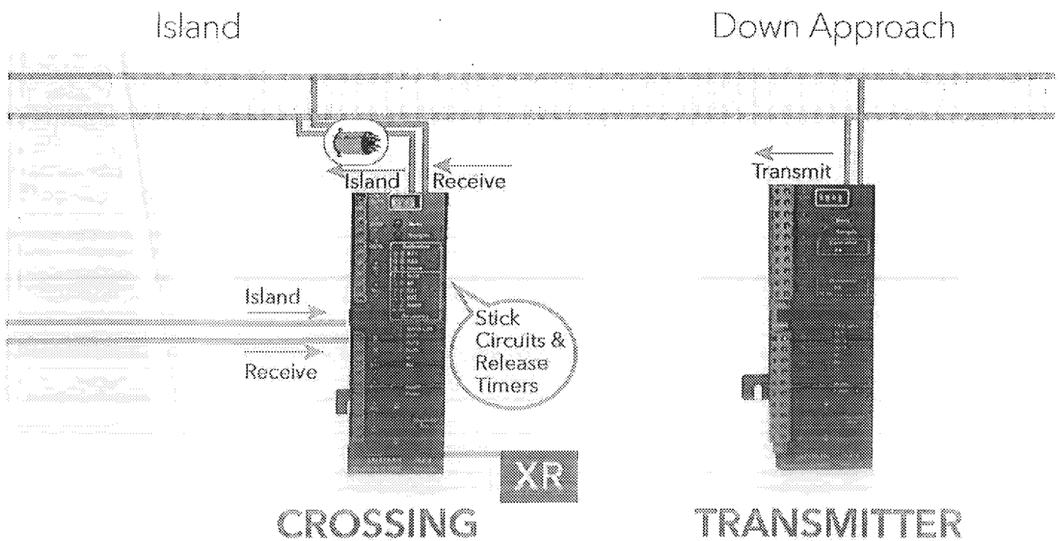
Power Supply	Voltage	9.0 Vdc min 16.5 Vdc max (<1 Vpp ripple)		
	Current: (12 V supply, typical)		Steady	Shunted
		Transmitter:	820 mA	850 mA
		Transceiver:	780 mA	590 mA
		Receiver:	780 mA	780 mA
		Crossing:	610 mA	590 mA
Inputs	12 Vdc Nominal Low: < 4.0 Vdc High: > 7.5 Vdc Maximum: 20 Vdc Impedance: approximately 1 kΩ			
Outputs	12 Vdc nominal 400 to 1000 Ω external load On voltage – load dependent, see manual Off voltage < 2.5 Vdc Suits Invensys Rail QS2 12 V relays (other manufacturers may not meet off voltage level)			
Frequency stability	±0.01%			
Modulation	Frequency Modulation with 8-bit serial address			
Train Shunt	Select between 0.06 Ω and 0.5 Ω			
Track Ballast Resistance	> 0.6 Ω.km			
Track length	640 to 2860 m maximum at 1.2 Ω.km ballast and 0.2 Ω depending on frequency, ballast and shunt			
Transmitter Load	25 Ω			
Receiver Load	250 Ω			
Pickup Delay	PSO: 0-30 s user configured Island: 2 - 8 s user configured			
Drop Time	PSO: < 1 s island: <0.5 s			
Stick Timer	5 to 60 m user configured			
Dimensions	Height: 242.3 mm Width: 92.7 mm Depth: 262.9 mm Weight: 2.7 kg			

179-185 Normanby Rd (Locked Bag 66), South Melbourne, Victoria 3205, Australia
T +61 1300 724 518 F +61 3 9233 8777 ABN 78 000 102 493
E enquiries.asiapacific@invensysrail.com W http://www.invensysrail.com

Ordering

ITEM DESCRIPTION		PART NUMBER
PSO 4000 UNITS	Transmitter	7000-7A471-0001
	Receiver	7000-7A473-0001
	Crossing Assembly	7000-7A474-0001
	Transceiver Assembly	7000-7A475-0001
PSO Module for GCP 4000		8000-A80428-03
PSO 4000 AUXILIARY EQUIPMENT	AC Shunt, Wide Band	8000-8A076-0001
	Battery Choke	6000-62648-0001
	Battery Choke	8000-8A065-0001
	Cab Signal Filter	7000-7A417-00XX [a]
	Line to Receiver Coupler	7000-7A388-0001
	PSO Battery Choke	7000-7A360-0001
	PSO Battery Line Filter	7000-7A418-0001
	PSO Insulated Joint Bypass Coupler (Tuned)	7000-7A422- ffff [b]
	PSO Line Coupler, Low Z	7000-7A403-0001
	PSO Line Terminator	7000-7A345-0001
	Receiver Line to Rail Coupler (Pole Mounted)	7001-7A377- ffff
	Receiver Line to Rail Coupler (Shelf Mounted)	7002-7A377- ffff [b]
	Transmitter to Line Rail Coupler	7000-7A399- ffff [b]
	Tuned Receiver Coupler	7000-7A355- ffff [b]
	Tuned Receiver Coupler	7000-7A366- ffff [b]
	QS2 Relay (12 V)	See *Datasheet 3B-5 Relay Style QS2*
PSO 4000 SUPPORTING EQUIPMENT	Safetran Diagnostic Terminal (DT)	Z224-9V234-A01D [c]

a. Refer to your Sales Manager for for the final two digits of the required code specifying the manufacturer and the frequency required for the location.
b. Order the component by the frequency required as per the railway's wiring or installation diagram (ie -0154 for 154 Hz frequency, 2630 for 2.63 kHz, 4000 for 4.0 kHz, etc)
c. The Safetran Diagnostic Terminal (DT) CD shipped will be the latest version available.



5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-9 FieldTrac Cutsheet

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10/09/2012

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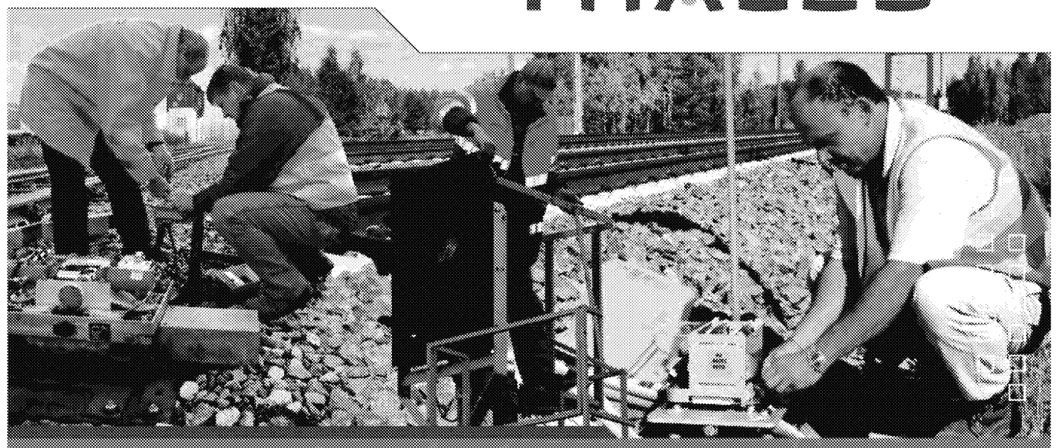


FieldTrac L910H

Electro-Hydraulic Point Machine with Internal Lock

Main References

- Canada
- Finland
- Germany
- Italy
- Spain
- Turkey
- Switzerland
- Austria
- Slovenia
- Britain
- Malaysia
- Several other countries

FieldTrac L910H is an electro-hydraulic point machine with internal lock.

The design is based on the successful model FieldTrac L710H.

The machine can be supplied as a trailable or non-trailable version and is especially suitable for application in severe environmental conditions such as snow, ice, etc.

FieldTrac L910H is designed for right- and left-hand layouts.

FieldTrac L910H has demonstrated reliable operation at temperatures below -38°C during cold winter nights in Finland

Main Functions

FieldTrac L910H is a highly reliable point machine with low maintenance requirements due to the elimination of gears and the use of hydraulics.

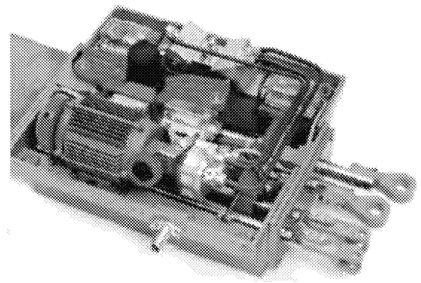
FieldTrac L910H is controlled by commands through the interlocking equipment. The points are moved via throw bars which are connected to the point machine. The points are continuously monitored.

> FieldTrac L910H

After the end position has been reached, the machine locks the closed blade and secures the open blade.

The throwing force and retaining force can be adjusted internally within certain limits to suit site requirements. In the event of a fault the machine can be operated by a hand crank

The driving motor, the hydraulics, the mechanical transmission parts with locking and retaining devices, the blade detects slides as well as the monitoring devices are all clearly positioned in a waterproof cast iron housing with steel cover and internal lock.



A total enclosed three-phase motor supplies the necessary force for the throwing of the points.

The closed hydraulic system consists of a reversible radial piston pump, two hydraulic cylinders, two adjustable pressure relief valves, two check valves and an oil container. The pressure relief valves, the check valves and the oil container from an integrated block.

Key Benefits

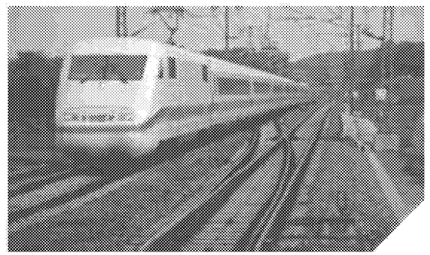
- Adjustable throwing force
- Adjustable retaining force
- Highly reliable
- Suitable for right-hand and left-hand layout without changes to the machine
- Virtually maintenance-free

Technical Features and Configuration

Power Supply	400 V AC, 3-phase, 50Hz 230 V AC, single phase, 50Hz
Power Input	approx. 700 W
Rotation Speed	Approx 1400 rpm
Fluid Power Medium	Hydraulic oil, according to climate
Movement of Drive Rod	160mm
Actuating Time	less than 6s
Actuating Force	max 6,000N
Retaining Force	max 9,300N

Environmental Characteristics

Storage Temperature	-40°C to +60°C
Operating Temperature	-40°C to +60°C



www.thalesgroup.com/security-services

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-10 LED Signal

ISSUED FOR PROPOSAL
10/09/2012

Description

Houses 1, 2, 3 or 4 high-reliability LED modules.

Powder coated, marine grade aluminium housing exploits the full benefits of LED signal elements.

Rear access through a single hinged door is not hindered by aspect separators required for incandescent signals. Abundant room for cable termination, internal wiring and replacement or maintaining of modules.

Two series:
- Standard—suitable for most applications
- 92G—optimised for use with VHLC, EC-4, EC-5, Electrologix, MicroLok II, GenraKode and VPI

Reliability

Doesn't rely on a single light source for safety-critical signalling applications: multiple LEDs in the signal elements are arranged as an interconnected matrix.

Not only are LEDs over 1000 times more reliable than incandescent lamps, but the light output will never reduce by more than 5% if one fails.

Invensys Rail confidently provides a 5-year warranty.

Lenses

An individual built-in lens for each LED improves beam deflection and provides greater light concentration.

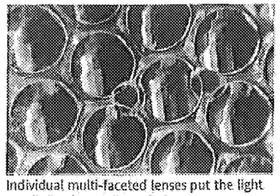
Lens options are:
- medium spread
- intermediate
- long range

Construction

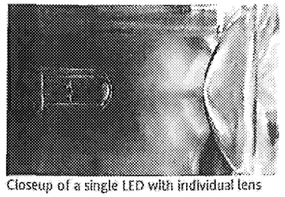
High strength polycarbonate LED element enclosure provides:
- clarity and superior optical properties
- resistance to heat distortion
- resistance to impact
- UV stability
- sealing to IP65 rating

Lamp Proving Load Options

Please discuss your requirements with us.



Individual multi-faceted lenses put the light precisely where it's needed



Closeup of a single LED with individual lens

Specifications

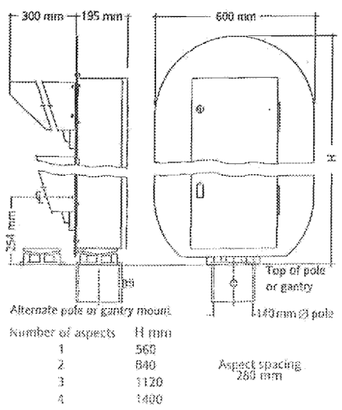
			12 Vac or Vdc	110 Vac
Supply voltage range			6.0–16 Vac 8.2–20 Vdc	85–135 Vac
Nominal power—Standard series at 12 Vac, 12 Vdc, or 110 Vac		Medium	Intermediate	Long
	Red	7.0 W	7.0 W	7.0 W
	Yellow	11.0 W	7.8 W	7.8 W
	Green	8.0 W	8.0 W	8.0 W
	White	8.0 W	8.0 W	8.0 W
	Blue	8.0 W	8.0 W	8.0 W
Nominal current—92G series	Red		1.6 A	Consult Invensys Rail
	Yellow		1.6 A	
	Green		1.4 A	
Guaranteed off voltage (signal will always be totally dark below this voltage)			5.3 Vac 7.3 Vdc	45 Vac (59 Vac for -70)
Total harmonic distortion (ac only)	< 20% over full Vac range			
Power factor (ac only)	> 0.9 over full Vac range			
Surge protection	Applied for 80 ms		45 Vrms	360 Vrms
Electrical noise	AAR part 11.5.1 Class A FCC title 47 B section 15			
Operating temperature	-40°C to +74°C			
Resistance to dust and moisture	IP65			
Resistance to vibration	AAR Section 11 Class B			
Weight of head (approx)	1 aspect 14 kg, 3 aspect 25 kg			
Module diameter **Illuminated aspect diameter**	200 mm (nominal) 180 mm (nominal)			
Colour				
Wavelength and chromaticity	Red	630 nm, x=0.704, y=0.295		
	Yellow	592 nm, x=0.592, y=0.406		
	Green	508 nm, x=0.089, y=0.475		
(white & blue to special order)	White	x=0.310, y=0.320		
	Blue	x=0.130, y=0.075		
Typical sighting distances				
Medium spread (suburban and low speed country use)		600 m against bright skyline		
Intermediate (country use)		1.5 km against bright skyline		
Long (country use with long sighting distances)		2.5 km against bright skyline		

See also:
- Datasheet 1A-8—LED retrofit kits for colour light signals
- Datasheet 9A-3—flashing light LED signals and retrofit kits
- Datasheet 1A-11—140 mm subsidiary LED signal applications

Ordering

Please provide:
- number and colours of aspects
- lens type
- supply voltage
- module options
- top-of-post or gantry mounting
- housing back colour

See our Product List or call our sales staff.



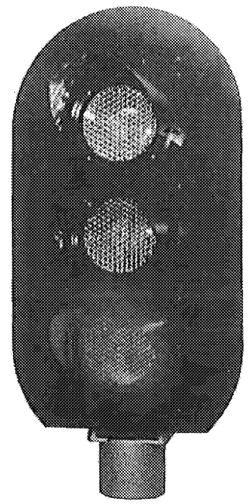
Number of aspects	H mm
1	560
2	840
3	1120
4	1400

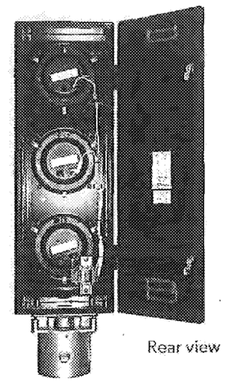
179–185 Normanby Rd (Locked Bag 66), South Melbourne, Victoria 3205, Australia
T +61 1300 724 518 F +61 3 9233 8777 ABN 78 000 102 483
E enquiries.asiapacific@invensysrail.com W http://www.invensysrail.com

invensys
Rail

LED Style L Signal

LED Signal Technology at Incandescent Prices





Rear view

- Housings for 1, 2, 3 or 4 aspects
- Low whole-of-life cost
- Reliability far surpasses incandescent signals
- Integral mounting for PJ1 Single Arm junction route indicators
- Long service life
- Low power consumption
- Phantom-free design
- High strength, lightweight, polycarbonate LED Element enclosure, IP65 rated
- 200 mm diameter
- 5-year standard warranty

Exceptional Value

Benefit from the superior performance of premium LED signals for a price similar to incandescent signals.

Exceptional Reliability

Multiple LEDs and parallel circuitry combined with the exceptional reliability of LED technology leads to lower maintenance costs and fewer train delays than incandescent lamps—essential for today's rail industry.

Application

The Style L signal housing is designed for Invensys Rail LED signal modules. It allows the full benefit of LED technology without sacrificing the essential functional requirements of mounting, rigidity and adjustment.

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-11 Radio Cutsheet

ISSUED FOR PROPOSAL
10/09/2012

Thales Radio Data Sheet

Thales Part number: 300-3-01782

Key Features

- 802.11 FHSS radio interoperable with existing Alvarion BreezeNET.11PRO
- Operating temperature range from -40°C to 70°C
- AREMA rated shock, vibration and EMI/EMC requirements
- Integrated amplifier with configurable transmit power
- Integrated Security Gateway for highly secured communication
- High speed client roaming support to 200km/h
- Single radio variant for wayside and on board implementation
- Software upgradable to enable higher bandwidth and other additional features

Specifications

Interfaces
LAN: 8 10/100/1000-BaseTX Ethernet Interfaces –
- 4 trusted interfaces for applications requiring encryption and/or authentication
- 4 untrusted interfaces for general applications

RF: 4 N-Type Connectors
Console: RS-232, USB (diagnostics, configuration and data collection)
Indicators: PWR, STATUS, RSSI, WLAN, LAN

Regulatory Approvals
Safety CE Mark, UL, RoHS
RF: FCC Part 15, Industry Canada, ETSI for 2.4Ghz operation

Power
Max: 20W
Input: 9-14 VDC

Management Interface
SNMP v3, command line interface (CLI), firmware/configuration transfer

Environmental
EN-50121-4, EN-50121-3.2, AREMA Part 11.5.1, EN55022/55024, IEC61000-6-2/-4

Protocols
IEEE 802.11 FHSS (1999)
IEEE 802.11i
IEEE 802.3u (10/100/1000BaseTX)
IEEE 802.1q
IEEE 802.1D/p
IEEE 802.3x

Amplifier
- Configurable transmit gain from -10 to 30dBm output power in 1dB step, controlled by AGC.

Radio
- Software configurable to access points or client of 802.11 FHSS radio.
- Configurable hop sequence and channels for FHSS for different regions

FHSS radio
- Support tunnel and open air profile
- Support speed up to 200km/h under roaming conditions
- Nominal packet latency of 20ms
- Maximum packet loss of 10% during high speed roaming, 1e-2 without roaming.
- Maximum disconnection (no packet transmission) time of 100ms during high speed roaming.
- Support 400kbps throughput (in conditions above) with packet size from 20 bytes to 1000 bytes.

Router
- Up to 120 static route entries
- QoS support, prioritization, priority based VLAN, traffic shaping, broadcast storm control and rate limiting, flow control.
- SNTP, NTP support

Security Gateway
- Support the following authentication and encryption functions using IPSec and ISAKMP per RFC 2401:
  - Authentication: SHA-1-HMAC
  - Encryption: AES-128, 192 and 256
  - Key Management: IKE
  - Certificate Management: SCEP
- NTP support for IPSec tunnel synchronization
- Encryption rate 10 K packet/s

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-12 Radio Antenna

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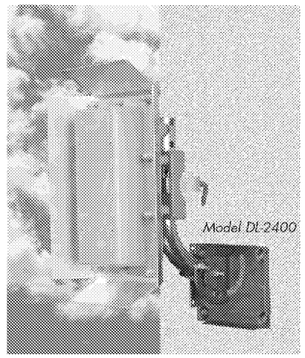
ANDREW®

PRODUCT SPECIFICATION



Microceptors shown on optional UM-1200 Microceptor Mount

Microceptor® Antennas

Flat Planar Array Models for 2.1–2.7 GHz and 2.4–2.5 GHz

Microceptor Antennas meet the need for an aesthetically pleasing antenna with a highly discriminative pattern

Designed to fill the need for a high performance antenna with a smaller, more attractive look, the Microceptor® meets the need for an aesthetically pleasing antenna with highly discriminative patterns.

The Microceptor is small, lightweight, unobtrusive, and concentrates the radiation away from the rear side of the antenna. This antenna offers an attractive solution for fixed subscriber and base station applications, as well as a high performance alternative to Yagi-style antennas. The Microceptor is an excellent choice for fixed data and telephony systems where user-specific content drives cellular and sectorized system architectures. Both cosmetic covers and premise mounts are available.

Features:

- Low profile antenna
- Superior directivity, cross-pol and side-lobe rejection with high front-to-back ratio
- Lightweight with quick mount bracket

Benefits:

- High customer acceptance
- Ensures customer satisfaction
- Minimizes installation time

One Company. A World of Solutions.

SPECIFICATIONS

Microceptor® Flat Planar Array Antennas

Electrical

Antenna Model Number	DL-2410/2412-x	DL-2122/2127/2400/2402-x	QD-2122/2127/2400/2402-x
Gain (dBi)	11 ±1 dB	13 ±1 dB	16 ±1 dB
Polarization isolation, dB	>25	>25	>30
Sidelobe suppression, dB	>17	>17	>17
-3 dB beamwidth, (° Vr:° Hz)	75:27	47:27	27:27
-10 dB beamwidth, (° Vr:° Hz)	138:48	89:46	47:47
Front/back ratio, dB	>25	>25	>30
Impedance, ohms	50	50	50
VSWR typical	1.5:1	1.5:1	1.5:1

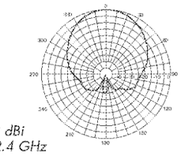
Mechanical

Antenna Model Number	DL-2410/2412-x	DL-2122/2127/2400/2402-x	QD-2122/2127/2400/2402-x
Output connector	"N" type female	"N" type female	"N" type female
Mounting, in (m)	1–2 (.025–.05) O.D. pipe	1–2 (.025–.05) O.D. pipe	1–2 (.025–.05) O.D. pipe
Vertical tilt	0–60° (optional)	0–60° (optional)	0–60° (optional)
Operational wind load	75 mph, 25 lb (11.34 kg)	75 mph, 25 lb (11.34 kg)	75 mph, 39.4 lb (17.87 kg)
Survivable wind load	140 mph, 49.4 lb (22.4 kg)	140 mph, 49.4 lb (22.4 kg)	140 mph, 77 lb (34.92 kg)
Radome	ABS	ABS	ABS
Reflector type	Planar array	Planar array	Planar array
Reflector material	Aluminum	Aluminum	Aluminum
Dimensions, in (m)	7.5 x 11 (.19 x .28)	7.5 x 11 (.19 x .28)	10.75 x 11 (.267 x .28)
Weight – Antenna, lb (kg)	1.4 (.64)	1.4 (.64)	2 (.91)
Weight – Mount, lb (kg)	1 (.45)	1 (.45)	1 (.45)

Ordering Information

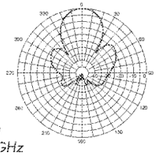
Frequency band, MHz	Gain, dBi	With tilt Type No.	Without tilt Type No.	Packaging
2100–2700	13	DL-2122	DL-2127	DL-xxxx-1 (1 per)
2100–2700	16	QD-2122	QD-2127	DL-xxxx-10 (10 per)
2400–2500	11	DL-2412	DL-2410	
2400–2500	13	DL-2402	DL-2400	QD-xxxx-1 (1 per)
2400–2500	16	QD-2402	QD-2400	QD-xxxx-10 (10 per)

Azimuth Patterns



DL-2400
Gain = 13.22 dBi
Frequency = 2.4 GHz
10 dB BW = 94.5 Degrees
3 dB BW = 47.2 Degrees

DL-2410
Gain = 11.24 dBi
Frequency = 2.4 GHz
10 dB BW = 138.2 Degrees
3 dB BW = 76.1 Degrees



QD-2400
Gain = 15.41 dBi
Frequency = 2.5 GHz
10 dB BW = 47.3 Degrees
3 dB BW = 26.4 Degrees

ANDREW®

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Internet: www.andrew.com

Bulletin PA100225-EN (12/04)

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

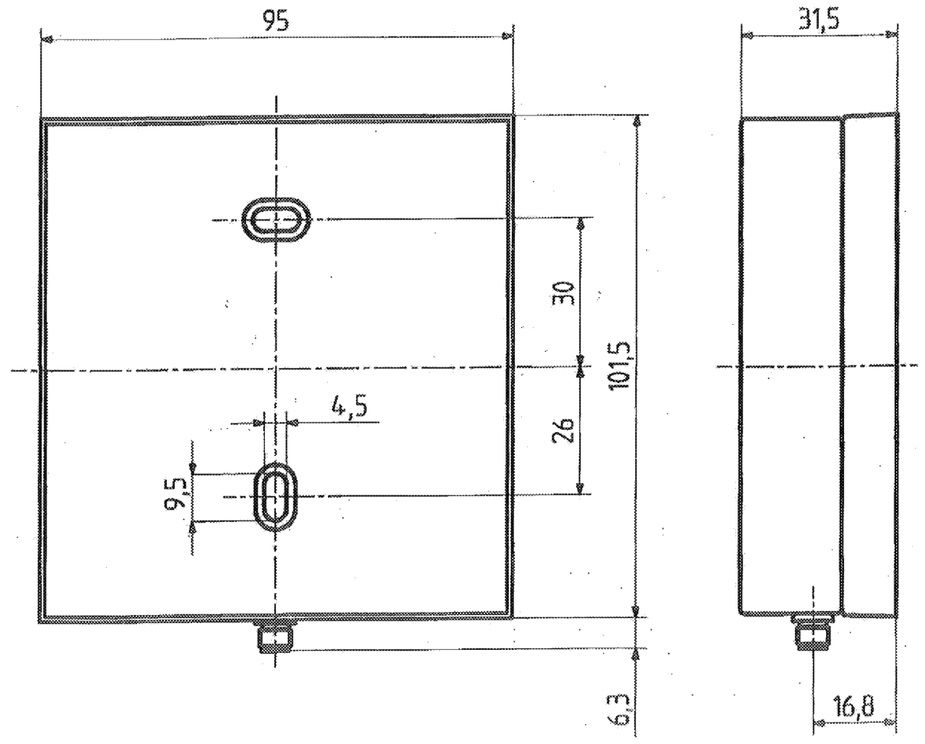
5.4.1.C-13 Planar Antenna

ISSUED FOR PROPOSAL
10/09/2012

HUBER+SUHNER®
PLANAR ANTENNA
FOR WIRELESS COMMUNICATION

SPA 2400/75/9/0/V

Dimensions (mm)



HUBER+SUHNER – Excellence in Connectivity Solutions

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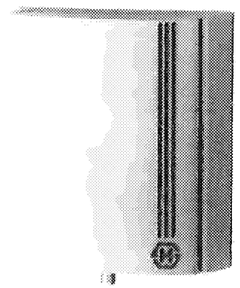
Last amended: 4417/07.2006

HUBER+SUHNER®
PLANAR ANTENNA
FOR WIRELESS COMMUNICATION

SPA 2400/75/9/0/V



Technical Data

Electrical Properties	
Frequency range	2300 - 2500 MHz
Impedance	50 Ω
VSWR	1.5
Polarization	linear, vertical
Gain	8.5 dBi
3 dB beamwidth horizontal	75°
3 dB beamwidth vertical	60°
Downtilt	0°
Front to back ratio	20 dB
Max. power	75 W (CW) at 25°C

Mechanical & Environmental Properties	
Dimensions	101 x 95 x 32 mm (3.98" x 3.74" x 1.26")
Weight	0.11 kg (0.24 lbs.)
Radome material	ASA
Radome colour	RAL 7035 (light grey)
Mounting socket material	ASA
Mounting socket colour	RAL 7042 (dark grey)
Back/base plane material	aluminium
2002/95/EC (RoHS)	compliant
Operating temperature range	- 40°C to + 80°C
Storage temperature range	- 40°C to + 80°C
Windload	15 N at 160km/h (100mph)

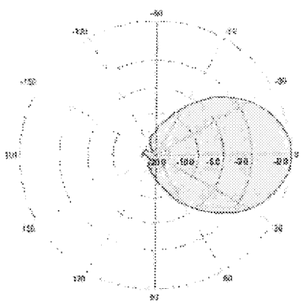
Available Types	Article no.	
1324.17.0006	22652578	N female pigtail (RG 58 C/U, 0.6m)
1324.17.0007	22652579	N female pigtail (RG 58 C/U, 1.83m)
1324.19.0002	22649580	SMA female
1324.26.0001	22651187	TNC female
1324.35.0001	84011333	QMA female

Wall mounting material included.

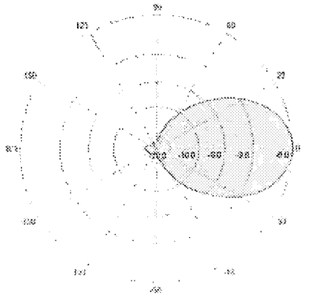
Mounting Hardware	Article no.	
9091.99.0029	22649576	mast mounting accessory
9091.99.0080	22652651	mast mounting and sidefill accessory

Documents	
01.02.0777	security instruction
01.02.1509	mounting instruction

Radiation Pattern



horizontal



vertical

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-14 Speed Sensor

ISSUED FOR PROPOSAL
10/09/2012

300-3-01768

Imag Speed Sensor

Type ISHW420DB-00201

TECHNICAL DESCRIPTION

Rowe Hankins Imag Speed Sensors are available for use in a wide range of applications. The information in this document is for the ISHW420DB-00201 sensor which is a 'True Zero Speed' Dual Channel Speed Sensor using Hall Effect technology.

The Imag dual channel sensor is designed to be a line replaceable unit packaged for easy mounting. The sensor electronics are totally encapsulated in a stainless steel shell and detects the changing magnetic field produced when a toothed wheel target is rotated past its sensing face. The sensor unit utilizes 2 Hall-Effect devices arranged so that the current pulse outputs are phase displaced from each other allowing for speed & direction sensing.

DESIGN STANDARDS

EN 50155 – Railway Applications. Electronic equipment used on rolling stock

EN 50121 -3 -2 – Railway Applications. Electromagnetic compatibility (Pt.3-2 Rolling stock – apparatus)

EN 61373:1999 Category 3 – Axle mounted equipment. Shock and Vibration

TECHNICAL PROPERTIES

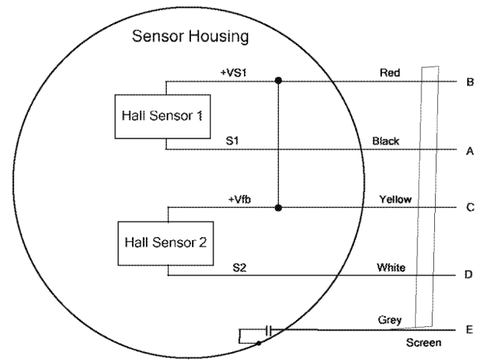
General:	
Target speed range.	0 to 5700 rpm (using 52 tooth target).
Number of output channels	2
Air gap (between sensor and target):	2.0 ±0.5mm
Ambient temperature range:	-40°C to 70°C
Storage temperature range	-55°C to 85°C
Relative humidity:	0 - 100% condensing
Service life:	30 years
Protection class (IEN 60529):	IP66
Shock and Vibration:	EN 61373 category 3 – Axle mounted equipment
Cable Type:	4 core screened cable, low smoke zero halogen. TD-004799 (Rockbestos Surprenant)
Cable length:	665 mm
Connector type:	MIL-C 5015 Locking bayonet – 10 way ABCIRH01T1819PCNF80M32V0
Housing material:	Stainless steel, 303 grade.
Weight:	Estimated: 350g
Outline Drawing	A34812. See Fig.3
Minimum bend radius (cable/conduit)	Cable: Static = 51mm, Dynamic = 90mm Conduit: Static = 35mm, Dynamic = 80mm

Imag Speed Sensor

Type ISHW420DB-00201

Identification / Labelling

The sensor is engraved with a part number specifically allocated for individual customers in accordance with project requirements. Typically the engraving includes; Rowe Hankins Ltd. Part Number, serial number & date code.

Electrical Properties:	
Power supply Vs:	Nominal 12VDC Voltage operating range: 9V to 16V. Note: The +V supply is common to both channels. Independent supply option available.
Current consumption:	≤ 16mA per channel
Output current low	4 to 8mA (Vs = 9 to16V, RL = 294R)
Output current high	12 to 16mA (Vs = 9 to16V, RL = 294R)
Reverse Supply Protection	Yes, up to 20V
Insulation resistance and test:	Insulation resistance > 100MOhm; measured at 500 VDC. Flash test at 2000Vrms, 50Hz a.c. for 1minute.
Number of Signal outputs:	2
Output waveform:	Square wave
Frequency response	0 to 5 kHz (true zero)
Duty cycle *	50% ±15
Phase shift: Channel 1 to Channel 2	90° ±25° Figure 1 & Figure 2
Safety overlap	=> 9°
Electromagnetic compatibility (EMC):	To EN 50121-3-2
Screening details:	Cable screen is internally connected to the sensor housing via a capacitor.
Output interface circuit diagram: Note for this sensor type the +V supply for each Hall sensor is internally connected together.	

* NOTE: Parameters have been based on target wheel with 52 teeth, 183.64mm OD, 15mm thick and ~5.5mm square tooth/valley

Imag Speed Sensor

Type ISHW420DB-00201

Rotation reference

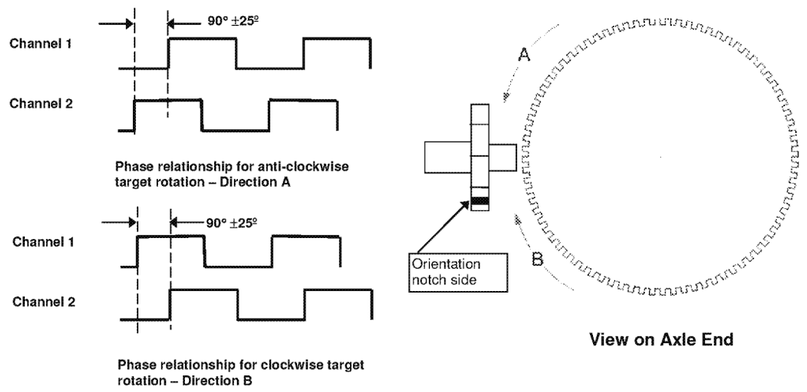


Figure 1

Safety Overlap

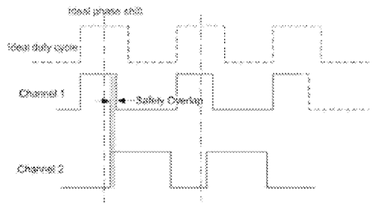


Figure 2

In addition to meeting the minimum/ maximum duty cycle and phase shift requirements, the sensor outputs will also ensure that a safety overlap of =>9˚ is maintained. (Figure 2 illustrates the safety overlap using exaggerated waveforms.)

Imag Speed Sensor

Type ISHW420DB-00201

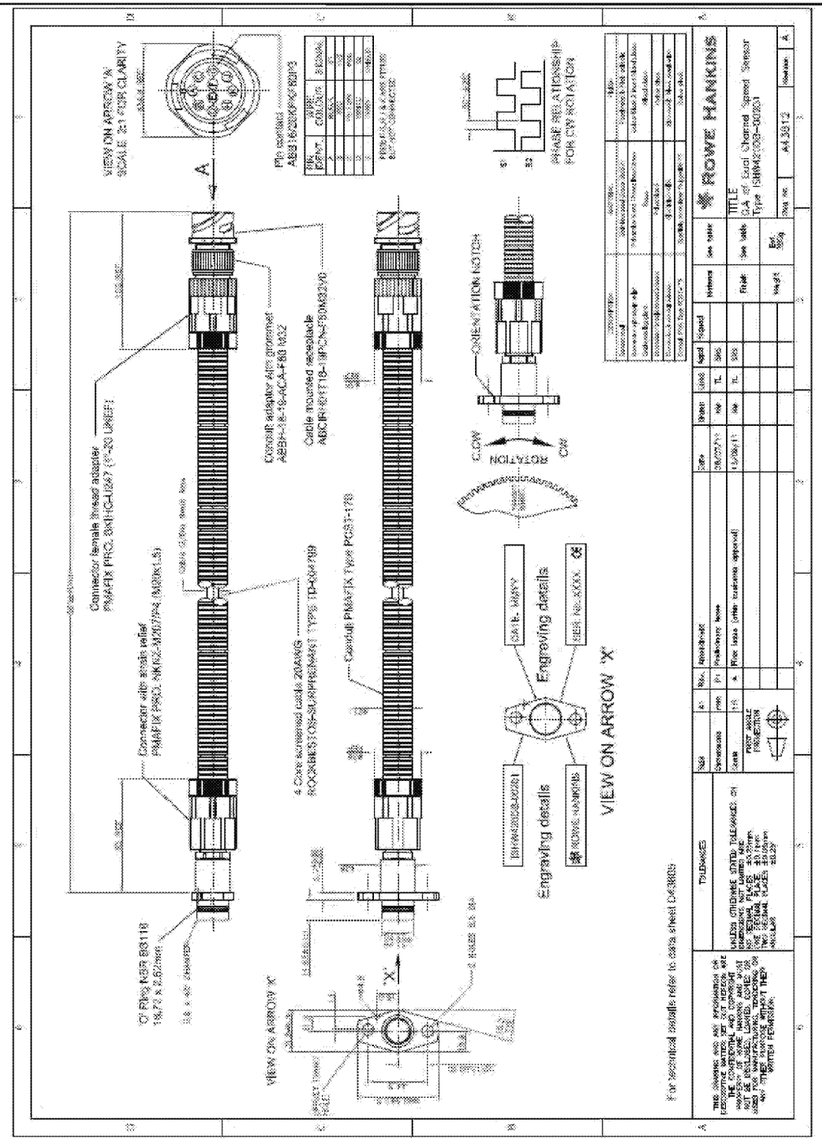


Figure 3 – Outline drawing. (Dimensions in mm)

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-15 Not Used

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

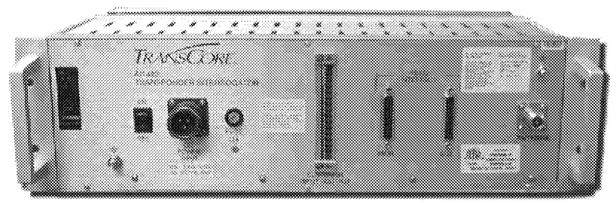
5.4.1.C-16 Half-Frame Reader

ISSUED FOR PROPOSAL
10/09/2012

AI1422 Half-Frame Reader

Features

- Ideal for modular systems requiring components with high tolerance to harsh shock and vibration environments.
- Provides customer input/output interface for monitoring reader status such as lock signal, power, radio frequency power, and three intermediate frequency monitor lines. Trigger input can be used to control activation of RF power.
- Compatible with half-frame, read-only tags in the 915-MHz frequency band.
- Studs on front panel can be used to ground other equipment to train body



The AI1422 Half-Frame Reader is an integrated tag interrogator consisting of a radio frequency (RF) module, tag decoder, and power supply.

The AI1422 Half-Frame Reader is designed specifically for use in mobile environments where a reader is rack-mounted inside a train's electronics cabinet and tags are mounted at fixed positions on the railbed or guideway sleepers. In this type of application, the AI1422 Half-Frame Reader sends tag data, containing position and location information, to a host computer mounted on the train.

The 1422 Half-Frame Reader generates an RF signal that a TransCore RF identification tag modulates and reflects. The AI1422 Half-Frame Reader then decodes and validates the tag data carried by the reflected signal. The AI1422 Half-Frame Reader transmits the data to a local host computer for processing.

The AI1422 Half-Frame Reader is compatible with TransCore's AA3233 Subway Antenna and AA3234 Light Rail Antenna and the following tags: AT5112, AT5114, AT5115, AT5117, and AT5119.

The AI1422 Half-Frame Reader provides two RS–232C interfaces. The main interface supports host communications in real-time mode for passing tag data to the host computer. The second port monitors communications functions.

The AI1422 Half-Frame Reader has two ground studs on the front panel that provide a path to the train body ground for test equipment or other rack modules.

transcore.com

TRANSCORE

product profile

AI1422 Half-Frame Reader

COMMUNICATIONS

Available Frequency Range
902—928 MHz

Approved Frequency Range[1]
902.25—903.75 and 910.00—921.50 MHz

1. Federal Communications Commission (FCC) and Industry Canada (IC)

Transmitter Frequency Accuracy
± 25 ppm at ambient temperature

Transmitter Frequency Stability
± 5.0 ppm over operating temperature range

HARDWARE FEATURES

Connector
N type socket

Communications Ports
1 Main RS–232C
1 Auxiliary RS–232C
110 to 19,200 baud

SOFTWARE FEATURES

Communication Buffer Capacity
32 Kbytes

INPUT POWER SUPPLY OPTIONS

Input Voltage
8V–35V DC, 14V–70V DC, and 28V–140V DC power supplies are available

Power Consumption
25 W (45 W maximum)

RF Power
0.8W ±0.1W

PHYSICAL

Dimensions
Size: 19.0 x 5.25 x 9.0 in. (48.3 x 13.3 x 22.9 cm)
Weight: 12 lb (5.4 kg)

Mounting Location
Rack-mounted inside a train's electronics cabinet rack or other suitable enclosure.

ENVIRONMENTAL

Operating Temperature
+32°F to +158°F (0°C to +70°C)

Storage Temperature
-40°F to +158°F (-40°C to +70°C)

Humidity
95% noncondensing

Vibration Tolerance
The AI1422 reader complies with vibration tolerance limits specified in AREMA C&S Manual, Part 11.5.1, Class J.

Shock Tolerance
The AI1422 reader complies with shock tolerance limits specified in AREMA C&S Manual, Part 11.5.1, Class J.

LICENSING

Equipment License
The user is required to obtain a Part 90 site license from the FCC to operate the unit in the United States. Access the FCC Web site at www.wireless.fcc.gov/uls for more information.

FCC ID: FIHAI142205618
Users in all countries should check with the appropriate local authorities for licensing requirements.

COMPLIANCE

RF Interference
Units have been tested and are verified to Part 15 of the FCC rules for a Class A digital device.

STANDARDS

The AI1422 Half-Frame Reader meets the limits established by RSS-210, Low Power Licence-Exempt Radio-communication Devices, of the IC standards.

DOCUMENTATION

AI1422 Half-Frame Reader User Guide

For more information:

Call **214.461.6443** (Sales Support) • **505.856.8007** (Technical Support)

411008-009 - 01/12

TRANSCORE
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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-17 Light Rail Antenna

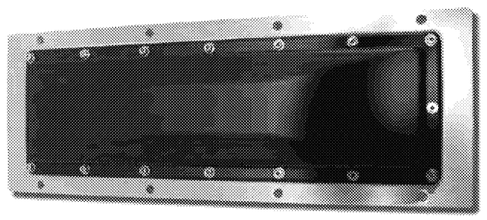
ISSUED FOR PROPOSAL
10/09/2012

product profile

AA3234 Light Rail Antenna

Features

- Constructed for high shock and vibration environments
- Rugged weatherproof enclosure
- Dimensions compatible with mounting underneath trains



The AA3234 Light Rail Antenna is designed specifically for light rail applications requiring a low profile, such as the undercarriage of commuter trains and people mover systems.

The AA3234 is designed to be mounted on a moving vehicle within 60 cm (2 ft) of the railway trackbed-mounted Amtech®-brand tags. This combination provides tag-antenna position information to an on-board vehicle computer system for a variety of applications.

The antenna can withstand up to 0.1 m (0.5 in) of ice over the case without damaging the contents. The rugged construction can withstand even the harsh cleaning chemicals used on the rail cars.

TRANSCORE

product profile

AA3234 Light Rail Antenna

COMMUNICATIONS

Frequency Range
902 to 928 MHz

Antenna Gain (Peak)
9.5 dBi

Polarization
Linear-Horizontal

VSWR
< 2.0:1

Impedance (Nominal)
50 ohms

3 DB Beam Width
30° in E-plane and 80° in H-plane

HARDWARE FEATURES

Connector
Type N male connector

PHYSICAL

Dimensions
Size: 22.0 x 8.0 x 2.0 in. (56.0 x 20.0 x 5.0 cm)

Weight: 7.7 lb (3.5 kg)

Mounting Location
Underside of locomotive with 3/8 in. bolts

ENVIRONMENTAL

Operating Air Temperature
-40°F to +167°F (-40°C to +75°C)

Humidity
100% condensing

Vibration Tolerance
0.2 Grms, 10 to 100 Hz

Shock Tolerance
2 G_{peak}, duration 4 to 10 ms

For more information:

Call **214.461.6443** (Sales Support) • **505.856.8007** (Technical Support)

411126-008 · 01/12

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.C TRAIN CONTROL CUT SHEETS

5.4.1.C-18 Transportation Tag

ISSUED FOR PROPOSAL
10/09/2012

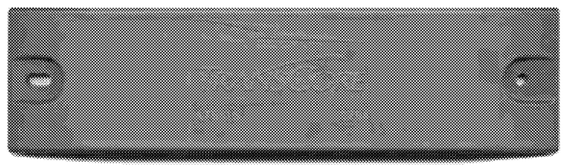
700-3-02271

product profile

AT5415 Hardened Transportation Tag

Features

- Supports American Trucking Associations (ATA) and Super eGo® (SeGo) protocols
- Non-battery for extended service life
- 2048-bit read/write memory
- Read/write capability in SeGo mode
- Compatible with multiple Amtech®-brand readers and TransCore® Encompass® multiprotocol readers
- Data encryption and authentication
- Harsh environment durability
- Factory-sealed case



The AT5415 Hardened Transportation Tag is a half frame, beam-powered tag used in 915 MHz radio frequency (RF) band applications with TransCore Amtech-brand and TransCore Encompass multiprotocol reader systems. It is packaged in a factory-sealed case, which makes this tag ideal for mounting on vehicle chassis, intermodal containers, or in any environment requiring a durable, weatherproof tag.

The AT5415 Hardened Transportation Tag is beam-powered (a small portion of the RF signal continually energizes the tag's circuitry) so no internal battery is required. In addition to giving the tag an unlimited service life, this feature limits the tag's range and reduces the possibility of cross-reads from nearby tags. System discretion is enhanced to within a 5- to 10- foot (1.5- to 3-meter) diameter reading area.

The tag can be factory-programmed, as specified by the customer, or the tag can be user-programmed in the field using the new AP4600 Multifunction Tag Programmer. The tag can store up to 10 six-bit alphanumeric characters of data (60 bits) compatible with previous ATA/AAR read-only readers

The tag's mutual authentication feature, in conjunction with TransCore Encompass readers, uses hardware-based protection that is more difficult to compromise than software-only protection. Mutual authentication prevents unwanted data from being written to the tag's protected memory space.

transcore.com

TRANSCORE

product profile

AT5415 Hardened Transportation Tag

COMMUNICATIONS

Frequency Range
902 to 928 MHz

Typical Working Range
5 to 10 ft (1.5 to 3 m)

Range depends on system parameters.

Polarization
Parallel with longer side

SOFTWARE FEATURES

Data Memory
ATA Mode: 60 bits

SeGo Mode: 2,048 bits

User memory programmable using RF link

POWER REQUIREMENTS

Power Source
Beam powered

LIFE EXPECTANCY

Service Life
Unlimited

PHYSICAL

Dimensions
Size: 9.3 x 2.38 x 0.69 in. (23.6 x 6.05 x 1.75 cm)

Weight: 5.3 oz (150.3 g)

Case Material
Weatherproof, sealed, UV-stabilized, gray case

Mounting Surface
Any smooth metal surface

Where mounting surface is non-metallic or irregular, the AT5415 Hardened Transportation Tag may be mounted to a metal backplate attached to the surface of the vehicle or object to be tagged.

Mounting Method
Rivet Mounting: The AT5415 Hardened Transportation Tag can be mounted directly to any smooth metal surface using blind rivets or TIR-approved fasteners.

ENVIRONMENTAL

Operating Temperature
-40°F to +185°F (-40°C to +85°C)

Storage Temperature
-67°F to +212°F (-55°C to +100°C)

Humidity
100% relative humidity, condensing

Vibration
20 G_{rms}, 20 to 2000 Hz

Shock, Normal Environment
200 G, half-sine pulse, 3 ms duration, 3 axes

AREMA Requirements
Meets AREMA 11.5.1, Class A (Trackbed) requirements

Ultraviolet (UV) Exposure
MIL-STD 810-D, Method 505.2: 10 years of Florida-level UV radiation

Dust Ingress/Water Immersion
Meets IP67 requirements for dust ingress and water immersion (≤1 meter of immersion)

COMPATIBILITY

ATA Mode: American Trucking Associations standard

Super eGo Mode: SeGo

ACCESSORIES

AP4600 Multifunction Tag Programmer
The AT5415 Hardened Transportation Tag can be programmed in the field using the AP4600 Multifunction Tag Programmer. The AP4600 programmer is designed for use in an office environment and connects to a host PC's USB port.

For more information:
Call **214.461.6443** (Sales Support) • **505.856.8007** (Technical Support)

600118 - 09/11

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D TRAIN CONTROL SKETCHES AND FIGURES

ISSUED FOR PROPOSAL
10/09/2012

Sketches

Figures

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-101 Zone 1 Track Map

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OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

Ottawa

TRAIN CONTROL
TRACK MAP

Contract No.	Dwg. No.

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Asset No.

Asset Group

Des.	Chk'd.
Dwn.	Chk'd.
Utility Circ. No.	Index No.

Const. Inspector

General Manager | Project Manager

REGISTERED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

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NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

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Dwg. No. 5.4.1.D-SK-101
3030-46SK-SW-5001-FP

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LEGEND

FACE OF BUMPER TICKBuFFX	GUIDEWAY END (GE)
DTC_X	DEPOT TRACK CIRCUIT
I	ELECTRICAL JOINT (EJX) -BOUNDARY OF TRACK CIRCUIT SECTION
ZC	ZONE CONTROLLER (ZC)
SW	SWITCH (SW)
	INTERLOCKING SIGNAL (RED/GREE/YELLOW) (SGP_X)
	TWO ASPECT SIGNAL (RED/GREEN) (SGP_X)
YCO	YARD CONTROL OPERATOR
MRR	MANUAL ROUTE RESERVATION

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-102 Zone 2 Track Map

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OTTAWA LIGHT RAIL TRANSIT PROJECT
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TRAIN CONTROL
TRACK MAP

Contract No.	Dwg. No.

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LEGEND

FACE OF BUMPER TICKBuFFX	GUIDEWAY END (GE)
DTC_X	DEPOT TRACK CIRCUIT
I	ELECTRICAL JOINT (EJX) -BOUNDARY OF TRACK CIRCUIT SECTION
ZC	ZONE CONTROLLER (ZC)
SW	SWITCH (SW)
	INTERLOCKING SIGNAL (RED/GREE/YELLOW) (SGP_X)
	TWO ASPECT SIGNAL (RED/GREEN) (SGP_X)
YCO	YARD CONTROL OPERATOR
MRR	MANUAL ROUTE RESERVATION

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-103 Zone 3 Track Map

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OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

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TRAIN CONTROL
TRACK MAP

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LEGEND

FACE OF BUMPER TICKBuFFX	GUIDEWAY END (GE)
DTC_X	DEPOT TRACK CIRCUIT
I	ELECTRICAL JOINT (EJX) -BOUNDARY OF TRACK CIRCUIT SECTION
ZC	ZONE CONTROLLER (ZC)
SW	SWITCH (SW)
	INTERLOCKING SIGNAL (RED/GREE/YELLOW) (SGP_X)
	TWO ASPECT SIGNAL (RED/GREEN) (SGP_X)
YCO	YARD CONTROL OPERATOR
MRR	MANUAL ROUTE RESERVATION

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-104 Zone 3 Track Map (contd.)

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OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

TRAIN CONTROL
TRACK MAP

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5.4.1.D-SK-104
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LEGEND

FACE OF BUMPER TCXBuFFx	GUIDEWAY END (GE)
DTC_x	DEPOT TRACK CIRCUIT
I	ELECTRICAL JOINT (EJX) -BOUNDARY OF TRACK CIRCUIT SECTION
ZC	ZONE CONTROLLER (ZC)
SW	SWITCH (SW)
	INTERLOCKING SIGNAL (RED/GREE/YELLOW) (SGP_X)
	TWO ASPECT SIGNAL (RED/GREEN) (SGP_X)
YCO	YARD CONTROL OPERATOR
MRR	MANUAL ROUTE RESERVATION

Consultant Drawing Number

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-105 Zone 4 Track Map

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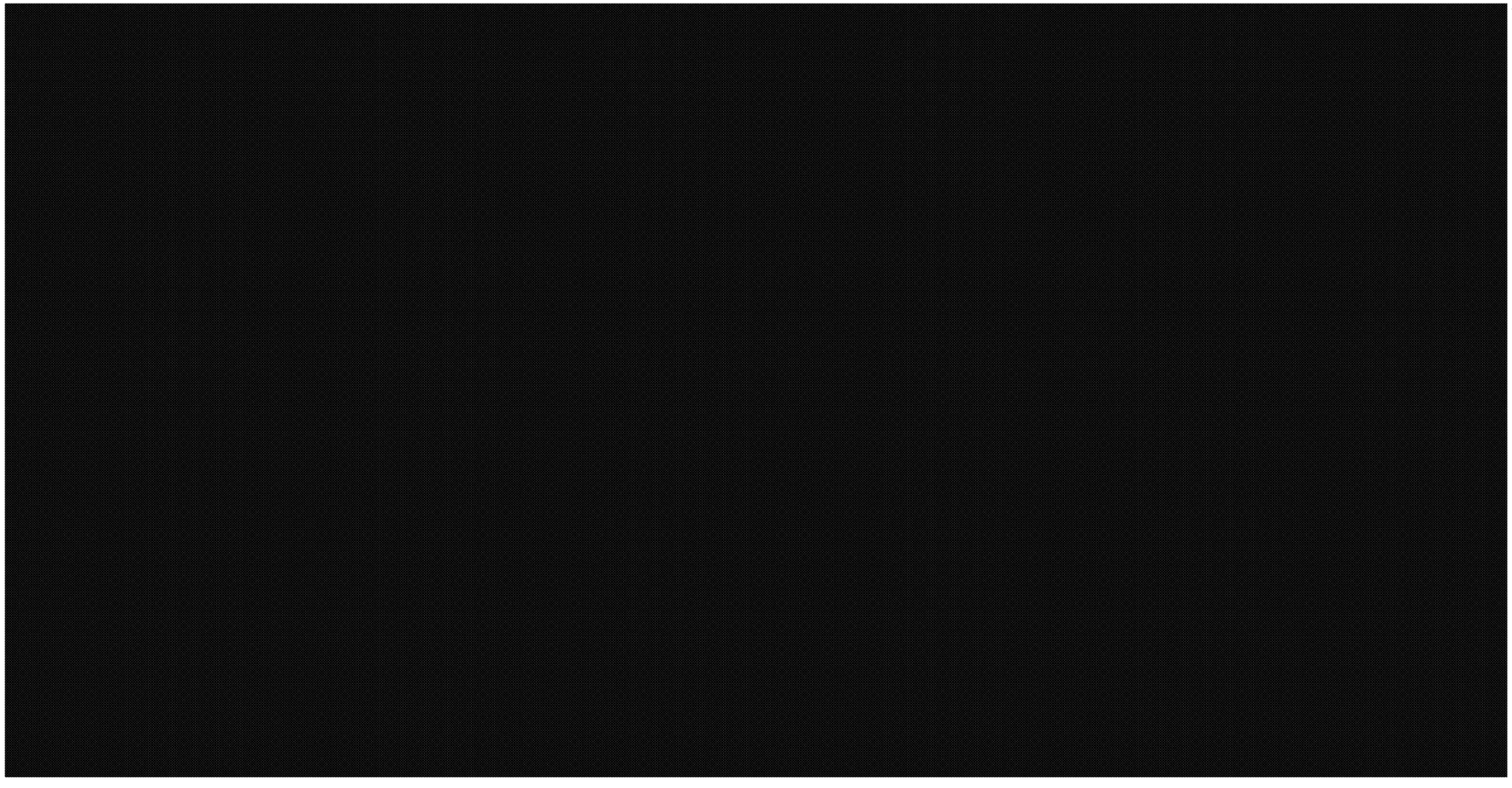
Consultant Drawing Number



OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

Ottawa

TRAIN CONTROL
TRACK MAP

General Manager	Project Manager

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LEGEND

FACE OF BUMPER TXXBuFFX	GUIDEWAY END (GE)
DTC_X	DEPOT TRACK CIRCUIT
I	ELECTRICAL JOINT (EJX) -BOUNDARY OF TRACK CIRCUIT SECTION
ZC	ZONE CONTROLLER (ZC)
SW	SWITCH (SW)
	INTERLOCKING SIGNAL (RED/GREE/YELLOW) (SGP_X)
	TWO ASPECT SIGNAL (RED/GREEN) (SGP_X)
YCO	YARD CONTROL OPERATOR
MRR	MANUAL ROUTE RESERVATION

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-106 Zone 4 Track Map (cont'd)

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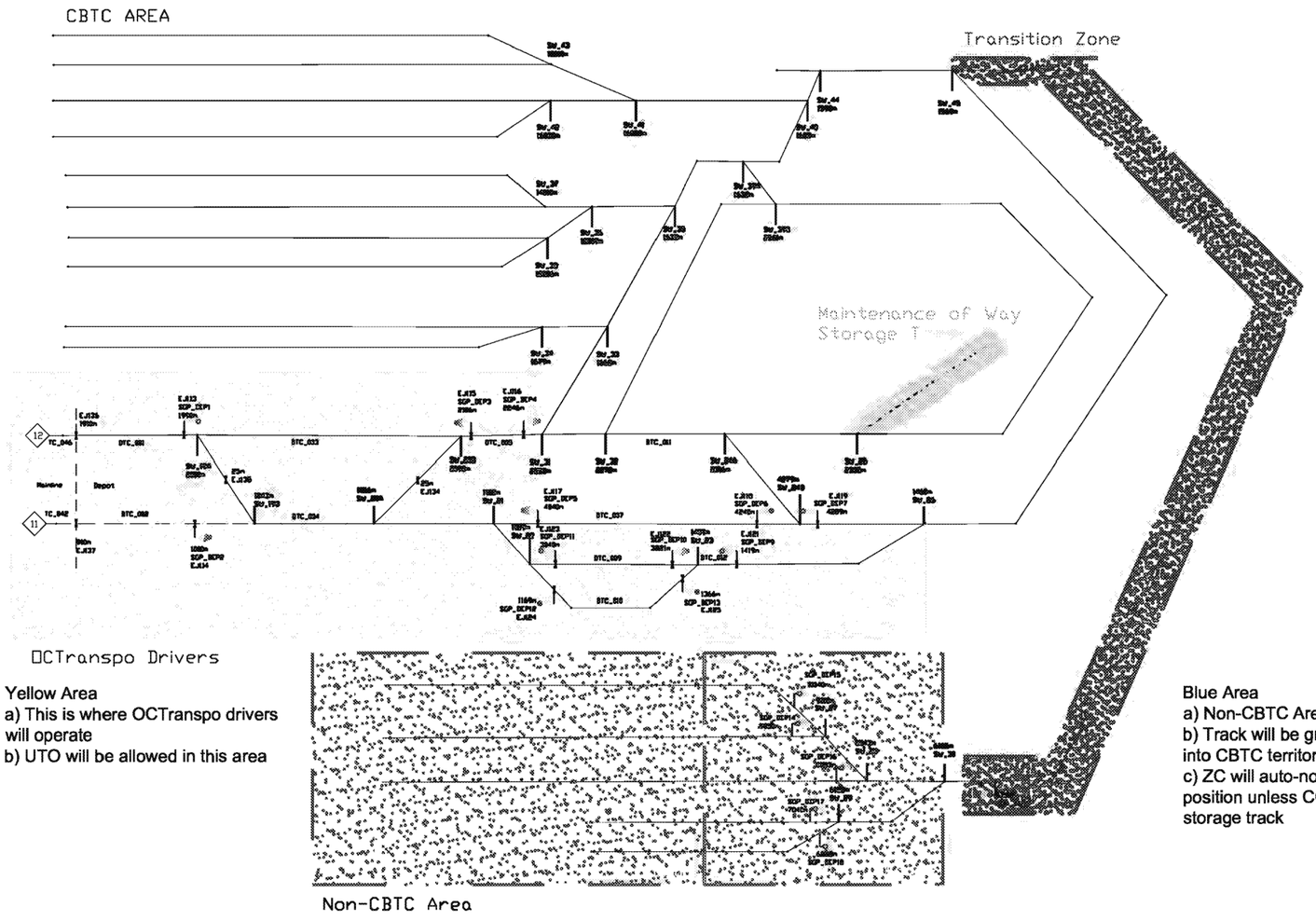
No Highlinghting
a) CBTC area- UTO operation

Red Area
a) Transition Zone (TZ)
b) Track will be graded to prevent trains from rolling into CBTC territory.
c) Zone Controller (ZC) will auto-normal SW_45 to the right-hand position unless YCO has authorized a move into or out of the TZ



OCTranspo Drivers

Yellow Area
a) This is where OCTranspo drivers will operate
b) UTO will be allowed in this area

Blue Area
a) Non-CBTC Area
b) Track will be graded to prevent trains from rolling into CBTC territory
c) ZC will auto-normal SW_25 to the right-hand position unless CO has set an MRR for the MOW storage track

LEGEND

DTC_x	DEPOT TRACK CIRCUIT
I	ELECTRICAL JOINT (EJX) -BOUNDARY OF TRACK CIRCUIT SECTION
ZC	ZONE CONTROLLER (ZC)
SW	SWITCH (SW)
	INTERLOCKING SIGNAL (RED/GREE/YELLOW) (SGP_X)
	TWO ASPECT SIGNAL (RED/GREEN) (SGP_X)
YCO	YARD CONTROL OPERATOR
MRR	MANUAL ROUTE RESERVATION

Pink Area
a) Non-CBTC Area - Manual operation by maintenance staff with 5km/h max speed
b) At SGP_DEP8 the driver will call the YCO via radio to request setting of one of the 5 routes into the maintenance shop
c) YCO will establish the manual route reservation to route the train into or out of the maintenance shop
d) YCO has access to CCTV coverage of entire yard, including this manual area

OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

TRAIN CONTROL
TRACK MAP

General Manager | Project Manager

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-201 MVB Sketches

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DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

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OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

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TRAIN CONTROL
TCMS_MVB SKETCHES

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3030-46SK-SW-5101-FP

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.1 TRAIN CONTROL SKETCHES

5.4.1.D-SK-202 Signalling System

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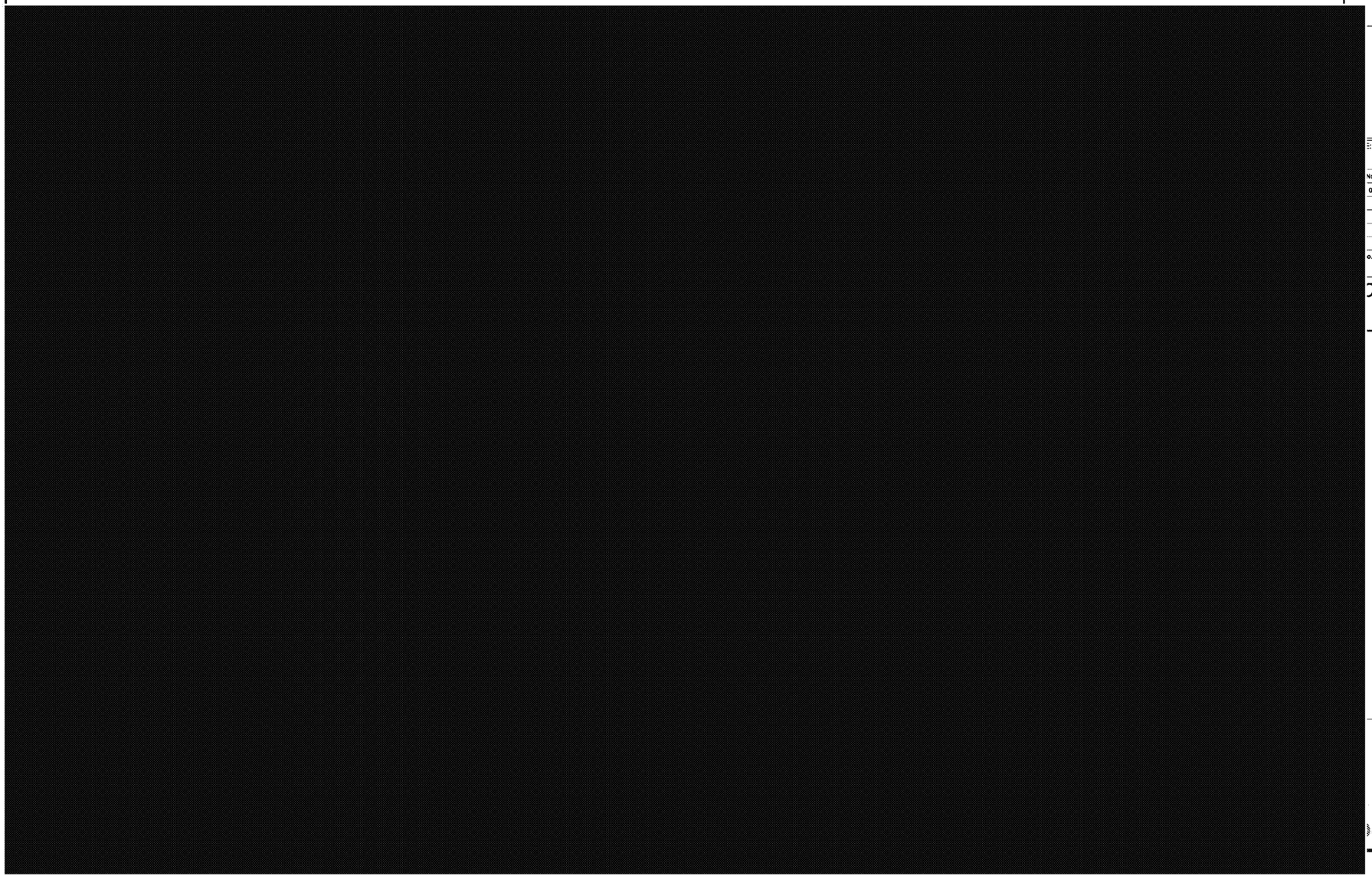
DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

Consultant Drawing Number

Ottawa LRT Signalling System Architecture



OTTAWA LIGHT RAIL TRANSIT PROJECT
TUNNEY'S PASTURE TO BLAIR RD

TRAIN CONTROL
SIGNALLING SYSTEM

General Manager | *Project Manager*

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3030-46SK-SW-5102-FP

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5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.2 TRAIN CONTROL FIGURES

5.4.1.D.2.1 LRT Systems and Vehicles Processes

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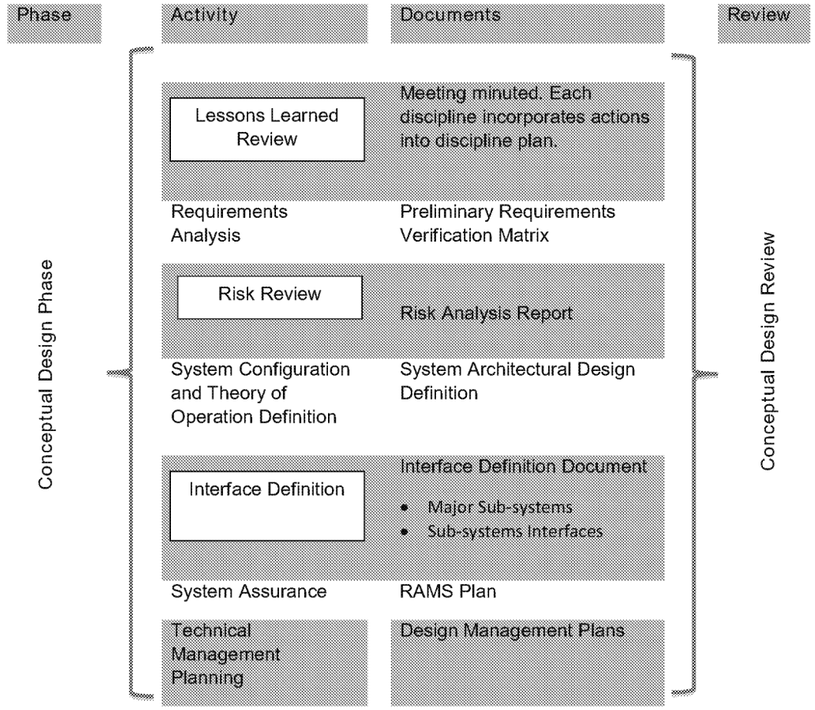
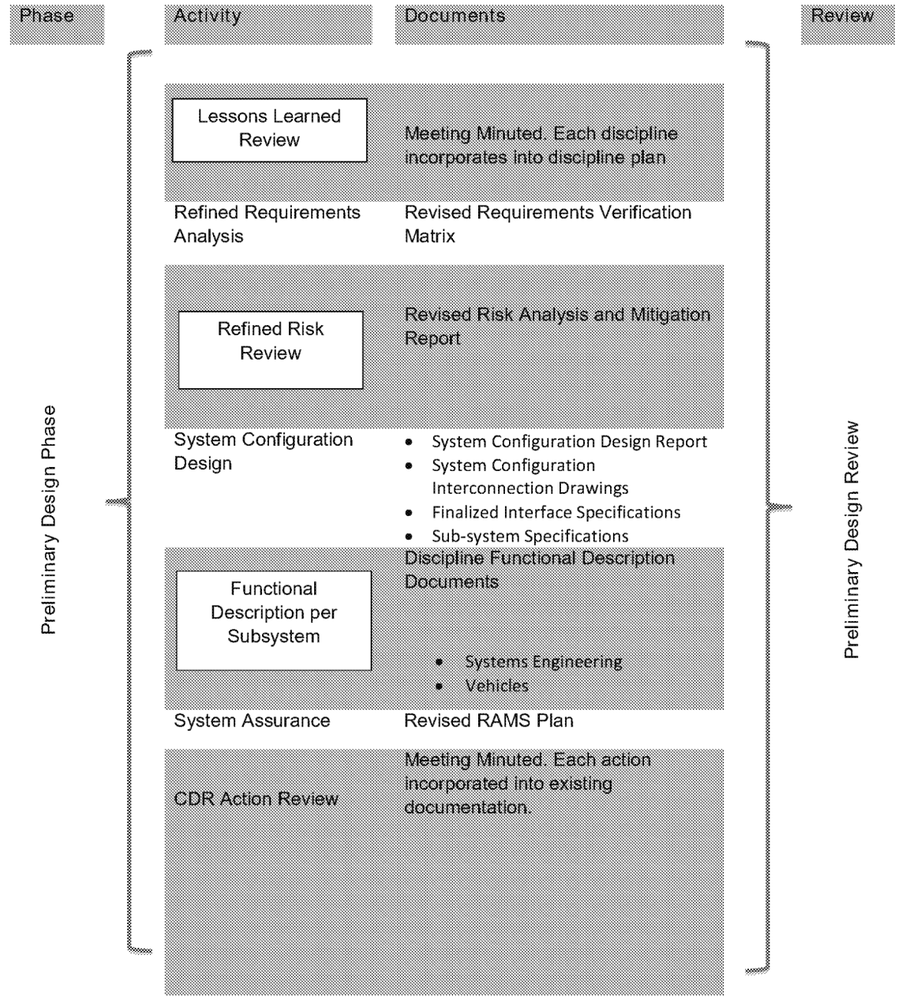
Figure 5.4.1.D2.1A - Design Methodology





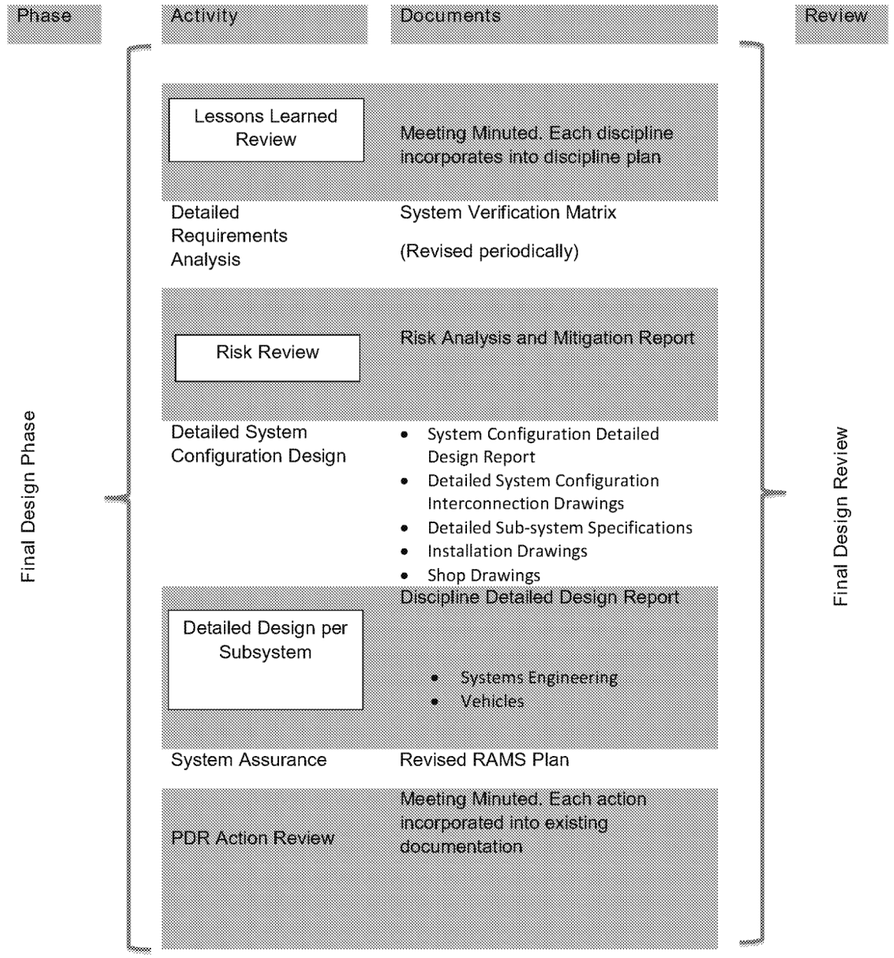


Figure 5.4.1.D2.1B - Interactions of the OLRT Project System Engineering Processes

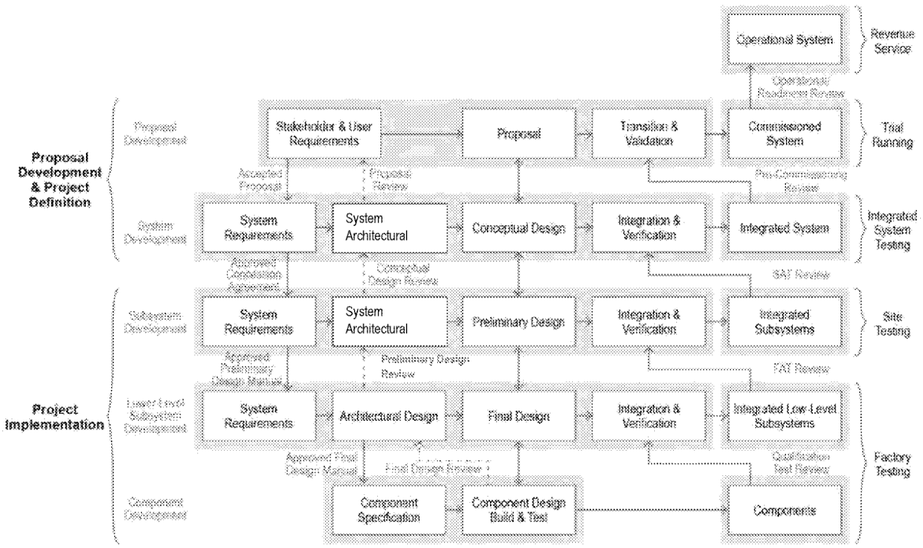


Figure 5.4.1.D.1C - System Validation and Verification

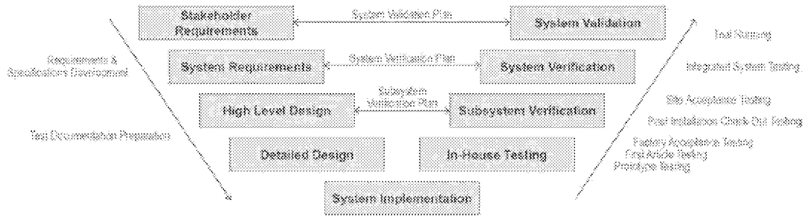


Figure 5.4.1.D.1D - Example Vehicle System Test and Commissioning Plan

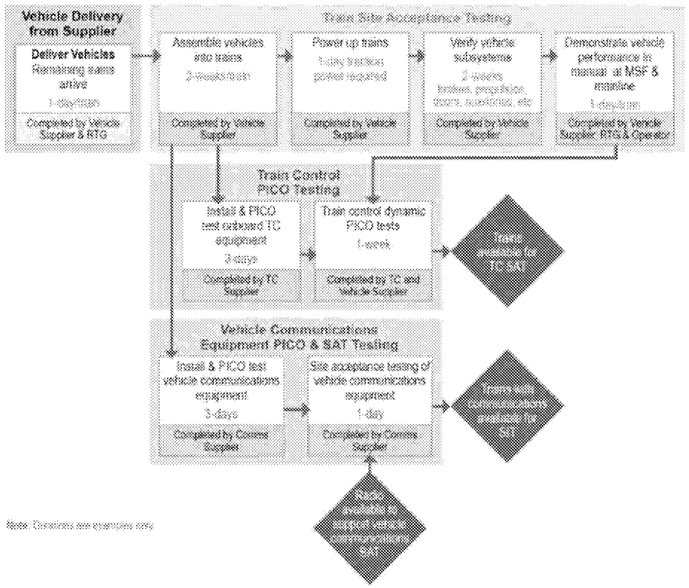
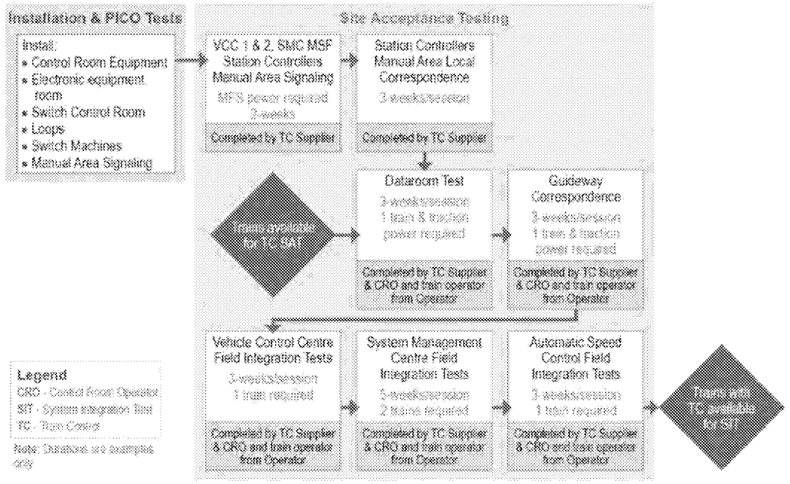


Figure 5.4.1.D.1E- Example Train Control System Test and Commissioning Plan



5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.2 TRAIN CONTROL FIGURES

5.4.1.D.2.2 Typical ATS Screens

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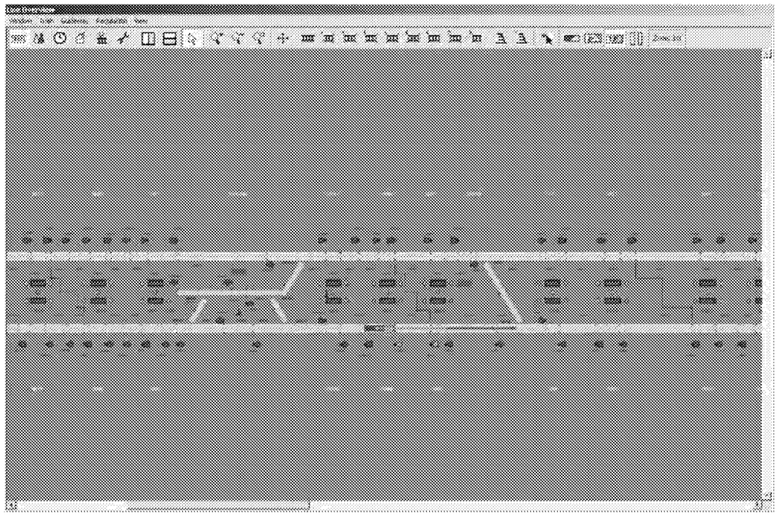
Figure 5.4.1.D2.2A - Typical Line Overview Screen



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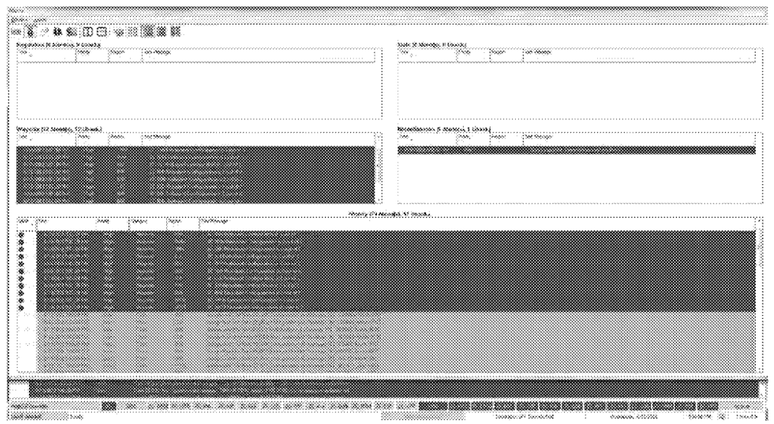
RFP No. OILC-11-00-P006

Figure 5.4.1.D2.2B - Typical Alarm Screen



THE PROPOSED OTTAWA LIGHT RAIL TRANSIT PROJECT: TUNNEY'S PASTURE TO BLAIR STATION

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.2 TRAIN CONTROL FIGURES

5.4.1.D.2.3 Software V Model Life Cycle

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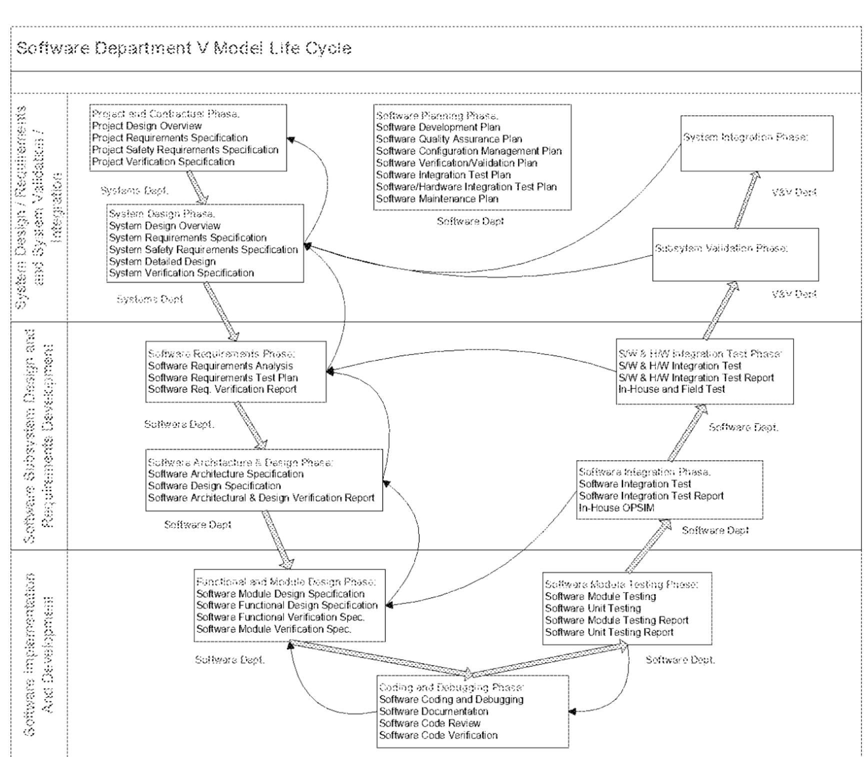
Figure 5.4.1.D2.3A - Software V Model Life Cycle



5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.2 TRAIN CONTROL FIGURES

5.4.1.D.2.4 DCS Design Overview

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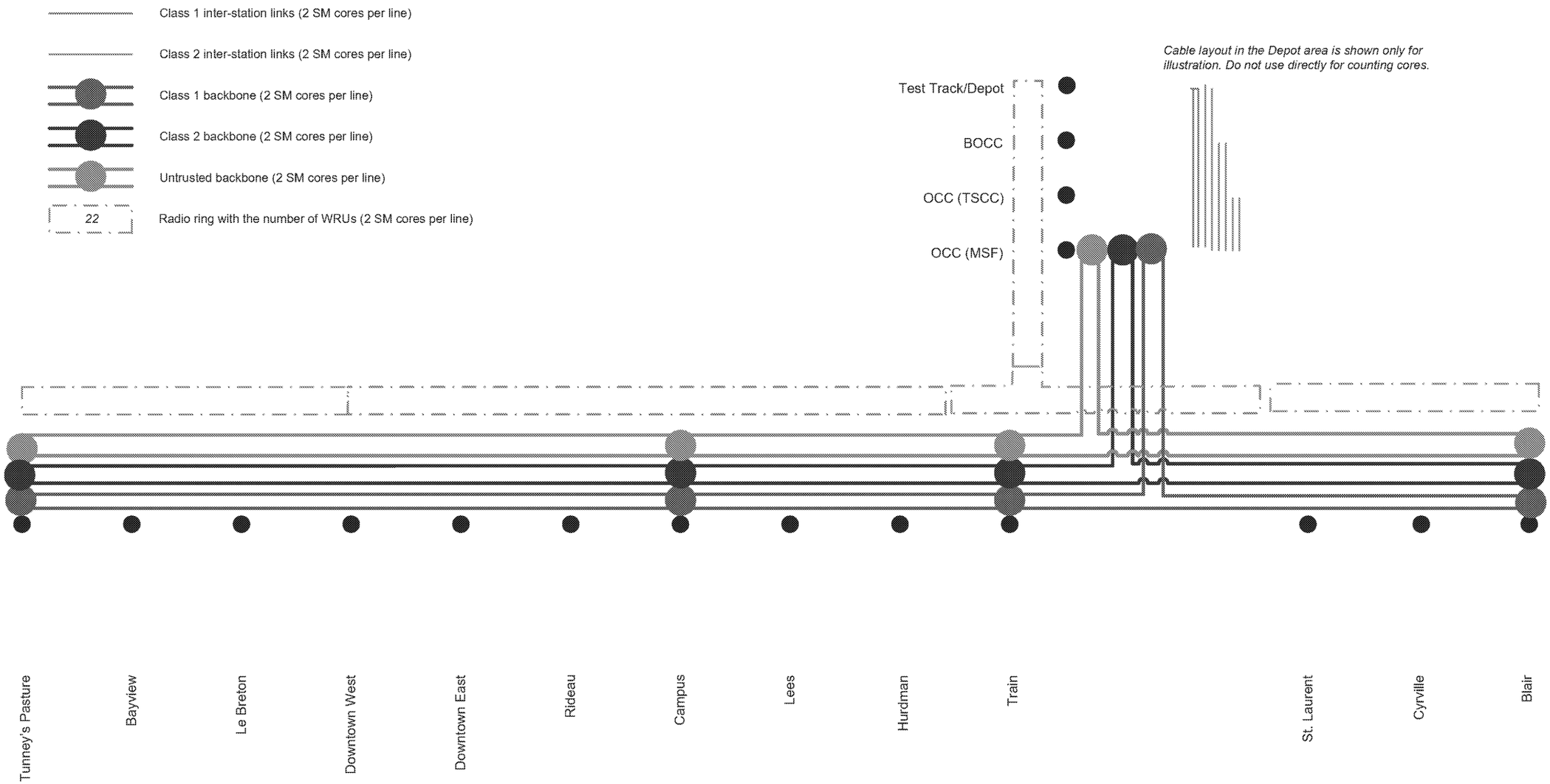
OTTAWA LRT DCS OVERVIEW



5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.2 TRAIN CONTROL FIGURES

5.4.1.D.2.5 DCS Design by Station

ISSUED FOR PROPOSAL
10/09/2012

Tunney's Pasture | Bayview | Le Breton | Downtown West | Downtown East | Rideau | Campus | Lees

[redacted]

Hurdman | Train | Maintenance and Storage Facility | Traffic Services Control | Backup Control Centre | Depot | St. Laurent | Cyrville

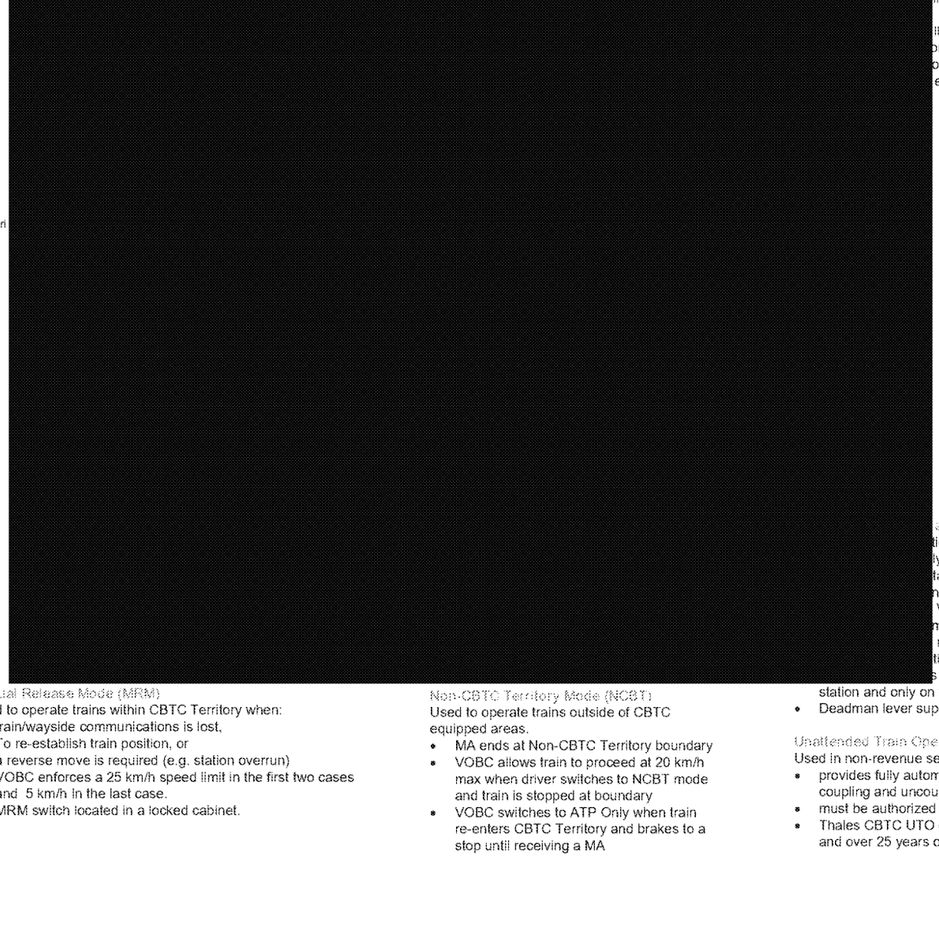
[redacted]

Blair

[redacted]

5.4.1 LRT SYSTEMS, VEHICLE AND POWER AND OPERATIONS
5.4.1.D.2 TRAIN CONTROL FIGURES

5.4.1.D.2.6 Train Mode Transition Diagram



ATP Only Mode
Driver operates train in accordance with TO indications.
ATP function of VOBC:
- controls train speed to penalty brake speed profile in accordance with the Movement Authority
- enforces that driver can open doors only when train stopped at station and only on the platform side

Coupling Mode
Used for driver controlled coupling. ATP function enforces:
- reduced speed for close-up and prevents movement through signal at stop
- newly created train(s) properly registered with CBTC before accepting a Movement Authority

Notes:
State transition details to be reviewed and agreed at Conceptual Design Review.
MA – Movement Authority
TOD – Train Operator's Display
YCO - Yard Control Operator

Manual Release Mode (MRM)
Used to operate trains within CBTC Territory when:
- train/wayside communications is lost,
- To re-establish train position, or
- a reverse move is required (e.g. station overrun)
- VOBC enforces a 25 km/h speed limit in the first two cases and 5 km/h in the last case.
- MRM switch located in a locked cabinet.

Non-CBTC Territory Mode (NCBT)
Used to operate trains outside of CBTC equipped areas.
- MA ends at Non-CBTC Territory boundary
- VOBC allows train to proceed at 20 km/h max when driver switches to NCBT mode and train is stopped at boundary
- VOBC switches to ATP Only when train re-enters CBTC Territory and brakes to a stop until receiving a MA

wn cab before driver exits cab – e.g.
t terminus, or end of shift.
ins active and performs all required

llowed to move and if the train is detected
nary, the VOBC will apply EB
ommunicate with the wayside and TOD and
e available information.

ation Mode (ATO)
tion on mainline:
y operates train according to ATS
tal) within the ATP envelop (vital)
ntrol of the train with the Master
VOBC will control the train using the
mmand
n/close with driver override
tions may be configured. ATP
s open only when train stopped at station and only on the platform side
- Deadman lever supervised

Unattended Train Operation Mode (UTO)
Used in non-revenue service only.
- provides fully automatic operation including unattended coupling and uncoupling
- must be authorized by Yard Control Operator
- Thales CBTC UTO operation proven on Canada Line and over 25 years of operation on Vancouver SkyTrain

Vehicle-Onboard CBTC Scope Split					
EQUIPMENT	**Design**	**Supplier**	**Install**	**Install Support**	**Test & Commission**
(TOD) Train Operator's Display	Thales	Thales	Alstom	Thales	Thales
TOD Connector and cable (to ethernet network)	Thales	Alstom	Alstom	Alstom	Alstom
TOD Connector and cable to CB for power supply	Thales	Alstom	Alstom	Alstom	Alstom
TOD Mounting Bracket & Hardware	Alstom	Alstom	Alstom	Alstom	Alstom
SDR (CBTC Radio)	Thales	Thales	Alstom	Thales	Thales
SDR (CBTC Radio) Connector and cable (to ethernet network)	Thales	Alstom	Alstom	Alstom	Alstom
SDR (CBTC Radio) Connector and cable (to CB for power supply)	Thales	Alstom	Alstom	Alstom	Alstom
SDR Power Supply	Thales	Thales	Alstom	Thales	Thales
SDR and SDR Power supply mounting bracket & hardware	Alstom	Alstom	Alstom	Alstom	Alstom
CBTC Diagnostic Computer	Thales	Thales	Alstom	Thales	Thales
CBTC Diagnostic Computer Connector and ethernet cable (to Thales' network switch)	Thales	Alstom	Alstom	Alstom	Alstom
CBTC Diagnostic Computer Connector and cable (to power supply)	Thales	Alstom	Alstom	Alstom	Alstom
CBTC Diagnostic Computer mounting bracket & hardware	Alstom	Alstom	Alstom	Alstom	Alstom
Vehicle TDMS	Alstom	Alstom	Alstom	Alstom	Alstom
CBTC Diagnostic Computer Connector and ethernet cable (to Alstom's TDMS)	Thales	Alstom	Alstom	Alstom	Alstom
Vehicle PI/PAS	Alstom	Alstom	Alstom	Alstom	Alstom
Ethernet network	Thales	Alstom	Alstom	Alstom	Thales
CBTC Main Processor Unit (MPU)	Thales	Thales	Alstom	Thales	Thales
MPU cable to ethernet network	Thales	Alstom	Alstom	Alstom	Alstom
MPU connector for cable to ethernet network	Thales	Alstom	Alstom	Thales	Thales
MPU cable to CB for power supply	Thales	Alstom	Alstom	Alstom	Alstom
MPU connector to cable to CB for power supply	Thales	Thales	Alstom	Thales	Thales
MPU Power supply	Thales	Thales	Alstom	Thales	Thales
CBTC Peripheral Processor/Vital Interface Module Unit (PPU/VIM)	Thales	Thales	Alstom	Thales	Thales
PPU/VIM External Interface Relays	Thales	Thales	Alstom	Thales	Thales
PPU/VIM cable to interface relays	Thales	Thales	Alstom	Thales	Thales
PPU/VIM cable from interface relays to Vehicle Terminal Block	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Peripheral interface cables to Vehicle Terminal Block	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Train line wires to Vehicle Terminal Block	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Cables to power supply CBs	Thales	Alstom	Alstom	Alstom	Alstom
PPU/VIM Connectors for cables to power supply CBs	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Power supply	Thales	Thales	Alstom	Thales	Thales
Accelerometer	Thales	Thales	Alstom	Thales	Thales
Accelerometer mounting plate	Thales	Thales	Alstom	Thales	Thales
Accelerometer cables and connectors	Thales	Alstom	Alstom	Thales	Thales
Proximity Sensor	Thales	Thales	Alstom	Thales	Thales

Proximity Sensor pig tail and connector	Thales	Thales	Alstom	Thales	Thales
Proximity sensor cable to Vehicle Terminal Block and connector	Thales	Alstom	Alstom	Alstom	Alstom
Proximity Sensor Mounting Bracket & Hardware	Alstom	Alstom	Alstom	Alstom	Alstom
Transponder Interrogator Unit (TIU)	Thales	Thales	Alstom	Thales	Thales
TIU serial cable to Vehicle Terminal Block and mating connector	Thales	Alstom	Alstom	Alstom	Alstom
TIU cable and connector to power supply CB	Thales	Alstom	Alstom	Alstom	Alstom
Transponder Interrogator Antenna	Thales	Thales	Alstom	Thales	Thales
Transponder Interrogator Antenna pig tail and mating connector	Thales	Thales	Alstom	Thales	Thales
Transponder Interrogator Antenna cable to Vehicle Terminal Block and mating connector	Alstom	Alstom	Alstom	Alstom	Alstom
Transponder Interrogator Antenna Mounting Bracket & Hardware	Alstom	Alstom	Alstom	Alstom	Alstom
Radio Antenna	Thales	Thales	Alstom	Thales	Thales
Radio Antenna cable and connector	Thales	Alstom	Alstom	Thales	Thales
Radio Antenna Mounting Bracket & Hardware	Thales	Alstom	Alstom	Alstom	Alstom
Speed Sensor	Thales	Thales	Alstom	Thales	Thales
Speed sensor pig tail and connector	Thales	Thales	Alstom	Thales	Thales
Speed Sensor cable to Vehicle Terminal Block and connector	Thales	Alstom	Alstom	Alstom	Alstom
Speed sensor Mounting Hardware	Alstom	Alstom	Alstom	Alstom	Alstom
Trainline wires	Alstom	Alstom	Alstom	Alstom	Alstom
Train Operator Panel (including all buttons and switches for signalling system)	Thales	Thales	Alstom	Thales	Thales
Train Operator Panel cable and connector	Alstom	Alstom	Alstom	Alstom	Alstom
Bypass and Manual Release Switches	Thales	Alstom	Alstom	Thales	Thales
Cables and connectors for Bypass and Manual Release Switches	Thales	Alstom	Alstom	Alstom	Alstom
VOBC Rack	Thales	Thales	Alstom	Alstom	Alstom
VOBC Enclosure (cubicle) compliant with EMI, IP and temperature requirements	Alstom	Alstom	Alstom	Alstom	Alstom
VOBC Rack Mounting Bracket and Hardware.	Alstom	Alstom	Alstom	Alstom	Alstom
Circuit Breakers	Thales	Alstom	Alstom	Alstom	Alstom
MVB	Alstom	Alstom	Alstom	Alstom	Alstom
Coupler Pins	Alstom	Alstom	Alstom	Alstom	Alstom
VOBC subracks grounding straps	Alstom	Alstom	Alstom	Alstom	Alstom
VOBC rack ground stud and strap to vehicle body	Alstom	Alstom	Alstom	Alstom	Alstom
Termination Panel for train subsystem I/Fs	Alstom	Alstom	Alstom	Alstom	Alstom
All external interface relays for signalling	Alstom	Alstom	Alstom	Alstom	Alstom
Relay Mounting Bracket and Hardware	Alstom	Alstom	Alstom	Alstom	Alstom
Set of On-Board Cables (including Radio Antenna to DCS Rack; tachometer, TOD to VOBC terminal block, misc. cabling, I/F to existing speed code reader,).	Alstom	Alstom	Alstom	Alstom	Alstom
Intermediate connectors for peripheral interfaces	Alstom	Alstom	Alstom	Alstom	Alstom
Terminal Blocks	Alstom	Alstom	Alstom	Alstom	Alstom
Terminal Blocks Mounting Bracket and Hardware	Alstom	Alstom	Alstom	Alstom	Alstom

Event Logger	Alstom	Alstom	Alstom	Alstom	Alstom
DOCUMENTATION					
CBTC-Vehicle Interface Document *	n/a	Thales **	n/a	n/a	n/a
VOBC Equipment Installation Manual	n/a	Thales	n/a	n/a	n/a
VOBC External Requirements (e.g. metal free zones, antenna height from TOR etc.)	n/a	Thales	n/a	n/a	n/a
VOBC Equipment Drawings	n/a	Thales	n/a	n/a	n/a
VOBC Interface Documents	n/a	Thales	n/a	n/a	n/a
VOBC Equipment Space Model (if required)	n/a	Thales	n/a	n/a	n/a
VOBC Static & Dynamic PICO Procedure Document	n/a	Thales	n/a	n/a	n/a
VOBC Static & Dynamic PICO Test Results	n/a	Thales	n/a	n/a	n/a
VOBC RAM Analysis	n/a	Thales	n/a	n/a	n/a
VOBC Hardware and Software Safety and Hazard Analyses	n/a	Thales	n/a	n/a	n/a
Onboard CBTC Reliability Growth Plan	n/a	Thales	n/a	n/a	n/a
Vehicle Performance and Characteristics Data	n/a	Alstom	n/a	n/a	n/a
Vehicle schematics (as required)	n/a	Alstom	n/a	n/a	n/a
VOBC User's Manual (includes FLMD user manual)	n/a	Thales	n/a	n/a	n/a
TOD Operator's Manual	n/a	Thales	n/a	n/a	n/a
SERVICES					
Onboard CBTC Equipment Installation	n/a	Alstom****	n/a	n/a	n/a
Onboard CBTC Equipment Static PICO [1st two revenue trains]	n/a	Thales***	n/a	n/a	n/a
Onboard CBTC Equipment Static PICO [balance of fleet]	n/a	Alstom****	n/a	n/a	n/a
Onboard CBTC Equipment Dynamic PICO [1st two revenue trains]	n/a	Thales***	n/a	n/a	n/a
Onboard CBTC Equipment Dynamic PICO [balance of fleet]	n/a	Thales	n/a	n/a	n/a
Onboard CBTC Equipment - TDMS Integration Testing	n/a	Thales & Alstom	n/a	n/a	n/a
Onboard CBTC Equipment - PI/PAS Integration Testing	n/a	Thales & Alstom	n/a	n/a	n/a
Early Onboard CBTC-Vehicle Integration Testing at factory	n/a	Thales & Alstom	n/a	n/a	n/a
Vehicle Characterization Testing (for ASC fine tuning)	n/a	Thales	n/a	n/a	n/a
* Includes VOBC-PI/PAS, VOBC-TDMS & VOBC-Vehicle Data logging Interfaces					
** Prepared by Thales with input from Alstom (both parties are signatories)					
*** with Alstom support as required					
**** with Thales support as required					
Notes:					
1. Provision of equipment includes spares (as required) for each unit's scope of supply. Spares includes both warranty spares and commissioning spares, and all associated documentation (including but not limited to spares catalogues).					

2. Thales will provide one (1) quantity of Level 1 and one (1) quantity of Level 2 onboard maintenance tools. Thales will provide Level 3 onboard Maintenance support. All parties are responsible for warranty of their procured and supplied equipment as per their scope of work.					
3. Rolling Stock Supplier is responsible for adaptation (electrical and mechanical) of the VOBC interfaces (including design and deployment of brackets, terminal blocks, circuit breakers, relay mountings, wires and cable routing) onboard the train.					
4. 1st two VOBCs will be delivered to France. Balance of VOBCs will be delivered on-site to Ottawa.					
5. With respect to "design" of cables, connectors, and circuit breakers, Thales will specify requirements (electrical and/or material).					
6. Generally speaking, the static PICOs will include all tests deemed necessary in order to ensure that onboard CBTC equipment is installed and wired correctly . Static PICO tests include wire count, wire "ring-out" etc.					

THALES

Attachment B
Technical and Program Conditions

1. Project Duration: The Base Proposal Price assumes the effectiveness of the subcontract for the Train Control System to be February 15, 2013 (NTP) and a sixty-four (64) month programme schedule for Thales to complete and handover the Train Control System to Rideau Transit Group. Revenue service of the Ottawa Light Rapid Transit system is expected to be May 24, 2018. The two year warranty period commences at the start of revenue service.

2. Our Base Proposal Price does not include CBTC cables. It is assumed Rideau Transit Group or its Installer will install the cables.

3. Thales will train Rideau Transit Group on the installation and testing of the first 1st Zone Controller and the 1st two point machines. RTG will perform installation and testing of remaining wayside items.

4. Thales will train the Rolling Stock Supplier on the installation and static PICO testing of the 1st two VOBCs. The Rolling Stock Supplier will perform installation and static PICO testing of the remaining onboard units.

5. COTS equipment such as ATS and DCS equipment installed in environmentally controlled equipment rooms (provided by RTG) complies with light industrial environmental requirements. Qualification to EN 50121:2000 Railway Applications – Electromagnetic Compatibility and AREMA Environmental Requirements apply to outdoor wayside equipment and trainborne equipment.

6. This proposal is based on an architecture that provides 4 redundant zone controllers for the mainline and 1 redundant zone controller for the depot.

7. [redacted]

8. Thales meets the intent of Schedule 15-2 part 4 Article 5.9(b) (iii), which is assessed to be an indirect attempt to specify a requirement to ensure speed measurement error sufficient to achieve system safety and operational targets. Thales meets the required system safety and operational targets.

OTTAWA LIGHT RAIL TRANSIT PROJECT

INQUIRY No. 507528-P002
TECHNICAL EXCEPTIONS AND DEVIATIONS FROM THE RFP DOCUMENTS

I/We declare that the deviations and exceptions listed hereunder and on the sheets attached directly hereto, are the only deviations and exceptions to the Proposal Documents. For each deviation and exception listed, the corresponding article, section, or clause is identified, with a price to be added to or to be deducted from the bid price to bring the specified deviation or exception into compliance with the Proposal Documents.

Article, Section or Clause	Requirement as Specified	Proposed Deviation	Price Adjustment to Conform to the Requirement as Specified
None	None	None	None

COMPLIANCE STATEMENT

The Proponent shall provide a clause by clause compliance statement in the format of the following table to the following documents:

- Communications Based Train Control System Specification, document number 507528-0000-48EG-0001, Revision 0;
- Ottawa Light Rail Transit Project Agreement Version 2.0, Schedule 15-2 Part 1 Article 2 "Operational Performance Requirements", and;
- Ottawa Light Rail Transit Project Agreement Version 2.0, Schedule 15-2 Part 4 Article 5 "Train Control".

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
2.1.2.1	The CBTC system shall be capable of reliably supporting a minimum sustained operating Headway of under 120 seconds, under typical operating conditions, and a minimum designed Headway of under 90 seconds.	YES	Performance Analysis Section - 1.6.2 Interstation Design Headway Results	
2.1.2.1	The CBTC system shall be capable of reliably supporting a minimum sustained operating Headway of 900 seconds (15 minutes) during a single track outage at any location throughout the Line to support maintenance activities and continued operation during unplanned outages.	YES	Performance Analysis Section - 1.6.2 Interstation Design Headway Results	
2.1.2.3	The CBTC system shall be capable of supporting Operating Scenario 1 and Operating Scenario 2 and shall be capable of being expanded in the future to support Operating Scenario 3, without undue modification or loss of investment in the initial CBTC system.	YES	Performance Analysis - Section 1.6 SIMULATION RESULTS Note that passenger capacity is not calculated since Rolling Stock not in Thales scope.	
2.1.2.4	To ensure an efficient and effective service, the CBTC system and the rolling stock shall support a maximum terminal to terminal travel time (start to stop) during the peak period. Actual terminal to terminal travel times shall be determined using stochastic operations simulation analysis of the proposed Line under manual and ATO operations.	YES	Performance Analysis Section - 1.2.3 TRAVEL TIMES AND AVERAGE SPEEDS	
2.1.2.4	The maximum terminal to terminal travel time during the peak period shall be 24 minutes in manual mode (including dwell time and accounting for underperformance resulting from driver-controlled vehicle movement) and 23 minutes in ATO mode (including dwell time).	YES	Performance Analysis Section - 1.2.3 TRAVEL TIMES AND AVERAGE SPEEDS	

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
2.1.2.4.1	Trip times for manual operations shall be determined through simulation with stochastic variations in driver performance and dwell times.	YES	Performance Analysis Section - 1.2.4 MANUAL OPERATING MODE	
2.1.2.4.1	Dwell time variance shall consider the effect of late trains based on industry experience as documented in the simulation report. In the absence of delay-based dwell time simulation, a randomized uniform distribution around the nominal calculated dwell times of not less than plus and minus 5 seconds shall be applied.	YES	Performance Analysis Section - 1.2.4 MANUAL OPERATING MODE	
2.1.2.4.1	Driver performance variations shall be set such that the average terminal to terminal running time shall be at least 6% greater that the ideal trip time under full performance.	YES	Performance Analysis Section - 1.2.4 MANUAL OPERATING MODE	
2.1.2.4.2	Trip times for ATO operations shall be determined through simulation with stochastic variations of dwell times, and appropriate variations in vehicle performance based on performance tolerances of the vehicle and the ATO equipment.	YES	Performance Analysis Section - 1.2.5 ATO OPERATING MODE	
2.1.2.4.2	For analysis purposes, dwell time variation for ATO operations shall follow a uniform distribution around the nominal, calculated dwell times based on experience and recommendations, but no less than plus and minus 5 seconds.	YES	Performance Analysis Section - 1.2.5 ATO OPERATING MODE	
2.1.2.4.3	Dwell times at each station, which shall be included in the calculation of the maximum travel time, shall be based on the directional peak hour passenger boardings and alightings.	YES	Performance Analysis Section - 1.2.6 DWELL TIMES	
2.1.2.4.3	The absolute minimum dwell time shall be 20 seconds at all stations during the peak period.	YES	Performance Analysis Section - 1.2.6 DWELL TIMES	
2.1.2.4.3	Passenger loading and unloading time at terminal stations is considered part of the terminal layover time, and shall not be included in the calculation of the maximum travel time.	YES	Performance Analysis Section - 1.2.6 DWELL TIMES	
2.1.2.4.4	Terminal time shall be defined based on the proposed Headway for each operating scenario and shall be maximized to the capacity of each terminal station.	YES	Performance Analysis Section - 1.2.7 TERMINAL TIMES	
2.1.2.4.4	A minimum terminal time shall be no less than one operating Headway.	YES	Performance Analysis Section - 1.2.7 TERMINAL TIMES	
2.1.2.4.4	The absolute minimum terminal time shall not exceed the calculated time required for passenger loading and unloading at the terminal stations during the peak hour including an	Not Applicable		Passenger loading / unloading time calculation not in Thales scope of work.

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	appropriate allowance for variations in passenger flow.			
2.1.2.4.4	An operational simulation validating compliance with these terminal times shall report the distribution of terminal times at each terminal station and discuss the ability of the CBTC system to reliably meet the terminal time requirements.	YES	Performance Analysis Section - 1.2.7 TERMINAL TIMES	
2.1.2.5.1	The MSF shall be designed and constructed to accommodate the LRVs that are required to meet the operational performance requirements for Operating Scenario 1 and Operating Scenario 2 (refer to section 2.1.2.3) as well as any non-revenue and specialty vehicles required to fulfil the Line's maintenance requirements and obligations.	Noted		
2.1.3	The CBTC system shall be based on a proven CBTC architecture which allows automatic operation of LRVs under manual supervision in a segregated guideway with short Headways. The CBTC system shall provide the ability to also operate the LRVs manually (line of sight).	YES	Technical Design Description - Section 1 SYSTEM OVERVIEW AND DESIGN PRINCIPLES	
2.1.3	Trains shall bi-directionally communicate to the wayside equipment through a high availability communications medium.	YES	Technical Design Description - Section 1.4 SelTrac CBTC Architecture	
2.1.3	The design of the CBTC system shall be fail-safe to maximize the safety and security of all personnel and passengers.	YES	Technical Design Description - Section 1.4 SelTrac CBTC Architecture	
2.1.3	The CBTC system is a safety critical computer based control system that provides the following minimum functionality: vehicle identification,	YES	Technical Design Description - Section 3.5 Train Length Determination	
2.1.3	vehicle location control and monitoring,	YES	Technical Design Description - Section 3.9 Train Tracking	
2.1.3	maintaining a safe distance between vehicles,	YES	Technical Design Description - Section 3.22 Safe Movement Authority Determination/Enforcement	
2.1.3	vehicle speed control,	YES	Technical Design Description - Section 4.2 Automatic Train Speed Control	
2.1.3	maintaining safe brake rates,	YES	Technical Design Description - Section 4.6 Braking/Acceleration Rate Selection	

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
2.1.3	vehicle route selection and fleet management,	YES	Technical Design Description - Section 5.2 Automatic Train Regulation	
2.1.3	interlocking control,	YES	Technical Design Description - Section 3.21 Switch Control	
2.1.3	power consumption optimization,	YES	Technical Design Description - Section 5.3.1.1 Green Timetable Compiler	
2.1.3	fixed block train detection and signals at interlockings (for failure management), on the mainline only and portion of the yard where the OC transpo drivers operate.	YES	Technical Design Description - Section 1.7.2.2 Manual Operation of Non-communicating Trains Technical Design Description - Section 3.9.2.1 Non-communicating Train Tracking	
2.1.3	broken rail detection, mainline only.	YES	Technical Design Description - Section 6.4 Broken Rail Detection System (BRDS)	
2.1.3	As a minimum, the fixed block train detection layout shall include a block for each station and one block between each station / interlockings. The Proponent shall provide the proposed block layout in the response to this Inquiry.	YES	Technical Design Description - Section 1.9.2 Wayside Equipment	
2.1.3.1	The Proponent shall provide fully automated control (driverless) of the MSF territory by the CBTC system, as implemented on the mainline, and integrated with the mainline System. The CBTC system shall ensure that trains are prevented from entering tha mainline in yard (driverless) mode.	YES	Technical Design Description - Section 7.1 Option for Automatic Depot	
2.1.3.1	The tracks leading into the vehicle maintenance shop shall be a manual operation area. The Proponent shall provide the necessary functionality to safely manage the transition between this manual area and the automatic tracks. The Proponent shall describe the operation of this transition area in the response to this Inquiry.	YES	Technical Design Description - Section 7.1 Option for Automatic Depot	
2.1.3.1.1	The Proponent shall provide, fully automatic coupling and uncoupling (unattended) in designated areas within the MSF territory. This functionality is required to reconfigure trains for	YES	Technical Design Description - Section 3.7 Train Automatic Coupling and Uncoupling	

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	unscheduled maintenance, etc.		(Option)	
2.1.3.1.1	With automatic coupling and uncoupling the final configuration of the Train(s) shall be established by the CBTC system without operator involvement.	YES	Technical Design Description - Section 3.7 Train Automatic Coupling and Uncoupling (Option)	
2.1.3.1.1	The Proponent shall specify the Onboard CBTC-Vehcile interface requirements to accommodate automatic coupling and uncoupling functionality.	YES	VOBC BBI	
2.1.3.3	The CBTC system shall include a Simulation Training and Testing System (STTS). The STTS shall be used for operator training, timetable performance verification, and CBTC system testing. The STTS shall execute the actual CBTC system software (excluding vital I/O components) that will be used in the revenue System, in conjunction with a track and vehicle emulator. The track and vehicle emulator shall allow the STTS to simulate indications from trains and from the wayside devices.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	The STTS shall provide functionality to simulate the following:	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	the entire Line, including both the mainline and the MSF territory,	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	movement of trains anywhere on the simulated track, and	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	all wayside devices to which the CBTC must interface (e.g. switches, signals, intrusion detectors, yard ESB and	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	the revenue System functionality.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	It shall be possible to execute predefined training / testing scenarios on the STTS including the injection of full or partial equipment failures. These equipment failures shall include, but not be limited to, the following:	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	switch failures,	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	Zone controller failures	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	ATS server failures	YES	Technical Design Description -	

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			Section 8.2 Training Centre	
2.1.3.3	vehicle propulsion failures,	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	communications failures, and	YES	Technical Design Description - Section 8.2 Training Centre (	
2.1.3.3	trainborne CBTC system equipment failures.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	It shall be possible for a trainer to prepare scripts for the training scenarios off-line and then load the scripts onto the STTS for execution via the Trainer's Workstation. The trainer shall be able to control the simulation, including injection of full or partial equipment failures via the Trainer's Workstation.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	It shall be possible to manually operate a selected simulated train as per manual mode of operation.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	All CBTC system displays available to the CROs in the revenue Control Room shall be available on the STTS. The STTS shall not communicate or interface with the revenue System in any manner.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.3	The STTS shall provide a playback or rerun capability where it shall be possible to review the revenue or STTS operators' interactions, the operating state of the train(s), and the equipment working state in fast-forward, pause, stop, or real-time speed modes.	YES	Technical Design Description - Section 8.2 Training Centre	
2.1.3.4	The CBTC system shall provide train location, destination and routing information to the wayside and vehicle-borne Passenger Information and Passenger Announcement systems via the Communications System.	YES	Technical Design Description - Section 5.9.1 Passenger Information System	
2.1.3.4	The CBTC system shall provide data to the Client's applications and systems. The CBTC system shall support periodic backup of operational data and logs to the City's central backup facility over a network connection that will be provided by Others.	YES	Technical Design Description - Section 5.9.4 City of Ottawa Applications	
2.1.3.4	Data requests and transfers to external systems shall occur over a network other than the CBTC network. The CBTC interface to external systems shall be provided with hardware and software security measures to block external access to the CBTC network.	YES	Technical Design Description - Section 5.9 ATS External Interfaces	

CLAUSE NUMBER	COMMUNICATIONS BASED TRAIN CONTROL SYSTEM SPECIFICATION, DOCUMENT NUMBER 507528-0000-48EG-0001 OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
2.1.3.4	The CBTC system shall provide such other information to the Communications Systems as may be identified by the Client during the detailed design review phase of the Project.	YES	Technical Design Description - Section 5.9.3 SCADA	
2.1.3.4	The CBTC system shall receive and react to information from the Communication System including, but not limited to, status of traction power sections.	YES	Technical Design Description - Section 5.9.3 SCADA	
2.1.3.4	The onboard CBTC System shall provide master clock time updates to the vehicle.	YES		

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CLAUSE NUMBER	SCHEDULE 15-2 PART 1 ARTICLE 2 "OPERATIONAL PERFORMANCE REQUIREMENTS" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
2.2 (a)	Although operation of rail service will be the responsibility of the City, Project Co shall thoroughly consider the operational needs and the functionality of the System during Design and Construction Work and shall validate the operational capabilities through performance simulation.	YES	Performance Analysis - Section 1.6 SIMULATION RESULTS	
2.3 (a)	The System shall be designed to reliably support a sustained operational Headway of 2 minutes or less under typical operating conditions.	YES	Performance Analysis - Section 1.6 SIMULATION RESULTS	
2.3 (b)	The System shall be designed to reliably support a sustained operational Headway of 15 minutes during a single Track outage at any location throughout the System to support Maintenance activities and/or continued operation during unplanned outages. Terminal to terminal trip time shall not significantly increase during single tracking operations, other than as a result of speed reductions applied through Maintenance work zones.	YES	Performance Analysis - Section 1.6 SIMULATION RESULTS	
2.5 (i)	Operating Scenario 1: Opening day operation with peak period Headways of approximately 3.25 minutes utilizing Train consists of approximately 120 metres in length to meet the Passenger carrying capacities identified in 2.6(a)i.	YES	Performance Analysis - Section 1.2.2 PLANNED OPERATING SCENARIOS Note that passenger capacity is not calculated since Rolling Stock not in Thales scope.	
2.5 (ii)	Operating Scenario 2: Year 2031 operation with peak period Headways of approximately 2.1 minutes utilizing Train consists of approximately 120 metres in length to meet the Passenger carrying capacities identified in 2.6(a)ii.	YES	Performance Analysis - Section 1.2.2 PLANNED OPERATING SCENARIOS Note that passenger capacity is not calculated since Rolling Stock not in Thales scope.	
2.5 (iii)	Operating Scenario 3: Ultimate capacity operation at a headway of not less than 2-minutes during the peak period with Train consists of approximately 150 metres in length providing a capacity of 24,000 PPHPD.	YES	Performance Analysis - Section 1.6 SIMULATION RESULTS Note that passenger capacity is not calculated, since Rolling Stock not in Thales scope.	
2.5 (d)	Notwithstanding the requirements related to the above service	YES	Performance Analysis - Section	

CLAUSE NUMBER	SCHEDULE 15-2 PART 1 ARTICLE 2 "OPERATIONAL PERFORMANCE REQUIREMENTS" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	scenarios, the proposed System and rolling stock shall further comply with the requirements of Section 2.3 – Operational Headways and Section 2.6 – System Capacity.		1.6 SIMULATION RESULTS Note that passenger capacity is not calculated, since Rolling Stock not in Thales scope.	
2.6 (i)	Operating Scenario 1 (Opening Year): 12,000 PPHPD	Noted		Note that passenger capacity is not calculated, since Rolling Stock not in Thales scope.
2.6 (ii)	Operating Scenario 2 (Year 2031): 18,000 PPHPD	Noted		Note that passenger capacity is not calculated, since Rolling Stock not in Thales scope.
2.6 (b)	The required System capacity shall be provided subject to passenger comfort load standards, maximum consist lengths, and appropriate operating Headways.	Noted		Rolling Stock not in Thales scope.
2.6 (ii)	The average standee density during the peak hour on the peak link load segment shall not exceed 3.33 standees per square meter of available standee space. Calculations of standee density shall account for areas unsuitable or uncomfortable for standees such as stairs, articulation areas, etc.	Noted		Rolling Stock not in Thales scope.
2.6 (iii)	At least 40 percent of the required service capacity must be provided by seats to maintain a high level of comfort and minimize the duration that passengers have to stand. Flip-up seats count toward the 40 percent requirement.	Noted		Rolling Stock not in Thales scope.
2.6 (i)	The maximum Train consist length shall be generally compatible with nominal platform lengths of 120 metres for Operating Scenarios 1 and 2 and be capable of operating in shorter consist lengths during off-peak periods.	Noted		Rolling Stock not in Thales scope.
2.6 (ii)	The rolling stock shall be configured to maximize Train capacity, and to be generally compatible with long term plans to expand maximum consists to nominal Platform lengths not exceeding 150 metres for Operating Scenario 3.	Noted		Rolling Stock not in Thales scope.
2.7 (a)	To ensure an efficient and effective service, the System and rolling stock shall support a maximum terminal to terminal (start to stop) travel time during the peak period. Terminal to terminal travel times shall be determined using stochastic operations simulation analysis of the proposed System under manual and ATO operations.	YES	Performance Analysis - Section 1.2.3 TRAVEL TIMES AND AVERAGE SPEEDS	

CLAUSE NUMBER	SCHEDULE 15-2 PART 1 ARTICLE 2 "OPERATIONAL PERFORMANCE REQUIREMENTS" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
2.7 (i)	Manual mode: 24 minutes including Dwell Time and accounting for typical underperformance resulting from Driver-controlled Vehicle movement.	YES	Performance Analysis - Section 1.2.3 TRAVEL TIMES AND AVERAGE SPEEDS	
2.7 (ii)	ATO mode: 23 minutes including Dwell Time.	YES	Performance Analysis - Section 1.6 SIMULATION RESULTS	
2.7 (i)	Trip times for manual operations shall be determined through simulation with stochastic variations in Driver performance and Dwell Times.	YES	Performance Analysis - Section 1.2.4 MANUAL OPERATING MODE	
2.7 (ii)	Dwell Time variation shall consider the effect of late Trains based on Project Co or industry experience as documented in the simulation report. In the absence of delay-based Dwell Time simulation a randomized uniform distribution around the nominal calculated Dwell Times of not less than plus and minus 5 seconds shall be applied.	YES	Performance Analysis - Section 1.2.4 MANUAL OPERATING MODE	
2.7 (iii)	Driver performance variations shall be set such that the average terminal to terminal running time shall be at least 6% greater than the ideal trip time under full performance.	YES	Performance Analysis - Section 1.2.4 MANUAL OPERATING MODE	
2.7 (i)	Trip times for ATO operations shall be determined through simulation with stochastic variations of Dwell Times, and appropriate variations in Vehicle performance based on performance tolerances of the Vehicle and ATO equipment as determined by Project Co.	YES	Performance Analysis - Section 1.2.5 ATO OPERATING MODE	
2.7 (ii)	For analysis purposes, Dwell Time variation for ATO shall follow a uniform distribution around the nominal, calculated Dwell Times based on Project Co experience and recommendations, but no less than plus and minus 5 seconds.	YES	Performance Analysis - Section 1.2.5 ATO OPERATING MODE	
2.7 (i)	Dwell Times shall be included in the calculation of the maximum travel time.	YES	Performance Analysis - Section 1.2.6 DWELL TIMES	
2.7 (iii)	Dwell Time at each Station shall be based on the directional	YES	Performance Analysis - Section	

CLAUSE NUMBER	SCHEDULE 15-2 PART 1 ARTICLE 2 "OPERATIONAL PERFORMANCE REQUIREMENTS" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	peak hour Passenger boardings and alightings provided in the Reference Documents.		1.2.6 DWELL TIMES	
2.7 (iv)	Dwell Time calculations shall be submitted as part of the Works Submittal according to Schedule 10 – Review Procedure.	Not Applicable		Dwell time calculation not in Thales scope of work.
2.7 (v)	An absolute minimum Dwell Time of 20 seconds shall be assumed at all Stations during the peak period.	YES	Performance Analysis - Section 1.2.6 DWELL TIMES	
2.7 (i)	Terminal time shall be defined based on the proposed Headway for each operating scenario and shall be maximized to the capacity of each terminal. Fall-back operation is assumed during peak periods.	YES	Performance Analysis - Section 1.2.7 TERMINAL TIMES	
2.7 (ii)	A minimum terminal time shall be no less than one operating Headway.	YES	Performance Analysis - Section 1.2.7 TERMINAL TIMES	
2.7 (iii)	The absolute minimum terminal time shall not exceed the calculated time required for Passenger loading and unloading at the terminals during the peak hour including an appropriate allowance for variations in Passenger flow.	Not Applicable		Passenger loading / unloading time calculation not in Thales scope of work.
2.7 (iv)	The operational simulation validating compliance with this Article shall report the distribution of terminal time at each terminal and discuss the ability of the System to reliably meet the terminal time requirements.	YES	Performance Analysis - Section 1.2.7 TERMINAL TIMES	
2.8 (i)	The planned service capacity as documented in the Operations Service Plan;	Not Applicable		Not in Thales scope of work
2.8 (ii)	To effectively execute the rail fleet Maintenance program proposed by Project Co in accordance with Schedule 15-3 with an appropriate Maintenance spare percentage; and	Not Applicable		Not in Thales scope of work
2.8 (iii)	For further certainty, fleet requirements beyond the initial fleet for Operating Scenario 1 shall be procured and provided at the direction of the City in accordance with Schedule 35 – Vehicle Option and Schedule 22 – Variation Procedure.	Not Applicable		Not in Thales scope of work
2.8 (b)	Project Co shall design and construct the MSF facility to accommodate the LRVs required to meet the Operational Performance Requirements identified in this Article for Operating Scenarios 1 and 2, as well as any non-revenue and specialty vehicles required to fulfill Project Co's Maintenance Requirements and obligations.	Not Applicable		Not in Thales scope of work

Note: The table has not been updated to include the latest Addenda. The Addendums were all reviewed and the compliant statement has not changed due to the addenda.

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CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
5.1	(a) Project Co shall provide for a CBTC system integrated with the wayside portion of the system.	YES	Technical Design Description Section - 1 SYSTEM OVERVIEW AND DESIGN PRINCIPLES	
5.1	(b) The CBTC system shall provide vital ATP with a moving or virtual block Design. The CBTC system's ATP function shall vitally enforce Train separation, switch and interlocking protection and direction of traffic interlocking. The ATP system shall vitally enforce all temporary and permanent speed restrictions as long as any portion of the Train is within the restriction zone.	YES	Technical Design Description Section - 1 SYSTEM OVERVIEW AND DESIGN PRINCIPLES	
5.1	(c) The CBTC system shall also provide a non-vital ATO overlay function operating within the limits established by the vital ATP system. The ATO function shall provide automatic speed regulation to keep the Train under the speed profile enforced by the vital ATP system. The ATO function shall also provide automatic station stopping and implement supervisory commands to adjust Headways and schedules.	YES	Technical Design Description Section - 1.7.2.2 Manual Operation of Non-communicating Trains	
5.1	(d) Trains shall normally operate in an ATO mode from Tunney's Pasture to Blair.	YES	Technical Design Description Section - 1.7.1 Normal Mode Operation	
5.1	(e) Future extension of the System beyond these Stations into partially segregated rights-of-way with at grade crossings shall require Trains to operate with ATP only in those areas.	Noted	Technical Design Description Section - 1.9.2 Wayside Equipment Technical Design Description Section - 3.27 Mode Allowed Zones	
5.1	(f) The CBTC system shall also have a non-vital ATS function to non-vitally adjust the Train speed limits within the ATP speed profile and adjust Station dwell times to optimize Headway and Train spacing and to reduce energy usage. The ATS system shall also provide non-vital interlocking command and control and automated operation of the line.	YES	Technical Design Description Section - 5.2.4.1 Dwell Regulation Technical Design Description Section - 5.2.5 Energy Savings Features	
5.1	(g) The Design of the wayside and onboard systems of the CBTC system shall provide minimum 80-90 second Headways.	YES	Technical Design Description Section - 1.7.1 Normal Mode Operation Technical Design Description Section - 2.4 Headway	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			Requirements	
5.1	(h) A fixed block Train detection system shall be provided to allow the CBTC system to locate Trains in case of communications failures. The fall back signals at the interlocking provide additional safety against head on and conflicting route collisions and switch derailments. A means shall also be provided to detect broken rail and inform the CBTC system of broken rail.	YES	Technical Design Description Section - 1.7.2.2 Manual Operation of Non-communicating Trains	
5.1	(i) Redundancy shall be built into all Train Control Systems to provide maximum availability.	YES	Technical Design Description Section - 3.2 VOBC Switchover Technical Design Description Section - 3.30 Failure Management Technical Design Description Section - 3.30.1 Zone Controller Failure Technical Design Description Section - 3.30.2 Communication Failure Technical Design Description Section - 3.30.2.0-1.1 ZC to VOBC Communication Loss Technical Design Description Section - 3.30.2.0-1.2 ZC to ZC Communication Loss Technical Design Description Section - 3.30.2.0-1.3 Failure of Wayside Radio Units	
5.3 (a)	(i) The CBTC system shall consist of Equipment located on the wayside, at the TSCC, at the MSF and onboard each LRV Train. The wayside, TSCC, and MSF Equipment shall be connected to each other by redundant fibre optic networks. The onboard Equipment shall communicate to the wayside and TSCC and MSF Equipment through wireless APs connected into the CBTC Network. Systems providing the same functionality, Safety and level of redundancy as that described below are acceptable regardless of the assignment of functions among hardware or the	YES	Technical Design Description Section - 1.9 Ottawa Light Rail Transit Project SelTrac Equipment Allocation	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	terminology used.			
5.3 (b)	(i) The TSCC shall serve as the command and control center for the OLRT. Work stations located in the TSCC shall communicate with redundant ATS and ATC servers located in the MSF. The TSCC workstations and the ATS servers located in the MSF shall allow the TSCC personnel to setup routes through interlockings using entrance/exit selection or direct switch control, and to clear, cancel or fleet signals. Using this system, TSCC personnel shall also be able to stop and release any Train or group of Trains. The TSCC personnel shall be able to put the ATS servers in an automatic mode to automatically set up routes through interlockings, send ATS commands to Trains to control dwell times, speeds, and acceleration or braking rates to manage Headways, and schedules and/or optimize energy usage. In the automatic mode, the ATS system shall also route Trains out of and into the MSF to build up and reduce service around the rush hours.	YES	Technical Design Description Section - 1.9.1.1 Traffic Control Centre	
5.3 (b)	(ii) The ATC servers shall maintain the most up to date Track Database. The ATC servers shall push the latest version of the Track Database including Track profile, Station locations and civil speed out to the ATC Zone Controllers and to all Trains. Handshaking shall be provided to ensure that all ATC servers, ATC Zone Controllers and Vehicles maintain the same up to date version of the Track Database. The ATC Zone Controllers shall maintain a registry of all equipped Vehicles in CBTC territory. Authorised TSCC personnel shall be able to use workstations to update, add or remove speed restriction zones and work zones.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (b)	(iii) The ATS workstations at the TSCC shall have display screens that allow TSCC personnel to view the entire line and all the Trains (identified by lead car number), interlockings and switch positions as well as Equipment warnings, alarms, temporary speed restriction zones and work zones. GUI controls shall be provided to allow the TSCC personnel to control interlockings and switches, to clear, cancel and fleet signals, to turn switch point heaters on and off, to stop and release Trains and to transfer interlockings and the entire line between automatic and manual operation.	YES	Technical Design Description Section - 1.10.1.1.3 TS Workstations Technical Design Description Section - 5.1 ATS Graphical User Interface	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
5.3 (b)	(iv) CBTC maintenance database servers shall be provided at the MSF to record all faults from wayside, TSCC, MSF and on board CBTC and network Equipment	YES	Technical Design Description Section - 1.10.1.1.7 Diagnostic Server	
5.3 (b) (iv)	A. Fault alerts and easy database access shall be provided for maintenance personnel.	YES	Technical Design Description Section - 8.1.4.3 Central Diagnostic Servers and Workstation	
5.3 (b)	(v) TSCC workstations and MSF servers shall be set up in a redundant configuration with redundant network interfaces.	YES	Technical Design Description Section - 1.10.1 TCC Equipment	
5.3 (c)	(i) ATC Zone Controllers shall be distributed throughout the line to control the Train movements in the various zones. Redundant ATC Zone Controllers shall be provided in each zone. The number of zones shall be determined by the latency requirements of providing the required Headways, the requirements of maximum availability, as well as the requirements of the vital interface with the interlocking controllers provided.	YES	Technical Design Description Section - 1.10.2.1.1 Zone Controller Configuration	
5.3 (c) (ii)	A. Receive Train location, length, speed and identification messages from each Train;	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.3 (c) (ii)	B. Synchronize Track Database versions with the MSF ATC server;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (c) (ii)	C. Receive signal status, switch position, and block occupancy status of the fixed block system either directly or from a VMIS;	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.3 (c) (ii)	D. Read input from the intrusion detection system installed at the OLRT Tunnel portals;	YES	Technical Design Description Section - 3.22.3.2 Portal Intrusion Obstruction	
5.3 (c) (ii)	E. Read inputs from the smoke detector system;	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.3 (c) (ii)	F. Request and receive the Track Database version from each Train in its zone;	YES	Technical Design Description Section - 1.6.1.2 Automatic	

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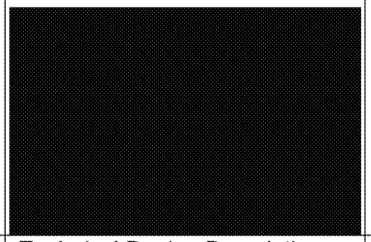
			Train Control: Movement Authority and Interlocking	
5.3 (c) (ii)	G. Deny Movement Authority to Trains without a valid Track Database version until the database is made current;	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.3 (c) (ii)	H. Send Movement Authorities to all Trains within its zone including overlap into adjacent zones;	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.3 (c) (ii)	J. Provide Train location to the ATS system;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 5.1.3 Line Overview Screen 	
5.3 (c) (ii)	K. Inform adjacent ATC Zone Controllers of all switch, signal positions and Train location information within it zone; and	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (c) (ii)	L. Receive the same information from adjacent controllers.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (c)	(iii) Redundant ATC Zone Controllers shall be provided for each zone.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (c)	(iv) Future expansion of OLRT may involve operation in partially separated rights-of-way with at-grade crossings. The ATC Zone Controllers shall have capability of interfacing with City traffic	YES	Technical Design Description Section - 1.9.2 Wayside Equipment	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	signals and with crossing barriers.			
5.3 (d)	(i) Redundant local ATS processors shall provide a non-vital interface between the ATS servers and the VMIS to allow ATS control of interlockings. The local ATS processors shall also connect to the Local Control Panel to allow local control of the interlocking.	YES	Technical Design Description Section - 1.9.1.2 Station ATS Equipment Technical Design Description Section - 1.9.2 Wayside Equipment [redacted]	
5.3 (d)	(ii) The local ATS processor shall direct ATS commands to Trains to adjust Train speeds and dwell times and shall obtain Train location information for the central ATS system. The processor shall also receive the Train locations from the ATC Zone Controller and report them to the MSF ATS servers.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture [redacted]	
5.3 (e)	(i) Interlockings shall be controlled by redundant VMIS units using standard interlocking Safety logic including route locking, approach locking, detector locking, etc. A fixed block Train detection system shall be used in all interlockings to supplement CBTC location detection. Vital interlocking logic shall include control of traffic direction between interlockings. Traffic direction status shall be vitally maintained through power failures. Vital interlocking control may be integrated into the Zone Controller	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking Technical Design Description Section - 1.7.1.4 Bidirectional Operation Technical Design Description	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	package provided that:		Section - 1.7.2.2 Manual Operation of Non-communicating Trains Technical Design Description Section - 3.19.3 Route Reservation [redacted]	
5.3 (e) (i)	A. Local control of the turn backs at terminal locations is not dependent on the health of the line CBTC Network: and	YES	Technical Design Description Section - 1.9.1 Automatic Train Supervision (ATS) Equipment	
5.3 (e) (i)	B. Failure of the CBTC portion of the Zone Controller shall not disable local control of terminal location turn backs or the interlocking controlling entrance to and exit from Maintenance and Storage Facility.	YES	Technical Design Description Section - 1.10.2.1.6 Local Control Panel	
5.3 (e)	(ii) The VMIS units shall vitally read the states of all fixed blocks including those outside the interlocking.	YES	Technical Design Description Section - 1.7.2.2 Manual Operation of Non-communicating Trains [redacted]	
5.3 (e)	(iii) The VMIS units shall provide the ATC Zone Controllers the status of all signals, switches, and fixed blocks within the zone as well as the allowed direction of traffic on each Track.	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	

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			[redacted]	
5.3 (e)	(iv) The local non-vital ATS processor shall allow the VMIS to process central ATS requests from the MSF ATS servers and provide indications to the ATS system.	YES	Technical Design Description Section - 1.9.1 Automatic Train Supervision (ATS) Equipment [redacted]	
5.3 (e) (iv)	A. The non-vital interface shall support a local control panel for testing and Emergency operation of the interlocking.	YES	Technical Design Description Section - 1.10.2.1.6 Local Control Panel	
5.3 (e) (iv)	B. The non-vital local ATS processor shall support local automatic operation of the interlocking based on approach triggering.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture [redacted]	

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5.3 (e) (iv)	C. In local automatic operation, Trains shall be routed to the inbound Platform Track first and only if that Track is occupied to the other Platform Track. Provisions shall be made for taking a Platform Track out of service.	YES	Technical Design Description Section - 1.9.1 Automatic Train Supervision (ATS) Equipment	
5.3 (e)	(v) In normal operation, approach locking shall utilize the ATC Zone Controller knowledge of Train speed and position and Movement Authority to minimize approach locking time.	YES	Technical Design Description Section - 1.6.2.1 Automatic Train Protection	
5.3 (e)	(vi) Wayside signals with stop, diverging and normal aspects controlled by the VMIS shall be provided at the interlockings. In case of CBTC system failure, visual signal protection of interlockings shall supplement line of sight operation between interlockings.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.9.2 Wayside Equipment	
5.3 (f)	(vii) A Local Control Panel with switch controls, signal controls and Track and switch indications and switch heater status shall be provided. Controls to select local or ATS control, and local automatic or local manual control shall be provided.	YES	Technical Design Description Section - 1.10.2.1.6 Local Control Panel	
5.3 (f)	(viii) The CIH shall be constructed with a white outer and be resistant to corrosion and weather damage. The Design shall minimize electromagnetic interference from the Traction Power fields.	Not Applicable		Equipment will be placed in the station equipment rooms. CIH's are not required
5.3 (f)	(ix) The CIH shall be insulated to a level that minimizes heating and cooling loads for the HVAC and heating systems.	Not Applicable		Equipment will be placed in the station equipment rooms. CIH's are not required
5.3 (f)	(x) A 600 VAC single phase feed shall be provided with appropriate step down transformer(s) and distribution panels for signal power and for bungalow power outlets, lighting, HVAC etc.	Not Applicable		As per the scope split Power and transformer to be supplied by others.
5.3 (f)	(xi) A transfer switch and an outside connection for a portable emergency generator and pad for placement of that generator shall be provided.	Not Applicable		As per the scope split Power and transformer to be supplied by others.
5.3 (f)	(xii) Power for vital signal systems shall not be grounded.	Not Applicable		As per the scope split Power and transformer to be supplied by others.
5.3 (f)	(xiii) Four (4) hour battery backup shall be provided to power all signal and CBTC systems including fixed block detection and switch operation.	Not Applicable	Technical Design Description Section - 1.10.1.3 UPS and Power Distribution Cabinets Technical Design Description	As per the scope split UPS to be supplied by others.

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			Section - 1.10.2.1 Equipment Installed in Wayside Equipment Rooms Technical Design Description Section - 1.10.2.1.7 UPS and Power Distribution Cabinets	
5.3 (f) (xiii)	A. Batteries chargers shall be redundant.	Not Applicable		As per the scope split UPS to be supplied by others.
5.3 (f) (xiii)	B. Battery charger filtering shall be sufficient that the ripple requirements of attached processor systems can be met even when batteries are not attached.	Not Applicable		As per the scope split UPS to be supplied by others.
5.3 (f) (xiii)	C. Batteries provided shall be selected for the required capacity and minimal degradation of capacity with age and suitable for the environmental conditions outlined in the Output Specifications.	Not Applicable		As per the scope split UPS to be supplied by others.
5.3 (f) (xiii)	D. Batteries shall not be lead acid.	Not Applicable		As per the scope split UPS to be supplied by others.
5.3 (f)	(xvi) A control head, transceiver and antenna shall be provided for the radio.	Not Applicable		To be supplied by communications subcontractor
5.3 (f)	(xvii) The CIHs shall be grounded. All racks in the CIH shall be connected to the earth ground bus.	Not Applicable		Equipment will be placed in the station equipment rooms. CIH's are not required
5.3 (g)	(i) Power switch machines provided shall:	YES	Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside Technical Design Description Section - 3.20 Switch Position Detection Technical Design Description Section - 3.21 Switch Control	
5.3 (g) (i)	A. Have heaters to prevent internal condensation;	YES	Technical Design Description Section - 1.9.3 Trackside Equipment Technical Design Description Section - 3.20 Switch Position Detection Technical Design Description Section - 3.21 Switch Control	

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5.3 (g) (i)	B. Have a lockable hand throw lever and mode of operation; and	YES	Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside Technical Design Description Section - 3.20 Switch Position Detection Technical Design Description Section - 3.21 Switch Control	
5.3 (g) (i)	C. Have a record of reliable operation in heavy traffic transit operation.	YES	Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside Technical Design Description Section - 3.20 Switch Position Detection Technical Design Description Section - 3.21 Switch Control	
5.3 (g)	(ii) Switch heaters shall be provided to prevent ice and snow from building up and immobilizing the switch points. Switch heaters shall:	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g) (ii)	A. Be controlled by the TSCC through the local ATS processor; and	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g) (ii)	B. Have sufficient power rating to operate successfully in the Ottawa climate.	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g)	(iii) Switch heaters shall be powered from the OCS.	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification

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				#1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g) (iii)	A. A switch heater case shall be provided at each interlocking or group of interlockings to distribute power to each switch heater;	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g) (iii)	B. A main circuit breaker and disconnect shall be provided at each switch heater case;	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g) (iii)	C. The elements for the switch heater for each switch shall be separately current protected; and	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g) (iii)	D. Current detection feedback shall be provided and heater failure shall be reported to the ATS servers at the MSF and to the ATS workstations at the TSCC. Indications shall also be provided on the Local Control Panel.	Not Applicable		As per the Ottawa LRT Project – 507528-P002 Supply of CBTC System – Clarification #1, answer 14, switch heaters will be supplied and controlled by others.
5.3 (g)	(iv) Switch machine controls shall provide overload protection and automatic recycling in case of obstructions.	YES	Technical Design Description Section - 3.20 Switch Position Detection	
5.3	(i) Wayside signals shall be provided only at MSF and mainline interlockings.	YES	Technical Design Description Section - 1.9.3 Trackside Equipment Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside	
5.3 (h) (i)	A. When the System is expanded into partially segregated	YES	Technical Design Description	

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	territory, wayside signals shall be provided at interconnected highway traffic signals.		Section - 1.6.2.1 Automatic Train Protection Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside	
5.3 (h)	(ii) Wayside signals shall be mounted such that the vertical center of the signal head is approximately 2.6 meters above top of rail. Lower signals may be provided in the MSF yard but the bottom of the signal head shall be at least 1 meter above top of rail.	YES	Technical Design Description Section - 1.9.3 Trackside Equipment	
5.3 (h) (ii)	A. Built in ladders shall be provided on high signal masts to permit the changing of aspect lamps.	YES	Technical Design Description Section - 1.9.3 Trackside Equipment	
5.3 (h)	(iii) Signal heads shall be located outside the dynamic envelope of the LRV.	YES	Technical Design Description Section - 1.9.3 Trackside Equipment	
5.3 (i)	(i) Passive transponders with location and Track information shall be installed along each Track in CBTC territory. The transponders shall be located at intervals as required to provide the specified Train location error limits, to provide verification of Track at interlockings and to provide the specified Station stopping precision.	YES	Technical Design Description Section - 1.9.3 Trackside Equipment Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside Technical Design Description Section - 1.10.2.2.1 Transponder Tags Technical Design Description Section - 1.10.2.2.1 Transponder Tags Technical Design Description Section - 3.3.1 Wheel Diameter Calibration	
5.3 (i)	(ii) The LRV's Onboard Computer shall detect missing of malfunctioning norming transponders and shall report this failure to the CBTC maintenance server.	YES	Technical Design Description Section - 1.10.2.2.1 Transponder Tags Technical Design Description Section - 1.10.2.2.1 Transponder Tags	

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			Technical Design Description Section - 3.30.3 Transponder Failure	
5.3 (j)	(i) In order to minimize disruption caused by communications failures, a fixed block Train detection system shall be provided. Fixed block status shall be provided to the ATC Zone Controller through the VMIS.	YES	Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside Technical Design Description Section - 3.4.1 Secondary Train Presence Detection	
5.3 (j)(i)	A. In case of failure of CBTC with an individual Train for more than a pre-determined time, the ATC Zone Controller shall determine the location of that Train from fixed block occupancy;	YES	Technical Design Description Section - 3.4.1 Secondary Train Presence Detection	
5.3 (j)(i)	B. In the case of a general communications crash and re-boot, the ATC Zone Controller shall utilize fixed block occupancy and vacancy to assist in verifying that all Trains are accounted for during recovery;	YES	Technical Design Description Section - 3.4.1 Secondary Train Presence Detection Technical Design Description Section - 3.9.2.1 Non-communicating Train Tracking	
5.3 (j)(i)	C. The length of fixed blocks shall be consistent with facilitating a quick recovery from a system crash; and	YES	Technical Design Description Section - 3.4.1 Secondary Train Presence Detection	
5.3 (j)(i)	D. Fixed block Train detection electronics and power Equipment shall be consolidated in the CIHs located at interlockings; and	YES	Technical Design Description Section - 1.9.2 Wayside Equipment Note that Fixed Block Train detection electronics will be collocated with the Zone Controllers in the Signalling Equipment Rooms	
5.3 (j)(i)	E. Track circuit voltage selection shall take into account the track bed, stability, leaf contamination, wheel and rail profile and the potential for rail oxidization due to climatic conditions.	YES	Technical Design Description Section - 3.4.1 Secondary Train Presence Detection	
5.3	(i) A broken rail detection system shall be provided.	YES	Technical Design Description Section - 6.4 Broken Rail Detection System (BRDS)	
5.3 (k)(i)	A. The broken rail protection system shall provide input to the ATC Zone Controllers.	YES	Technical Design Description Section - 6.4 Broken Rail	

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			Detection System (BRDS)	
5.3	(l) The broken rail detection requirement applies to all mainline Tracks. It shall also apply to MSF Tracks if warranted by Safety analysis.	YES	Technical Design Description Section - 6.4 Broken Rail Detection System (BRDS)	
5.3 (m)	(i) The TSCC workstations, the MSF servers and all wayside CBTC controllers and interfaces, shall be connected to each other and to wayside APs over independent redundant fibre optic networks.	YES	Technical Design Description Section - 1.9.5 Data Communication System (DCS) Equipment	
5.3 (m)	(ii) Networks Design and Equipment shall be based upon an open standard such that replacement Equipment may be procured from multiple sources.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 2.3 Data Communication System (DCS) Description	
5.3 (m)(ii)	B. The fibre optic backbone networks shall designed such that for each node there are 2 paths to any other node.	YES	Technical Design Description Section - 2.3.3 DCS Network Topology	
5.3 (m)(ii)	C. Network switches shall be located in CIHs and in station communications rooms as needed.	YES	Technical Design Description Section - 2.3.3.1 Wayside Network	
5.3 (m)(ii)(C)	i. All network switches regardless of location shall have at least 4 hours of battery backed up power.	Noted		As per scope split UPS to be supplied by others.
5.3 (m)	(iii) The Network shall be designed to reliably meet the latency requirements determined by the Headway requirements outlined in Part 1 Article 2 – Operational Performance Requirements.	YES	Technical Design Description Section - 2.3.2 DCS Performance Features Technical Design Description Section - 3.10 Train Separation	
5.3 (m)	(iv) The integrity of vital messages shall not depend on network protocols but upon error checking and time stamp checking methods used by the attached vital systems.	YES	Technical Design Description Section - 1.6.1.5 Data Communication System	
5.3 (m)	(v) The CBTC system fibres shall be run in separate cables from all other communications systems. Each of the two CBTC fibre optic networks shall be run in a separate cable and a separate conduit or trough. The routing of fibre cables shall minimize the possibility disabling both networks with a single digging accident or lightning strike.	YES	Technical Design Description Section - 2.3.3.2 Radio Network	

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5.3 (n)	(i) APs shall be provided along the right of way.	YES	Technical Design Description Section - 1.10.2.2 Equipment Installed at Trackside Technical Design Description Section - 1.10.2.2.3 Wayside Radio Units (Access Point) and Antennae	
5.3 (n)	(ii) Communications between APs and Trains shall be based upon an open or proprietary standard such that replacement APs may be procured from multiple sources.	YES	Technical Design Description Section - 2.3 Data Communication System (DCS) Description Technical Design Description Section - 2.3.3.2 Radio Network	
5.3 (n)	(iv) Advanced encryption and error checking, time stamping, etc. in accordance with EN 50159-2 or equivalent standard shall be used to prevent deliberate and random message falsification and to guarantee message integrity. Additional measures shall be taken to mitigate the possibility of and damage from non-safety critical interference such as denial of service and man in the middle attacks and to reduce potential interference from external wireless networks.	YES	Technical Design Description Section - 1.5 Standards Compliance Technical Design Description Section - 2.3 Data Communication System (DCS) Description Technical Design Description Section - 2.3.4 Security	
5.3 (n)	(v) The CBTC wireless communication system shall not carry data for any other Vehicle or wayside system.	YES	Technical Design Description Section - 2.3.1 Overall use of DCS network	
5.3 (n)	(vi) Nodes on both backbone networks shall be able to talk to all APs.	YES	Technical Design Description Section - 2.3 Data Communication System (DCS) Description Technical Design Description Section - 2.3.3 DCS Network Topology	
5.3 (n)	(vii) APs shall be spaced along the Alignment as needed to provide redundant radio coverage for each Train antenna at all times. Not only shall coverage be redundant but APs shall be redundant.	YES	Technical Design Description Section - 2.3.3 DCS Network Topology Technical Design Description Section - 2.3.3.2 Radio Network	

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5.3 (n)	(viii) AP electronics shall be protected in sealed enclosures watertight to IP67 or NEMA equivalent. Alternatively, they shall be IP65, and be mounted high enough to prevent them being under water due to any environmental condition.	YES		
5.3 (n)	(ix) Project Co shall perform propagation studies and intermodulation studies to determine placement of APs and antennas on the wayside and the proper location of antennas on the Trains.	YES	Technical Design Description Section - 2.3.3.2 Radio Network	
5.3 (n)	(x) Frequency selection and antenna placement for LRV voice and non CBTC data radios shall be coordinated to minimize interference with CBTC wireless communication.	YES	Technical Design Description Section - 2.3.3.2 Radio Network	
5.3 (n)	(xi) Power for all APs shall be provided from a source with a minimum of a 4 hour battery backup. Power distribution to the APs shall be redundant. A short in a single AP shall not affect the operation of any others.	YES	Technical Design Description Section - 2.3.3.2 Radio Network	
5.3 (o)	(i) A TSCC and CIH event recording systems shall be provided to record changes in switch positions, and signal aspects, fixed block occupancy, Train location, and ATS commands to the interlockings and Trains.	YES	Technical Design Description Section - 2.3.4.2.2 Audit and Data Collection Technical Design Description Section - 5.5 Event Logging	
5.3 (o)	(ii) All events shall be time stamped.	YES	Technical Design Description Section - 5.5 Event Logging	
5.3 (o)	(iii) Sufficient storage shall be provided to record all events for a minimum of 60 days.	YES	Technical Design Description Section - 5.5 Event Logging	
5.3 (o)	(iv) Onboard CBTC systems shall report all changes in Movement Authority, all Onboard Computer Train Control commands, all changes in speed limits, etc. to the Vehicle Event Recorder.	YES	Technical Design Description Section - 5.5 Event Logging Technical Design Description Section - 6.3.0-2 Vehicle Monitoring System Technical Design Description Section - 6.3.0-4 Vehicle Event Recorder Technical Design Description Section - 8.1.4.2 Local Diagnostic Data Collectors	
5.3 (p)	(i) The onboard components of the CBTC system shall include redundant Onboard Computers, redundant VLS, a CBTC Panel in	YES	Technical Design Description Section - 1.4 SelTrac CBTC	

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	each cab, and redundant CBTC data radios and antennas. The onboard systems shall be powered any time battery power is available on the Vehicle.		Architecture Technical Design Description Section - 1.9.4 On-Board Equipment Technical Design Description Section - 1.10.3 On-Board Equipment	
5.3 (p)(ii)	A. Manage and verify communications with wayside CBTC systems;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (p)(ii)	B. Obtain Movement Authority from the ATC Zone Controller;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (p)(ii)	C. Vitally check the integrity and version of its Track Database;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.6.1.3 Automatic Train Control: Train Position and Speed Technical Design Description Section - 1.8.1 Guideway Data Definition	
5.3 (p)(ii)	D. Obtain an up to date Track Database as necessary;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.8.1 Guideway Data Definition	
5.3 (p)(ii)	E. Vitally determine the length of the Train and Train integrity;	YES	Technical Design Description Section - 3.5 Train Length Determination	
5.3 (p)(ii)	F. Determine location of the Train and the maximum accumulated position error based upon data provided by the VLS;	YES	Technical Design Description Section - 3.3.1 Wheel Diameter Calibration Technical Design Description Section - 3.3.3 Wheel Slip	

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			Detection and Compensation Technical Design Description Section - 3.4 Train Position Determination	
5.3 (p)(ii)	G. Communicate Train location, length, speed and maximum position error to the ATC Zone Controller;	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (p)(ii)	H. Calculate and enforce a penalty brake speed profile based upon Train location, Track grades, Movement Authority, civil and temporary speed restrictions and work zones;	YES	Technical Design Description Section - 3.13 Overspeed Protection Technical Design Description Section - 3.15 Train Door Status Supervision Technical Design Description Section - 3.17 Train Departure Authorization Technical Design Description Section - 3.22.3.5 Switch Obstruction Technical Design Description Section - 3.23 Open/Close Track/Zone Technical Design Description Section - 6.4 Broken Rail Detection System (BRDS)	
5.3 (p)(ii)	I. Initiate an emergency brake application for any violation of the penalty brake speed profile or if a Train moves beyond the end of its Movement Authority;	YES	Technical Design Description Section - 3.13 Overspeed Protection Technical Design Description Section - 3.19.4 Movement Authority	
5.3 (p)(ii)	J. Obtain a vital determination that the Train is within the Station and stopped before doors may be opened;	YES	Technical Design Description Section - 1.6.2.1 Automatic Train Protection Technical Design Description Section - 1.10.2.2.2 Proximity Plate at Stations	

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			Technical Design Description Section - 3.3.2 Zero Speed Detection Technical Design Description Section - 3.14 Train Alignment Determination	
5.3 (p)(ii)	K. Vitally permit door opening on the Platform side of the Train only;	YES	Technical Design Description Section - 2.2.4 Train Door Opening / Closing Process: Technical Design Description Section - 3.16 Train Door Enable Control Technical Design Description Section - 4.3 Train Door Control	
5.3 (p)(ii)	L. Provide zero velocity status to any Vehicle systems that need it;	YES	Technical Design Description Section - 1.6.2.1 Automatic Train Protection Technical Design Description Section - 3.3.2 Zero Speed Detection	
5.3 (p)(ii)	M. Provide a vital roll back protection function; and	YES	Technical Design Description Section - 1.6.2.1 Automatic Train Protection Technical Design Description Section - 3.11 Rollback Protection	
5.3 (p)(ii)	N. Have a non-vital processor to implement automatic speed regulation, automatic station stopping and other ATO functions and to implement ATS commands received from the wayside.	YES	Technical Design Description Section - 1.6.2.2 Automatic Train Operation Technical Design Description Section - 2.1.1 Automatic Train Operation (ATO) Mode Technical Design Description Section - 4 Automatic Train Operation (ATO) Technical Design Description Section - 4.2 Automatic Train	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			Speed Control Technical Design Description Section - 4.2.1 Start-up On a Grade Technical Design Description Section - 4.2.2 Run Type Management Technical Design Description Section - 4.2.3 Station Stopping Technical Design Description Section - 4.3 Train Door Control Technical Design Description Section - 4.5 Station Skip Technical Design Description Section - 4.6 Braking/Acceleration Rate Selection Technical Design Description Section - 4.7 Dwell Control Technical Design Description Section - 4.8 Alarms Monitoring and Reporting Technical Design Description Section - 4.12 Fire Alarm Monitoring Technical Design Description Section - 4.13 Train Wake-up (Automatic Depot Option) [redacted]	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
5.3 (p)(iii)	A. The VLS shall determine Vehicle location based upon vital tachometer pulse counting with error correction based on vital interrogation of wayside norming transponders.	YES	Technical Design Description Section - 3.4 Train Position Determination	
5.3 (p)(iii)	B. Vital checks shall be provided for speed sensor and pulse counter integrity.	YES	Technical Design Description Section - 3.3.1 Wheel Diameter Calibration Technical Design Description Section - 3.3.3 Wheel Slip Detection and Compensation	
5.3 (p)(iii)	C. The VLS shall also independently detect the direction of Train motion.	YES	Technical Design Description Section - 3.3 Train Speed Determination	
5.3 (p)(iii)	D. An algorithm shall be provided to account for distance travelled during spins and slides.	YES	Technical Design Description Section - 3.3.3 Wheel Slip Detection and Compensation	
5.3 (p)(iv)	A. Redundant data radios and antennas shall be provided to communicate with the wayside CBTC controllers through wayside APs.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 3.30.2.0-1.1 ZC to VOBC Communication Loss	
5.3 (p)(iv)	B. Redundant communication paths and Equipment shall be provided both for Train to wayside and for all networked CBTC subsystems within the Vehicle and Train.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture	
5.3 (p)(iv)	C. Any Train network used by the CBTC system to communicate between CBTC Onboard Computers on different Vehicles in a Train shall be redundant and have a proven record of reliable communication over electrical coupler heads that are frequently coupled and uncoupled. Reliance on Ethernet through standard electrical coupler heads for the operation of the CBTC system is not permitted.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture VOBC BBI Section 3.6.2.1 Coupler Interface	
5.3 (p)(v)	A. A CBTC Panel shall be mounted in each cab. The CBTC Panel shall be separate from the Train Display Screen.	YES	Technical Design Description Section - 1.6.2.2 Automatic Train Operation Technical Design Description Section - 1.9.4 On-Board Equipment	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD) Technical Design Description Section - 2.1.2 Automatic Train Protection (ATP) Mode	
5.3 (p)(v)	B. The CBTC Panel shall be designed to minimize distraction from the task of operating the Train.	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)	C. The displays on the CBTC Panel shall be designed for at least 100,000 hours MTBF.	YES		
5.3 (p)(v)(C)	i. Inputs shall be by pushbuttons rather than touch screen.	N/A		All buttons and mode switches to be provided by Alstom
5.3 (p)(v)	D. The CBTC Panel shall at minimum display:	YES	Technical Design Description Section - 1.6.2.2 Automatic Train Operation Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	i. Train CBTC operating mode;	YES	Technical Design Description Section - 1.6.2.2 Automatic Train Operation Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD) Technical Design Description Section - 2.1 Train Operating Modes	
5.3 (p)(v)(D)	ii. CBTC operational status as result of checks when entering CBTC territory, self-checks, etc.;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	iii. Current CBTC determined Train speed;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	iv. Currently authorized maximum CBTC Train speed;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
5.3 (p)(v)(D)	v. Train speed alarm active;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	vi. Side on which doors are enabled to open;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	vii. ATS Station hold active indication;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	viii. Bypass stop at next Station indication;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(D)	ix. Dwell over warning; and	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD) Technical Design Description Section - 4.7 Dwell Control Technical Design Description Section - 5.4.16.2.0-1 The [redacted]	
5.3 (p)(v)(D)	x. Short messages indicating the reason for a temporary speed restriction or the approach to a work zone, faults, etc.	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)	E. The CBTC Panel shall support at minimum the following system inputs:	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(v)(E)	i. Mode Selection – ATO, ATP Only, Coupling, or Non CBTC Territory.	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(vi)	A. In order to allow movement of the Train under CBTC failure conditions, a CBTC bypass switch shall be provided in a locked cabinet to allow the Train Driver to bypass all CBTC control of the	YES	Technical Design Description Section - 2.1 Train Operating Modes	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	Train and its propulsion, braking and emergency brake systems.		Technical Design Description Section - 2.1.8 ATP Cut-out Mode	
5.3 (p)(vi)(B)	i. An indicator that CBTC is bypassed shall flash on the CBTC Panel;	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.3 (p)(vi)(B)	ii. Master Controller commands shall be passed directly to the propulsion and braking system;	Noted		
5.3 (p)(vi)(B)	iii. The propulsion system shall non-vitally limit Train speed to a reasonably safe speed; and	Noted		
5.3 (p)(vi)(B)	iv. Operation with CBTC bypassed shall be line of sight under TSCC supervision with observance of interlocking signals.	Noted		
5.3 (q)	(i) Before any equipped Train may enter CBTC mainline territory and receive Movement Authority it shall register with the wayside CBTC system.	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.3 (q)	(ii) When the Onboard Computer determines it has entered CBTC territory it shall disable the Non-CBTC Territory mode of operation, come to a stop and attempt to initialize the Train with the wayside CBTC system.	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.3 (q)	(iii) During Train initiation the Onboard Computer shall:	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.3 (q)(iii)	A. Provide all data required by the wayside CBTC system to track the Train and the moving or virtual block it is occupying;	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.3 (q)(iii)	B. Update and verify the Track Database; and	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.3 (q)(iii)	C. Provide any other information required for ATS scheduling and routing.	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.3 (q)	(iv) If initialization requires RFID tags on the Vehicle and wayside tag readers, tags shall be provided on all Vehicles and readers shall be provided at all entrances to CBTC Territory and as required to handle contingencies.	Not Applicable		RFID tags are not required by Thales' signalling system.
5.3 (r)	(i) Non-Revenue high rail Vehicles shall be detected and protected by the CBTC system.	YES	Technical Design Description Section - 3.9.2 Non-	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			Communicating Trains (NCT) Technical Design Description Section - 3.9.2.1 Non-communicating Train Tracking	
5.4	(a) Modes of line operation and interlocking operation shall be selectable from the TSCC ATS workstation.	YES	Technical Design Description Section - 5.4 Manual Control Functions	
5.4	(b) Modes of CBTC Vehicle operation shall be selectable from the Control Panel. The mode of operation of each Vehicle shall be reported to the ATS system and displayed on the TSCC dispatcher's workstation display and recorded in the TSCC event recorder.	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD)	
5.4 (c)	(i) ATP Only mode of operation may be used in any CBTC area.	YES	Technical Design Description Section - 2.1.2 Automatic Train Protection (ATP) Mode	
5.4 (c)	(ii) In ATP Only mode all vital communications between the wayside and the Vehicle shall be processed.	YES	Technical Design Description Section - 2.1.2 Automatic Train Protection (ATP) Mode	
5.4 (c)	(iii) In ATP Only operation, the Train speed shall be controlled within the limits of the penalty brake speed profile.	YES	Technical Design Description Section - 2.1.2 Automatic Train Protection (ATP) Mode	
5.4 (c)	(iv) Door opening and closing shall be enabled.	YES	Technical Design Description Section - 2.1.2 Automatic Train Protection (ATP) Mode	
5.4 (c)(iv)	A. The ATP system shall allow door opening only within the limits of the Station and only on the Platform side.	YES	Technical Design Description Section - 3.15 Train Door Status Supervision	
5.4 (c)	(v) When a Train exceeds a service brake speed profile 2 to 3km/hr below the penalty brake speed profile, the ATP system shall request a service brake application until the Train is below the service brake speed profile. An alarm shall sound until the Train is underspeed.	YES	Technical Design Description Section - 3.13 Overspeed Protection	
5.4 (c)	(vi) When the Train is 2 to 3 seconds from an automatic service brake application, an alarm shall sound.	YES	Technical Design Description Section - 3.13 Overspeed Protection	
5.4 (c)(vi)	A. Timing of the alarm and the service brake speed profile shall be designed so that a Driver will not exceed the penalty brake	YES	Technical Design Description Section - 3.13 Overspeed	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	speed.		Protection	
5.4 (c)	(vii) If the Train speed crosses the penalty brake speed profile, an emergency brake application and removal of all propulsion power shall be initiated.	YES	Technical Design Description Section - 3.13 Overspeed Protection	
5.4 (c)	(viii) ATS speed modification commands and station hold commands will not be enforced by the Onboard Computer ATO function. However, "station hold" and "next station bypass" indications shall be provided on the CBTC control panel.	YES	Technical Design Description Section - 1.10.3.5 Train Operator Display (TOD) Technical Design Description Section - 4.4 Platform Hold Technical Design Description Section - 4.5 Station Skip Technical Design Description Section - 4.6 Braking/Acceleration Rate Selection Technical Design Description Section - 5.4.7 Set Acceleration and Braking Rate Technical Design Description Section - 5.4.13 Train Hold Technical Design Description Section - 5.4.14 Platform Skip Technical Design Description Section - 5.4.15 Platform Close Technical Design Description Section - 5.4.17 Temporary Speed Restriction	
5.4 (d)	(i) ATO is a non-vital function overlaid on the vital ATP function and operating within the limits imposed by the ATP function. ATO mode shall be initiated from the CBTC Panel. In ATO mode, the Onboard Computer ATO function controls the propulsion and braking trainlines to:	YES	Technical Design Description Section - 2.1.1 Automatic Train Operation (ATO) Mode	
5.4 (d)(i)	A. Limit acceleration and braking rates in order to ensure a level of passenger comfort consistent with the required Headway and run times;	YES	Technical Design Description Section - 4.2 Automatic Train Speed Control	
5.4 (d)(i)	B. Allow the Train to operate as close as possible to the ATP penalty brake speed profile without exceeding it;	YES	Technical Design Description Section - 4.2 Automatic Train	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			Speed Control	
5.4 (d)(i)	C. Accurately stop Trains in Stations;	YES	Technical Design Description Section - 4.2.3 Station Stopping	
5.4 (d)(i)	D. Hold Trains at Stations based on ATS commands;	YES	Technical Design Description Section - 4.4 Platform Hold	
5.4 (d)(i)	E. Skip Station stops based upon ATS commands;	YES	Technical Design Description Section - 4.5 Station Skip	
5.4 (d)(i)	F. Adjust allowed acceleration and braking rates and non-vital speed limits based on ATS commands received; and	YES	Technical Design Description Section - 4.6 Braking/Acceleration Rate Selection	
5.4 (d)(i)	G. Adjust maximum speeds within the ATP penalty brake profile to comply with ATS energy saving or schedule enforcement commands.	YES	Technical Design Description Section - 5.2.4.2 Run Type Regulation Technical Design Description Section - 5.2.5 Energy Savings Features	
5.4 (d)	(ii) Automatic door opening and closing with override shall be a configurable feature of the ATO mode of operation.	YES	Technical Design Description Section - 2.2.4 Train Door Opening / Closing Process:	
5.4 (d)	(iii) A Driver may be required to take control of Train operation even during ATO operation. The interface with the Train Control system shall be such that a Driver may assert control of the Train with the same Master Controller handle movement as would be used if the CBTC system were in ATP Only Mode. For example, it may be necessary for the ATO function to monitor the Master Controller output as well as its own propulsion and braking requests and output to the trainlines the more restrictive of the two.	YES	Technical Design Description Section - 2.1.1 Automatic Train Operation (ATO) Mode	
5.4 (d)	(iv) The deadman function of the Master Controller handle shall be active during ATO.	YES	Technical Design Description Section - 4.11 Deadman Switch Monitoring	
5.4 (d)	(v) Automatic correction of station overruns shall not be provided.	YES	Technical Design Description Section - 3.24 Crawlback Protection	
5.4 (d)	(vi) With future expansion into partially segregated rights-of-way with at-grade crossings, the ATO mode shall be automatically	Noted	Technical Design Description Section - 1.9.2 Wayside	

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	cancelled when the Train enters the partially segregated territory. The Train shall drop back to ATP Only Mode.		Equipment Technical Design Description Section - 3.27 Mode Allowed Zones	
5.4 (e)	(i) A Train Control function shall be provided to allow a Train to close in on another Train at reduced speed for coupling purposes. This function shall not permit movement into an interlocking with a signal at stop.	YES	Technical Design Description Section - 2.1.5 Coupling Mode	
5.4 (e)	(ii) When two Trains or Vehicles couple, the new Train that is formed shall register with the CBTC system before Movement Authority can be granted.	YES	Technical Design Description Section - 3.6 Train Manual Coupling and Uncoupling	
5.4 (e)	(iii) When a Train decouples into two Trains or Vehicles each section must register with the CBTC system before Movement Authority can be granted.	YES	Technical Design Description Section - 3.6 Train Manual Coupling and Uncoupling	
5.4 (f)	(i) The Non-CBTC Territory Mode is provided for operation in areas where CBTC enforcement is not applied.	YES	Technical Design Description Section - 2.1.6 Non-CBTC Territory Mode	
5.4 (f)(i)	A. Movement Authority shall end at the beginning of Non-CBTC Territory. In order to move the Train into Non-CBTC Territory, a Driver must select Non-CBTC Territory Mode.	YES	Technical Design Description Section - 2.2.2 Train Exit from CBTC Territory	
5.4 (f)(i)	B. In Non–CBTC Territory Mode, the Onboard Computer enforces a 20km/h speed limit.	YES	Technical Design Description Section - 2.1.6 Non-CBTC Territory Mode	
5.4 (f)(i)	C. Upon leaving Non-CBTC Territory, Non-CBTC Territory Mode is disabled and the Train will brake to a stop until it receives Movement Authority to proceed from with the wayside CBTC system.	YES	Technical Design Description Section - 2.2.1 Train Entry into CBTC Territory	
5.4 (g)	(i) A Manual Release mode shall be provided for each Vehicle to allow a latched manual operation at a restricted speed through areas where communications has failed. The restricted speed shall be enforced by the ATP function. When communications is restored, the Onboard Computer shall automatically disable this mode and return to the previous mode of operation.	YES	Technical Design Description Section - 2.1.7 Manual Release Mode	
5.4 (g)	(ii) Manual Release mode shall be initiated by activating a switch which is not accessible from the cab seat. This mode is a line of sight operating mode which requires TSCC permission.	YES	Technical Design Description Section - 2.1.7 Manual Release Mode	
5.4 (g)	(iii) The Manual Release mode shall also allow a limited reverse	YES	Technical Design Description	

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	movement of no more than 5 meters after a Station overrun. During reverse movement speed shall be limited to 5km/h. The reverse movement feature shall only be available when the Train is in close proximity to a station.		Section - 2.1.7 Manual Release Mode	
5.4 (h)	(i) The automatic mode of the ATS system shall control interlockings and switches, as well Train dwell times, Train speeds and acceleration rates within the parameters allowed by the ATP and vital interlocking systems.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.6.1.1 Station to Station Operation Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking Technical Design Description Section - 1.6.1.3 Automatic Train Control: Train Position and Speed Technical Design Description Section - 1.6.1.4 Automatic Train Supervision: Signalling Management and HMI	
5.4 (h)	(ii) In Automatic mode, the ATS system shall enforce schedules. When delays occur the ATS system shall automatically adjust Headways, departure times and speeds to optimize recovery and return to schedule. The ATS system shall also automatically control the interlocking interfacing with the yard to build up and reduce service around rush hours with minimal disruption of mainline traffic	YES	Technical Design Description Section - 1.6.1.4 Automatic [redacted]	
5.4 (h)	(iii) Automatic mode shall also automatically set up routes and clear signals to bring Trains out of the MSF to the Mainline to build up service for rush hours and take Trains off the line to reduce service after rush hours.	YES	Technical Design Description Section - 5.2.2 Train Launch/Train Entry to Service	
5.4 (h)	(iv) Two optimization options for automatic operation shall be	YES	Technical Design Description	

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	provided:		Section - 5.2.3 Schedule/Headway Regulation	
5.4 (h)(iv)	A. Headway and schedule optimization; and	YES	Technical Design Description Section - 5.2.3 Schedule/Headway Regulation Technical Design Description Section - 5.2.4 Variance Control	
5.4 (h)(iv)	B. Energy saving.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 5.2.4.2 Run Type Regulation Technical Design Description Section - 5.2.5 Energy Savings Features Technical Design Description Section - 5.2.5.1 Energy Optimisation at the Supervision Level Technical Design Description Section - 5.2.5.1.1 Adaptive Slow Running Technical Design Description Section - 5.2.5.1.2 Arrival/Departure Coordination Technical Design Description Section - 5.2.5.2 Energy Efficient Planning Technical Design Description Section - 5.3.1.1 Green Timetable Compiler	
5.4 (i)	(i) In the Manual Operation mode of the ATS system, the TSCC personnel shall control interlocking signals and switches through the TSCC workstation.	YES	Technical Design Description Section - 5.4 Manual Control Functions	
5.4 (i)(i)	A. The TSCC personnel shall be able to set up routes by selecting entrances and exits or by selecting switch position for	YES	Technical Design Description Section - 5.4.1 Manual Route	

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	each switch.		Technical Design Description Section - 5.4.2 Line Assignment Technical Design Description Section - 5.4.3 Run Assignment Technical Design Description Section - 5.4.4 Shuttle Operation	
5.4 (i)(i)	B. The TSCC personnel shall be able to request switch positions and block and block and unblock switches	YES	Technical Design Description Section - 5.4.19 Manual Switch Control Technical Design Description Section - 5.4.25.2 Switch Blocking	
5.4 (i)(i)	C. The TSCC personnel shall be able to call, cancel and fleet signals.	YES	Technical Design Description Section - 5.4.1 Manual Route	
5.4 (i)(i)	D. The TSCC personnel shall be able to set interlockings to an automatic turn back mode with approach triggering, scheduled departure ring offs and inbound Track preference. Automatic departure schedule adjustment to recover from delays shall not be available in this mode.	YES	Technical Design Description Section - 1.7.1 Normal Mode Operation Technical Design Description Section - 1.7.1.3 Turnback Operation Technical Design Description Section - 1.7.2.1 Failures External to the System Technical Design Description Section - 5.2.9 Diversions	
5.5	(a) The ATS servers or similar shall provide Train location information to the Train arrival announcement system.	YES	Technical Design Description Section - 5.9.1 Passenger Information System	
5.5	(b) The ATS servers shall provide data to City of Ottawa applications.	YES	Technical Design Description Section - 5.9.1 Passenger Information System	
5.5	(c) Data requests and transfers to outside systems shall take place over a network other than the CBTC network. The ATS interface to outside systems shall be provided with hardware and software security measures to block outside access to the CBTC network.	YES	Technical Design Description Section - 5.9.1 Passenger Information System	

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5.5	(d) The OBC shall provide a location and direction trigger to the Vehicle Automatic Announcement to trigger Station announcements.	YES	Technical Design Description Section - 5.9.1 Passenger Information System	
5.6	(b) Project Co shall Design and implement a solution for Train Control in the MSF that provides:	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)	(i) Control of power switches and interlockings from the YCC control panel.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)	(ii) A display on the YCC panel of all Trains on all Tracks and the order of the Vehicles in them.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)(ii)	A. The level of detail shall be selectable.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)	(iii) Standard signal system interlocking protection such as route locking, approach locking, detector locking, etc.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)	(iv) Signals at all interlockings to allow safe movement of Trains without functioning onboard CBTC systems.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)	(v) Yard speed limit enforcement for CBTC equipped Trains.	YES	Technical Design Description Section - 7.1 Option for Automatic Depot	
5.6 (b)	(vi) The Design of the yard Train Control System shall allow for coupling and uncoupling of Trains on any Tracks between interlockings.	YES	Technical Design Description Section - 2.1.5 Coupling Mode Technical Design Description Section - 3.6 Train Manual Coupling and Uncoupling	
5.6 (b)	(vii) The YCC shall not control the signals and switches in the interlockings entering or leaving the yard. These shall be controlled by the TSCC and the CBTC system.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)(vii)	A. CBTC transponders and wireless APs shall be installed on MSF yard lead Tracks approaching the interlockings interfacing with the mainline.	YES	Technical Design Description Section - 7 Depot Operation	
5.6 (b)(vii)	B. Trains which are not registered and initialized with the CBTC system shall not be permitted to leave the MSF yard without a manual override	YES	Technical Design Description Section - 7 Depot Operation	
5.7	(a) The Vehicle borne CBTC systems shall be provided with fault monitoring and diagnostic capabilities in accordance with Part 4 Article 3 – Revenue Vehicles.	YES	Technical Design Description Section - 8.1.1 Maintenance Approach	
5.7	(b) All Vehicle borne CBTC systems shall report faults to the Vehicle monitoring system.	YES	Technical Design Description Section - 6.3 On_Board	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
			External Interfaces	
5.7	(c) The OBC shall provide time of day correction to the VMS.	YES	Technical Design Description Section - 6.3 On_Board External Interfaces	
5.7	(d) All microprocessor based Vehicle and wayside Train Control Systems shall monitor and report faults to a CBTC maintenance server.	YES	Technical Design Description Section - 5.5 Event Logging Technical Design Description Section - 8.1.1 Maintenance Approach Technical Design Description Section - 8.1.2 Diagnostics Technical Design Description Section - 8.1.4.2 Local Diagnostic Data Collectors Technical Design Description Section - 8.1.4.3 Central Diagnostic Servers and Workstation	
5.8 (a)	(ii) Signal Cable used in Tunnels shall be provided with a low smoke zero halogen jacket.	YES	Technical Design Description Section - 1.10.2.2.4.1 Signal cable, Signal Case and Junction Box	
5.8 (a)	(iii) If audio frequency Track circuits are provided, the twisted pair or pairs for each impedance bond shall be run in a separate cable from the cable for any other impedance bond. The use of multi twisted pair cables feeding multiple impedance bonds is strictly prohibited.	YES	Technical Design Description Section - 1.5 Standards Compliance	
5.8 (a)	(iv) Signal wires from cables shall be terminated with compression lugs.	YES	Technical Design Description Section - 1.5 Standards Compliance	
5.8 (b)	(i) Signal cases, junction boxes, and switch heater cases shall be constructed of stainless steel, aluminum or fibreglass with locking doors and neoprene door seals.	YES	Technical Design Description Section - 1.10.2.2.3 Wayside Radio Units (Access Point) and Antennae	
5.8 (b)	(ii) All cable wires shall be terminated on AAR terminal boards with links and double nut locking. Gold nut links shall not be used in unheated cases and junction boxes.	YES	Technical Design Description Section - 1.10.2.1.3 Cable Termination Frame	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
5.8 (b)	(iii) Signal cases and junction boxes shall be earth grounded.	YES	Technical Design Description Section - 1.10.2.2.3 Wayside Radio Units (Access Point) and Antennae	
5.9 (a)	(i) Communications latency and CBTC Equipment response times shall be optimized to facilitate the Operational Performance Requirements outlined in Part 1, Article 2.	YES	Technical Design Description Section - 2.3.2 DCS Performance Features	
5.9 (b)	(i) The worst case ATP location error shall not exceed 5 meters for each Vehicle with all wayside transponders working and without any slides or spins.	YES	Technical Design Description Section - 3.4 Train Position Determination	
5.9 (b)	(ii) The Train shall stop reliably such that all doors are located on the Platform, with the required door setbacks from the Platform ends. The Train Control System shall be designed to allow precision stopping to support the future addition of Platform screen doors.	YES	Technical Design Description Section - 3.3.2 Zero Speed Detection Technical Design Description Section - 3.14 Train Alignment Determination	
5.9 (b) (ii)	A. The braking profile shall be adjustable to prevent Station over runs during low adhesion conditions.	YES	Technical Design Description Section - 3.3.2 Zero Speed Detection Technical Design Description Section - 4.2.3 Station Stopping Technical Design Description Section - 4.6 Braking/Acceleration Rate Selection	
5.9 (b)	(iii) The worst case ATP speed measurement error shall not exceed 1% with scheduled wheel diameter checking.	Meets with intent	Thales meets the intent of Schedule 15-2 part 4 Article 5.9(b) (iii), which is assessed to be an indirect attempt to specify a requirement to ensure speed measurement error sufficient to achieve system safety and operational targets. Thales meets the required system safety and operational targets.	
5.10 (a)	(i) The OBC shall generate penalty brake speed profiles within	YES	Technical Design Description	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	the limits of the safe braking model described in IEEE STD 1474.1		Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.5 Standards Compliance Technical Design Description Section - 3.22.5 Safe Braking Simulation	
5.10 (a)	(ii) The penalty brake for CBTC shall be an emergency friction brake without any Track brake application. Propulsion shall be disabled in a fail safe manner. Sanding shall be provided but shall be assumed not to work for purpose of safe braking computation.	YES	Technical Design Description Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.5 Standards Compliance Technical Design Description Section - 3.28 Emergency Brake Application	
5.10 (b)	(i) If the OBC fails to receive a Movement Authority update from the ATC Zone Controller it shall continue to enforce the speed profiles from the previous Movement Authority as well as speed restrictions. If the communications failure continues for longer than 5 seconds the Onboard Computer shall command and enforce a full service brake to stop.	YES	Technical Design Description Section - 3.30.1 Zone Controller Failure Technical Design Description Section - 3.30.2.0-1.1 ZC to VOBC Communication Loss	
5.10 (b)	(ii) If the ATC Zone Controller fails to receive a location update from a Train it shall maintain the previous location for Train separation purposes. If the communications failure continues for an approved length of time, the zone controller shall use fixed block occupancy for Train location. During communications failures fixed block occupancy shall also be used for approach locking and for route and detector locking release.	YES	Technical Design Description Section - 3.30.2.0-1.1 ZC to VOBC Communication Loss	
5.10 (c)	(i) The ATC Zone Controllers shall stop Train movement between the portal and the first station after the portal upon detection of pedestrian intrusion into the portal. The ATC Zone Controllers shall prevent Train movement in and into that area until the cause of the intrusion alarm is determined and the intrusion system is reset from the TSCC.	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.10 (d)	(i) The ATC Zone Controllers shall stop any Trains from entering	YES	Technical Design Description	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	the Tunnel or approaching an area where smoke is detected. In the Tunnel, but beyond the fire zone, trains shall not be prohibited from moving.		Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking	
5.10 (e)	(i) The ATC Zone Controller shall enforce a restricted speed or stop through any area indicating broken rail. A warning shall be presented on the CBTC Panel when the Onboard Computer is enforcing that restriction. If investigation proves that there is no broken rail, the restriction may be lifted from a TSCC workstation.	YES	Technical Design Description Section - 6.4 Broken Rail Detection System (BRDS)	
5.10 (f)	(i) The speed limit of any temporary or civil speed restriction zone shall be enforced while any part of the Train is within the boundaries.	YES	Technical Design Description Section - 3.18 Temporary Speed Restriction	
5.10 (f)	(ii) When a Train approaches a work zone, ATO operation shall be suspended. The Train shall operate in ATP Only Mode, and the assigned speed limit or stop shall be enforced.	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking Technical Design Description Section - 3.27 Mode Allowed Zones	
5.10 (f)(ii)	A. Some work zones may require operation at limited speed while others may require a stop before proceeding on permission of the work crew. Both rules shall be enforced by the CBTC system.	YES	Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking Technical Design Description Section - 1.6.1.2 Automatic Train Control: Movement Authority and Interlocking Technical Design Description Section - 3.27 Mode Allowed Zones	
5.10 (g)	(i) The CBTC system Design shall account for degraded modes of operation and shall develop a Safety analysis of fall back operation in accordance with the standards outlined in this article.	YES	Technical Design Description Section - 1.7.2.2 Manual Operation of Non-communicating Trains	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
5.11	(a) Overall reliability of the CBTC Train Control System shall be such that with the provided redundancy, availability is 99.99% or greater. Availability calculations shall be based on the formula:	YES	Technical Design Description Section - 1 SYSTEM OVERVIEW AND DESIGN PRINCIPLES Technical Design Description Section - 1.4 SelTrac CBTC Architecture RAM Analysis Section – 6 OTTAWA LRT MTBF, MTBSAF, AND ACMT SUMMARY Compliant - Preliminary [redacted]	
5.11 (a)	Availability = Mean_Time_Between_CBTC_System_Functional_Failures / (Mean_Time_Between_CBTC_System_Functional_Failures + Mean_Time_To_Restore_CBTC_System)	Noted	RAM Analysis Section – 4.2.1 Availability Calculation	
5.11 (a)	(i) Mean_Time_To_Restore_CBTC_System includes repair crew travel time and time to replace failed Trains on the line as well as mean time to repair the failure.	YES	RAM Analysis Section – 6 OTTAWA LRT MTBF, MTBSAF, AND ACMT SUMMARY Compliant - Preliminary [redacted]	
5.11	(b) CBTC availability does not include failures of fixed block or broken rail detection systems or switch machines. etc.	Noted	RAM Analysis Section – 6 OTTAWA LRT MTBF, MTBSAF, AND ACMT SUMMARY	
5.11	(c) The CBTC system shall be designed for a 30 year life.	YES	Technical Design Description Section - 1.5 Standards Compliance	
5.11 (d)	(i) The CBTC Onboard Equipment shall meet an overall	YES	Technical Design Description	

CLAUSE NUMBER	SCHEDULE 15-2 PART 4 ARTICLE 5 "TRAIN CONTROL" OLRT TECHNICAL REQUIREMENT	COMPLIANT? (YES / NO)	IF YES, RELEVANT SECTION OF PROPONENT'S TECHNICAL PROPOSAL IN SUPPORT OF THE COMPLIANCE STATEMENT.	IF NO, STATE THE DIFFERENCE BETWEEN THE PROPONENT'S TECHNICAL PROPOSAL AND THE OLRT TECHNICAL REQUIREMENT
	requirement of 480,000 km mean distance between chargeable failures		Section - 1.4 SelTrac CBTC Architecture Technical Design Description Section - 1.5 Standards Compliance Technical Design Description Section - 1.9.4 On-Board Equipment Assuming an overall average speed of 24 kph, a mean time between service affecting failures of 20,000 hours can be achieved.	
5.12	(a) Environmental requirements measures shall be included as part of the overall System Design considerations from the start of the Design to the final in-service testing. The wayside and onboard systems supplied must meet the temperature and humidity conditions found in Ottawa.	YES	Technical Design Description Section - 1 SYSTEM OVERVIEW AND DESIGN PRINCIPLES	
5.12	(b) At a minimum, all wayside Equipment shall meet all of the environmental requirements as delineated in the AREMA Environmental Requirements. Project Co shall test Equipment and submit certified test results showing the dates, locations and testing agency that performed the verification, at the City's request.	YES	Technical Design Description Section - 1.5 Standards Compliance [redacted]	
5.12	(c) The onboard Equipment shall meet the requirements of EN 50155 and the environmental conditions outlined in Part 4 Article 3 – Revenue Vehicles.	YES	Technical Design Description Section - 1.5 Standards Compliance	

Note: The table has not been updated to include the latest Addenda. The Addendums were all reviewed and the compliant statement has not changed due to the addenda.

END OF APPENDIX

Additional Complete Vehicle Onboard Equipment Packages Agreement

This Additional Complete Vehicle Onboard Equipment Packages Agreement (the "Option Agreement") is made as of this 12 day of February, 2013

BETWEEN

OLRT CONSTRUCTORS, an unincorporated joint venture, comprising **SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.**, **DRAGADOS CANADA, INC.** and **ELLISDON CORPORATION**, and having an office at 195 The West Mall, Toronto, Ontario M9C 5L5 (hereinafter called the "**Construction Contractor**") of the one part; and

THALES CANADA INC. coba THALES CANADA, TRANSPORTATION SOLUTIONS having its registered office at 105 Moatfield Drive, Toronto, Ontario M3B 0A4 CANADA (hereinafter called the "**Subcontractor**") of the other part

(the Construction Constructor together with the Subcontractor , the "Parties" and, individually any one of them, a "Party")

In consideration of the execution of an agreement between the Subcontractor with the Construction Contractor for the supply of automatic train control systems for the Project (the "**CBTC Supply Agreement**"), OLRT Project Subcontract No 507528-P002A, and other good and valuable consideration, the receipt of which is hereby acknowledged and confirmed, Thales agrees to abide by the terms of this Option Agreement as set forth below.

1. All capitalized terms not defined in this Option Agreement will have the meaning ascribed thereto in the CBTC Supply Agreement. In the case of any inconsistency, the meaning ascribed in the CBTC Supply Agreement will take precedence.

Additional Complete Vehicle Onboard Equipment Packages

2. The Construction Contractor and the Subcontractor agree that during the Option Term, the Construction Contractor shall have the option to purchase from Thales (the "**Option**") additional complete vehicle onboard equipment packages ("**Additional CBTC Packages**") at the fixed unit price described as Option A in Schedule B – Subcontractor Price and Payment Milestones of the CBTC Supply Agreement. The fixed unit price includes Dynamic PICO, which price is valid for any Order issued within [redacted] years after the Financial Close date and is subject to escalation for the final [redacted] years of that period, with the escalation base period of [redacted]. The Escalation Formula is as specified in Schedule B – Subcontractor Price and Payment Milestones of the CBTC Supply Agreement.

3. The Option shall be exercised by written notice (the "**Order**") given by the Construction Contractor to the Subcontractor and will specify, among others, the number of Additional CBTC Packages that the Construction Contractor wishes to purchase and the delivery date.

Terms & Conditions for the Order

4. Subject to the provisions of this Section 4, the terms and conditions that will apply to each Order shall be in accordance with the applicable terms of the CBTC Supply Agreement and the provisions of Schedule 35 of the Project Agreement (only if and to the extent applicable to this Option Agreement for the Additional CBTC Packages).

Price and Payment

a. The price of each Additional CBTC Package per Additional Vehicle will be described as Option A in Schedule B – Subcontractor Price and Payment Milestones of the CBTC Supply Agreement.

b. The Construction Contractor shall, for the Additional CBTC Packages under an Order, make payment of the aforementioned price as per the following milestones:

[redacted] on placement of order

[redacted]% on delivery of Additional CBTC Packages

[redacted] on issuance of an acceptance certificate by the Construction Contractor, which shall be issued within 30 days of receipt of a safety certificate from Thales that is satisfactory to Construction Contractor (acting reasonably)

Delivery Terms

- Delivery Duty Paid (DDP) Ottawa in accordance with INCOTERMS 2010

- Delivery will be 18 months from Subcontractor's receipt of order and not before the completion of the deliveries of all thirty four (34) VOBC's of the CBTC Supply Agreement

- Dynamic PICO/VOBC Safety validation completion would be 1 month after the completed train is made available for Thales CBTC testing

- Construction Contractor shall make train equipped with VOBCs purchased under this Option Agreement available to Subcontractor for dynamic testing of VOBC units within 4 months of delivery of such VOBC's or 22 months from Subcontractor's receipt of order for such VOBC's, whichever is later.

- Delivery Address is: Ottawa

c. All payments under any Order shall be conditional on their being in place a valid and enforceable Letter of Credit for the relevant agreement.

Performance Letter of Credit

d. Within 15 days of receipt of each Order, the Subcontractor will deliver a letter of credit ("**Letter of Credit**") in the amount of [redacted]% of the price of the total Additional CBTC Packages to be purchased and sold under the Order in a form substantially similar to that attached as Exhibit "A" to this Option Agreement. The Subcontractor shall ensure that the Performance Letter of Credit is valid and enforceable with respect to each Order until

the date when the City takes possession of the Additional Vehicles and deficiencies, if any, in the Additional CBTC Packages have been solved ("**City's Takeover Date**").

e. The Performance Letter of Credit shall be issued by a first class Canadian bank approved by the Construction Contractor. In the case where the rating of the issuer's senior unsecured debt has been downgraded by S&P below an A- rating, the Construction Contractor may on ten (10) Business Days' notice demand that the Subcontractor provide replacement Performance Letter of Credit which meets the requirements of this Clause.

f. The Construction Contractor will bear costs associated with a delayed City's Takeover Date unless such delay arises because of the Subcontractor's failure to comply with the terms of this Option Agreement or an Order. If the terms of the Performance Letter of Credit specify its expiry date, and the Subcontractor has not become entitled to receive the Performance Letter of Credit by the date 28 days prior to the expiry date, the Subcontractor shall extend the validity of the Performance Letter of Credit until the obligations under the Order have been completed and any defects have been remedied, failing which the Construction Contractor may immediately demand payment.

g. The Construction Contractor shall not make a claim under the Performance Letter of Credit, except for amounts to which the Construction Contractor is entitled under the Subcontract in the event of:

(a) failure by the Subcontractor to extend the validity of the Performance Letter of Credit as described in the preceding paragraph or failure by the Subcontractor to Provide replacement Performance Letter of Credit as required in the event of a downgrade of the issuer, in which event the Construction Contractor may claim the full amount of the Performance Letter of Credit,

(b) failure by the Subcontractor to remedy a default under this Option Agreement or an Order within ten (10) Business days, or such extended time period as agreed to between the Subcontractor and Construction Contractor, after receiving the Construction Contractor's notice requiring the default to be remedied, or

(c) circumstances which entitle the Construction Contractor to termination of this Option Agreement or an Order, irrespective of whether notice of termination has been given.

Warranty Letter of Credit

h. For each Order, the Subcontractor shall provide the Construction Contractor with a performance security ("**Warranty Letter of Credit**") in a form substantially similar to that attached as Exhibit B for proper performance of its warranty obligations under this Option Agreement and each Order relating to the Additional CBTC Packages provided

under this particular Order, equal in value to [redacted]%) of the total value of the Order.

i. The Warranty Letter of Credit shall be issued to the Construction Contractor 30 days prior to the expiry of the Performance Letter of Credit for each Order, so as to be in effect from the City's Takeover Date and shall expire two years after the City's Takeover Date. For greater certainty, the Warranty Letter of Credit for an Order shall only take effect upon the expiry of the Performance Letter of Credit for that Order.

j. The Warranty Letter of Credit shall be issued by a first class Canadian bank approved by the Construction Contractor. In the case where the rating of the issuer's senior unsecured debt has been downgraded by S&P below an A- rating, the Construction Contractor may on ten (10) Business Days' notice demand that the Subcontractor provide replacement Warranty Letter of Credit which meets the requirements of this Clause.

k. The Construction Contractor shall return the Performance Letter of Credit to the Subcontractor upon the City's Takeover Date.

l. Other than as specified here, the terms and conditions of the CBTC Supply Agreement related to the Warranty Performance Security will apply mutatis mutandis to the Letter of Credit, including the draw conditions and provisions related to the replacement of letters of credit.

m. The exercise of the options available under the Option Agreement shall not have the effect of extending the expiry of the Warranty Performance Security applicable to the Subcontracted Works performed under the Subcontract. The Warranty Performance Security does not entitle the Construction Contractor to a General Warranty Period under the CBTC Supply Agreement that would extend past [redacted].

n. The Construction Contractor shall not make a claim under the Warranty Performance Security except for amounts to which the Construction Contractor is entitled in the event of a failure by the Subcontractor to remedy a default of its warranty obligations under this Option Agreement and each Order with respect to the particular VOBC Package that is the subject of the Warranty Performance Security, within thirty (30) business days after Subcontractor receiving the Construction Contractor's notice requiring the default to be remedied.

Warranty

o. The warranty provisions of the CBTC Supply Agreement will apply *mutatis mutandis* to the Additional CBTC Packages to be purchased and sold under an Order. The General Warranty Period in relation to the hardware and such software embedded provided under an Order will commence on the City's Takeover Date for the relevant Order and continue until two years after the City's Takeover Date thereof. The Latent Defect Warranty Period will continue until 15 years after issuance of the City's Takeover Date for the

relevant order of Complete Vehicle Onboard Equipment Packages for Additional Vehicles. For clarity, the warranty provisions hereunder shall not have the effect of extending the General Warranty Period for equipment and software provided under the CBTC Supply Agreement.

Limitation of Liability

p. The total cumulative, aggregate liability of Subcontractor to the Construction Contractor, under or in connection with this Option Agreement or each individual Order other than as specified below shall not exceed the price of the relevant/individual Order. Except with respect to the quantum of the limitation of liability (which is as set out herein) the provisions of the CBTC Supply Agreement regarding limitations of liability and exclusions thereof will apply *mutatis mutandis* to each order.

Indemnities

q. The indemnity provisions of section 17 of the CBTC Supply Agreement will apply *mutatis mutandis* to this Option Agreement and each of the Thales P&S Agreement.

5. The Construction Contractor, as applicable, will forward to Subcontractor any notice, request or other communication that it receives relating to Subcontractor's rights and obligations under this Option Agreement or any Order, without undue delay, and in any case within two Business Days of receipt by Construction Contractor. The Construction Contractor and Subcontractor acknowledge that Project Co is bound by an equivalent provision under the Construction Contract.

6. The Construction Contractor may assign its interest in this Option Agreement or any Order at any time to Project Co (or as Project Co may direct) or the Maintenance Contractor. Upon assignment to the Project Co (or as Project Co may direct), or the Maintenance Contractor (as the case may be), all of the corresponding obligations of the Construction Contractor arising from and after, but not prior to, the date of assignment shall transfer to the assignee. In addition all applicable requirements pertaining to the use, care and maintenance of the Equipment shall transfer to the assignee.

7. This Option Agreement and any Order placed against this Option Agreement will continue in force notwithstanding any termination or unenforceability of the Construction Contract or the CBTC Supply Agreement.

8. Upon the occurrence of any event which would entitle Subcontractor to terminate this Option Agreement or an Order, Subcontractor shall serve notice (a "**Default Notice**") on the Construction Contractor, Project Co and the Collateral Agent of the occurrence, specifying details of such event and, if the relevant matter or circumstance has not been rectified or remedied by the Construction Contractor (or otherwise) within 30 Business Days of delivery of the Default Notice (the "**Default Period**"), Subcontractor may serve a further notice on the Construction Contractor terminating this Option Agreement or the relevant Order with immediate effect, with a copy of

such notice to Project Co and the Collateral Agent, provided that, at any time prior to the expiry of the Default Period, Subcontractor acknowledges and agrees that either the Collateral Agent or Project Co may, but is not obligated to, (i) assign the Construction Contractor's rights under this Option Agreement or any Order to a replacement contractor and/or (ii) cure the event which gave rise to the Subcontractor's right to terminate this Option Agreement or an Order, within 30 days from the Subcontractor's issuance of the further notice and the Subcontractor shall not be obligated to perform its obligations under the relevant agreement until such event which gave rise to the Subcontractor's right to terminate the relevant agreement has been cured; provided further that, unless agreed by the parties otherwise, upon assignment the replacement contractor shall be responsible for any obligations of the Construction Contractor (or the replacement contractor) arising from future performance of the relevant agreement.

9. With regards to this Option Agreement and any Order placed against the Option Agreement, the Subcontractor shall have the same rights and remedies in relation to the Construction Contractor (but not the Maintenance Contractor) as provided to the Subcontractor within the CBTC Supply Agreement, and/or Prime Contract, and/or Project Agreement, and such rights and remedies shall be applicable to this Option Agreement and any Order placed against the Option Agreement

10. This Option Agreement shall enure to the benefit of and bind the successors and permitted assigns of the parties.

11. This Option Agreement, and each of the documents contemplated by or delivered under or in connection with this Option Agreement, shall be governed by and construed in accordance with the laws of Ontario and the laws of Canada applicable therein and shall be treated in all respects as an Ontario contract, without regard to conflict of laws principles.

12. The Subcontractor and Construction Contractor both agree that any dispute arising out of this Option Agreement will be subject to the Dispute Resolution Procedure under the CBTC Supply Agreement. Except as aforesaid, all parties hereby irrevocably attorn to the exclusive jurisdiction of the courts of the Province of Ontario and all courts competent to hear appeals therefrom.

13. Each party shall do all things, from time to time, and execute all further documents as necessary to give full effect to this Option Agreement.

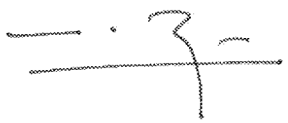
14. This Option Agreement may be executed in one or more counterparts. Any single counterpart or a set of counterparts executed, in either case, by all the parties shall constitute a full, original and binding agreement for all purposes. Counterparts may be executed either in original or faxed form provided that any party providing its signature in faxed form shall promptly forward to the other party an original signed copy of this Option Agreement which was so faxed.

In witness whereof, the authorized representatives of the parties have set their signatures below:

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:



Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA, TRANSPORTATION SOLUTIONS

Per:

Name:
Title:

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Name:
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Per:

Name:
Title:

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THALES CANADA INC.
coba THALES CANADA, TRANSPORTATION SOLUTIONS
Per:

Name:
Title:

Per:

Name:
Title:

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Name:
Title:

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name: RON AITKEN
Title: VP

Per:

Name: KEVIN LEMAY
Title: VP

On behalf of the Subcontractor:

THALES CANADA INC.
coba THALES CANADA, TRANSPORTATION SOLUTIONS
Per:

Name:
Title:

Per:

Name:
Title:

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Per:

Name: Manuel Rivaya
Title: Executive Vice President

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

THALES CANADA INC. coba THALES CANADA, TRANSPORTATION SOLUTIONS

Per:

Name: Michael Mackenzie
Title: COO