SUBCONTRACT AGREEMENT

Between

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

and

ALSTOM POWER & TRANSPORT CANADA INC.

Relating to the
Supply of Rail Vehicles for the
Ottawa Light Rail Transit Project

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APPENDIX NO.	APPENDIX NAME	NAME AND NO. OF INCLUDED DOCUMENTS
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		A2. Documents from Annex A to the LOI:

		- (i) Vehicle Specification - (iv), (v), (vi), (vii) Technical Response Extracts (Sections 5.4.2, 5.4.3, 5.4.5.2, 5.4.5.9) - (viii) Light Rail Vehicle Appendix Summary Document
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	RESOLUTION PROCEDURE	
Appendix J	INSURANCE	
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Appendix L	PRELIMINARY PROJECT MANAGEMENT PLAN	
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This SUBCONTRACT AGREEMENT made as of the 12th day of February 2013.

Between:

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

and

ALSTOM POWER & TRANSPORT CANADA INC., having its registered office at 1010 Sherbrooke Street, Suite 2320, Montreal, Quebec, H3A 2R7 (hereinafter called the "**Subcontractor**") of the other part

Whereas the Construction Contractor has been awarded a contract to design and construct the Project ("**Construction Contract**") with RIDEAU TRANSIT GROUP GENERAL PARTNERSHIP ("**Project Co**") dated on or about February 12, 2013.

Whereas the Construction Contractor desires that the following portion of the Works, dealing with the supply of light rail vehicles, 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.

Therefore the Construction Contractor and the Subcontractor agree as follows.

Article I – Subcontractor's Basic Obligation

The Subcontractor shall, at its own cost and risk:

(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 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. so as to satisfy the Output Specification;

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

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

vii. in a manner consistent with the Quality Plans;

viii. in a timely and professional manner;

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

x. 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;

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

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

(c) 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 Subcontractor shall not be under any obligation to perform any of the Construction Contractor's obligations under this Subcontract or the Construction Contract, other than as provided in this Subcontract;

(d) assist the Construction Contractor in developing and implementing, in accordance with Schedule 15-4 – Regulatory Standards to the Project Agreement, regulatory standards relating to the design, construction, operation, safety, security and maintenance of a light rail transit system, including the System and the Project, provided the Subcontractor's assistance will in general be limited to attending meetings relevant to the Vehicles and reviewing relevant documentation prepared by others. The Parties acknowledge that the model of the Vehicle (Citadis Spirit™) is used worldwide and that it is the City's stated intention, as per Section 1(e) of Schedule 15-4 – Regulatory Standards to the Project Agreement, to regulate the design, construction, operation, maintenance, safety and security of the System in a prudent and timely manner generally consistent with other regulatory authorities of municipal light rail transit systems in Canada and elsewhere. Furthermore, the Parties agree that they will seek to have the City adopt Regulatory Standards that do not prescribe requirements that are in addition to those prescribed in the Project Agreement.

(e) cooperate with and provide assistance to the Construction Contractor in fulfilling its obligations under Attachment 38 – Extensions and Additional Phases to the Construction Contract; and

(f) enter into an Option to Purchase Agreement in the form attached hereto as Appendix C (Option Agreement).

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 any direction 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 regarding the achievement of Integration.

The Approved Subcontract Schedule will set out the latest dates for the incorporation of various inputs into the Vehicle design. Integration requirements that are issued or modified after such dates would be the basis for Construction Contractor Variation, where appropriate.

Article II – Construction Contractor's Basic Obligation

The Construction Contractor shall, at its own cost and risk:

(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 Subcontractor, including the Subcontract Price at the times and in the manner prescribed in Appendix E (Payment Schedule); and

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

Article III – Coming into Force

Clauses 1.16.1, 1.16.2 and 1.16.3 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 Subcontract has been signed by both Parties;

(b) The Subcontractor has provided the Construction Contractor with the Guarantee from ALSTOM Transport SA;

(c) Financial Close of the Project Agreement has been achieved.

Within 15 days of the coming into force of this Agreement, the Subcontractor will deliver to the Construction Contractor evidence of insurance, as required pursuant to Appendix J (Insurance), and the Performance Security. At the same time, the Subcontractor will commence the Subcontracted Works and will be entitled to submit its payment application for Payment Milestone 1 (Advance Payment).

Article IV – Back-to-Back Principle

Unless otherwise indicated in this Subcontract, the Parties agree that all obligations, liabilities and risks borne by Construction Contractor under the Construction Contract (including representations, warranties, covenants, indemnities and liabilities of every kind and nature except as expressly excluded hereunder) but only in those documents in Appendix M1 (Back-to-back documents) and to the extent applicable to the Subcontracted Work required to be performed thereunder through the Latent Defect Warranty Period, as well as any rights and entitlements available to the Construction Contractor in respect thereof, shall be passed through to Subcontractor under this Agreement under the back-to-back principle. The back-to-back principle means that:

(a) The Subcontractor is obliged to the Construction Contractor to the same extent as the Construction Contractor is obliged to Project Co, as such obligations relate and to the extent related to the Subcontracted Work, and for certainty, where the Construction Contractor is required to under this Subcontract, it will be deemed to be acting reasonably in requiring the Subcontractor to comply with any such back-to-back obligation; and

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

The Subcontractor expressly confirms and acknowledges that it is aware of the provisions of those parts of the Construction Contract and the Project Agreement listed in Schedule M (Project Agreement and Construction Contract Extracts). Construction Contractor confirms that it has provided Subcontractor with copies of all provisions of the parts of Construction Contract and the Project Agreement listed in Schedule M (Project Agreement and Construction Contract Extracts).

1.0 GENERAL PROVISIONS

1.1 **Definitions**

In the present Subcontract, the following capitalized terms shall have the meanings stated hereinafter, unless stated otherwise in a particular Attachment in which case such definition shall have the meaning given to it in that Attachment solely for the purposes of that Attachment.

Capitalized terms not defined in this Sub-Clause 1.1 or elsewhere in this Subcontract will have the meanings given to such terms in Attachment 1 – Definitions and Interpretation to the Construction Contractor, or if not defined therein, in Schedule 1 – Definitions and Interpretation to the Project Agreement.

"**Acceptance**" means the acceptance of a Vehicle by the Construction Contractor upon completion of the Vehicle in accordance with the terms of this Subcontract (other than Punch List Items) and passing of all Acceptances Tests.

"**Acceptance Certificate**" means the certificate issued under Clause 10.

"**Acceptance Tests**" means the tests which are required by this Subcontract to demonstrate the performance of the Vehicles as further specified in Appendix G (Vehicle Testing) and any other tests which are agreed to by both Parties in writing or instructed as a Variation, and which are carried out under Clause 10 as a condition for Acceptance of the Vehicles by the Construction Contractor.

"**Affiliate**" means an "**affiliate**" as that term is used in the *Securities Act* (Ontario) and any successor legislation thereto, and, in the case of 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, in force in the Province of Ontario, or otherwise binding on the Construction Contractor, the Construction Contractor Personnel, the Subcontractor, the Subcontractor Personnel, Project Co, any Project Co Party, the City, any City Party or any City Person.

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

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

"**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 (a) any contractor or subcontractor of City; (b) City's Representative; (c) any delegate of City's Representative; and (d) any director, officer, employee, agent, servant, representative or advisor (including legal and financial advisors) of City or any of the foregoing.

"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, IO and its directors, officers and employees, but excluding Project Co, any Project Co Party, the Construction Contractor, the Construction Contractor Personnel, the Subcontractor and the Subcontractor Personnel.

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

"**Collateral Agent**" means BNY Trust Company of Canada (in its capacity as collateral agent for the Senior Creditors.

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

"**Compensation Event**" has the meaning given in Section 41.1(a) of the Project Agreement.

"**Completion**" means the completion of the Subcontracted Works in accordance with the terms of this Subcontract (other than Punch List Items), the passing of all Integration Tests and readiness of all Vehicles to be integrated into the System.

"**Completion Certificate**" means the certificate issued by the Construction Contractor upon Completion of the Subcontracted Works.

"**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, Subcontractor Equipment and the supply, installation, testing and commissioning of Vehicle Equipment.

"**Construction Contract**" has the meaning given to it in the recitals.

"**Construction Contractor**" means OLRT Constructors, an unincorporated joint venture consisting of Dragados Canada, Inc., SNC-Lavalin Constructors (Pacific) Inc. and EllisDon Corporation.

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

"**Construction Contractor Variation**" means a Variation initiated by the Construction Contractor under this Subcontract.

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

"**Construction Contractor's Personnel**" or "**Construction Contractor Personnel**" means the Construction Contractor's Representative, the assistants referred to in Sub-Clause 3.2 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, who acts on behalf of the Construction Contractor.

"**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 Laws or where monitoring, remediation or removal of such any of the foregoing substances is otherwise required pursuant to Applicable Laws. 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 2 % over the rate of interest per annum quoted by TD Canada Trust from time to time as its reference rate for Canadian Dollar demand loans made to its commercial customers in Canada and which it refers to as its "prime rate", as such rate may be changed by it from time to time, without compounding, from the due date of the amount payable until the date (or dates) of payment.

"**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.

"**Delay Liquidated Damages**" means liquidated damages which the Subcontractor is obliged to pay to the Construction Contractor under Sub-Clause 8.6.

"**Design**" means the entire process for the design of the Vehicles as required by this Subcontract.

"**Design and Specification Requirements**" means the documents set out in Appendix A (Technical Requirements) and the Output Specifications and any additions and modifications to such documents in accordance with the Subcontract.

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

"**Direct Losses**" means all damage, losses, 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 whether arising under statute, contract or at common law, except 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.

"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.

"Epidemic Defect" means a Defect which shall be deemed to have occurred at any time during the Maintenance Term when the failure rate within a Population of a component, subsystem or system exceeds 10% measured over the time period in which the constant failure rate is expressed and is measured by component, subsystem or system and similar root cause. However, for the avoidance of doubt, an Epidemic Defect shall exclude any Defect which arises:

(a) as a result of the failure by the Operator to operate the System in accordance with the Operation Requirements;

(b) out of the replacement or repair of any component, subsystem or system where such replacement or repair is the responsibility of the Operator or the City;

(c) out of the replacement or repair of any component, subsystem or system by the Maintenance Contractor where such replacement or repair is a product of the Design Life of the applicable component, subsystem or system; and/or

(d) any Defect which occurs after the expiration of the Design Life of such component, subsystem or system.

For the purposes hereof, the "Population" of a component, subsystem or system means the total number of identical line replaceable units of a distinct type and function, whether the line replaceable unit consists of individual components, subassemblies or unit assemblies, incorporated in the fleet of vehicles provided as part of the Project.

"**Epidemic Defect Warranty**" and "**Epidemic Defect Warranty Period**" have the meaning set out in Sub-Clause 12.2.

"**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 Subcontractor Equipment, Materials, Equipment and Temporary Works, or any of them as appropriate.

"**Guarantor**" means ALSTOM Transport SA.

"**Guarantee**" means the guarantee to be provided by the Guarantor, in the form set out in Appendix F (Letter of Credit and Guarantee Forms).

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

(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:
1. a director or officer of the corporation; or

2. 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.

"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.

"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.

"**Independent Certifier**" has the meaning given to it under the Project Agreement.

"**Independent Certifier Agreement**" has the meaning given to it under the Project Agreement.

"**Indirect Losses**" has the means given to it under Sub-Clause 17.6.

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

"**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.

"**Lands**" has the meaning given to it in the Project Agreement and generally refers to lands on which the System will be constructed;

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

"**Latent Defect Warranty**" and "**Latent Defect Warranty Period**" have the meanings set out in Sub-Clause 12.3.

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

"**Lenders' Technical Advisor**" means WS Atkins International Ltd., in its capacity as the senior creditors' technical advisor under the Credit Agreement.

"**Maintenance Contractor**" means Rideau Transit Maintenance General Partnership, or its assignee.

"**Maintenance Services**" means the maintenance and other work to be performed and services to be provided by Project Co as described in Section 1.2 of Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements to the Project Agreement, as such work and services may from time to time be varied in accordance with the Project Agreement, but specifically excluding the Governmental Activities.

"**MSF 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, as stated in Appendix H (MSF Usage).

"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.

"**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" means any of the milestones listed in Appendix E (Payment Schedule).

"Payment Milestone Date" means a date on which a Milestone Payment is scheduled to be due to Subcontractor under Appendix E (Payment Schedule) or, where not specified therein, Appendix D (Vehicle Planning).

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

"**Performance Security**" means a letter of credit or the letters of credit (as the context requires) to be provided by the Sub-Contractor under Sub-Clause 4.2.

"**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 otherwise to carry out the Project in accordance with this Agreement, but excluding Excluded Permits.

"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.

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

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

"**Project Agreement**" means the 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**" is defined in the preamble.

"**Project Co Event**" means:

(a) a breach of any of the express provisions of the Construction Contract (whether or not resulting in a Project Co Event of Default) by Project Co 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 an 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 Construction Contract; or
ii. the ability of the Construction Contractor to perform its obligations under the Construction 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 Event of Default**" means a Project Co Events of Default as defined in the Construction Contractor or the Project Agreement, as the specified in the context.

"Project Co Party" means:

(a) the Maintenance Contractor;

(b) any person engaged by Project Co, or the Maintenance Contractor, from time to time as may be permitted by the Project Agreement to procure or manage the provision of the Project Scope (or any of them); and

(c) in respect of each of the above, their subcontractors of any tier, agents, employees, officers and directors,

but not including the Construction Contractor, the Construction Contractor Personnel, the Subcontractor and the Subcontractor Personnel.

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

"Project Data" 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.

"**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, pertaining to, government, in each case having jurisdiction over such circumstance or matter.

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

"**Relief Event**" means any of the following events or circumstances to the extent, in each case, that it causes any failure by a Party to perform any of its obligations under this Subcontract:

(a) fire, explosion, lightning, storm, tempest, hurricane, tornado, flood, ionizing radiation (to the extent it does not constitute Force Majeure), earthquake, riot or civil commotion;

(b) failure by any Utility Company, Railway Company, local authority or other like body to perform works or provide services, provided, however, that a failure by any Utility Company to perform works or provide services in connection with the construction, installation or relocation of Utility Infrastructure in connection with the Design and Construction Works and Highway Work shall not, in any event, be cause for a Relief Event, unless the Subcontractor:

i. has performed its obligations under any applicable Utility Agreement and the relevant Utility Company has failed to meet its obligations thereunder; and

ii. has made all, and is continuing to make any, commercially reasonable efforts to diligently enforce its legal rights under any applicable Utility Agreement and otherwise cause the Utility Company to perform those works or services;

(c) accidental loss or damage to the Civic Works, the Works and/or the System, the Highway Work and/or the Highway or any roads servicing the Site or the Highway Site;

(d) failure or shortage of power, fuel or transport;

(e) blockade or embargo falling short of Force Majeure;

(f) any official or unofficial strike, lockout, work to rule or other labour-related action generally affecting the System, the Highway, the construction industry (or a significant sector of the industry), the facilities maintenance industry, transit systems or public highways in the Province of Ontario;

(g) any civil disobedience or protest action, including any action taken by any person or persons protesting or demonstrating against the carrying out of any part of the Project Scope or the construction and/or operation of transit systems or public highways in general, provided, however, that a civil disobedience or protest action shall not, in any event, be cause for a Relief Event unless the Subcontractor has fully complied with Sub-Clause 6.6.2(c); or

(h) with respect to Tunnel Work only, bursting or overflowing of water tanks, apparatus or pipes if such events are not attributable to the actions or omissions of Subcontractor or any Subcontractor Personnel and are not properly inferable, readily apparent or readily discoverable from the Background Information;

provided, in each case, that such event does not arise (directly or indirectly) as a result of any act or omission of the Party claiming relief and (i) in the case of Subcontractor claiming relief, as a result of any act or omission of any Subcontractor Personnel or (ii) in the case of the Construction Contractor claiming relief, as a result of any act or omission of any Construction Contractor Personnel.

"Required Revenue Service Availability Date" means May 24, 2018, 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 Business Days following the Revenue Service Availability has been certified by the Independent Certifier; and

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

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

"Station" means a Passenger station on the System.

"Subcontract" means the present instrument and its Appendices.

"**Subcontract Dispute**" has the meaning given in Appendix I (Subcontract Dispute Resolution Procedure).

"**Subcontract Dispute Resolution Procedure**" means the procedure set forth in Appendix I (Subcontract Dispute Resolution Procedure).

"**Subcontract Price**" means Two hundred fifty-seven million three hundred five thousand eight hundred seventeen dollars ($257,305,817), as may be adjusted pursuant to the terms hereof and as broken down, for reference only, in Appendix B (Price Breakdown).

"**Subcontracted Works**" means the design, engineering, manufacturing, delivery, testing, commissioning and warranty of the Vehicles and the Vehicle Equipment and the performance of all other obligations by the Subcontractor under this Subcontract.

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

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

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

"**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 System, 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**" or "**Subcontractor Personnel**" means the Subcontractor's Representative and all personnel whom 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 of any tier, for a part of the Subcontracted Works; and the legal successors in title to each such person.

"**System**" means the light rail rapid transit system to be Designed, Constructed, supplied, tested, commissioned and Maintained by Project Co in accordance with this Project Agreement, being the Fixed Facilities, the Vehicles and the E&M, but, for greater certainty, including 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 Variation in Law" means any Variation 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.

"**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 the Construction Contractor's Equipment specified in Appendix H (MSF Usage), required on Site for the execution and completion of the Subcontracted Works.

"**Time for Completion**" means the time for completing the Subcontracted Works under Sub-Clause 8.2, as stated in Appendix D (Vehicle Planning) (with any extension under Sub-Clause 8.4).

"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 Project Scope of the Project Agreement, including in relation to the whole or any part of the Highway Work, the Works or the Maintenance Services, as well as any change under the Construction Contract or the Subcontract.

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

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

"**Vehicles**" means all light rail vehicles to be provided by the Subcontractor under the Subcontract used to carry Passengers on the System, including all Vehicle Equipment contained therein, and all spare Vehicles as required in accordance with the Vehicle Design and Construction Requirements and Operation Requirements and Specifications; and "**Vehicle**" has a corresponding meaning.

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

1.2 Interpretation

In the Subcontract, except where the context requires otherwise:

(a) words indicating one gender includes 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 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 Clause 21. 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 in the event of ambiguities, conflicts or inconsistencies between or among any of the provisions of this Agreement and those documents which are incorporated herein by reference, the priority of the documents shall be in accordance with the following sequence:

(a) any provision of this Subcontract or provision incorporated by reference into this Subcontract establishing a higher standard of safety, reliability, durability, performance or service shall take precedence over a provision establishing a lower standard of safety, reliability, durability, performance or service;

(b) the main body of the Subcontract;

(c) the Output Specifications;

(d) the Appendices and documents classified as "Mutual" in Sub-Clause 1.6;

(e) the Construction Contract, as incorporated by reference through Appendix M (Project Agreement and Construction Contract Extracts);

(f) the Project Agreement, as incorporated by reference through Appendix M (Project Agreement and Construction Contract Extracts);

(g) the Appendices and documents classified as "Alstom" in Sub-Clause 1.6; and

(h) the Appendices and documents classified as "Reference" in Sub-Clause 1.6

For the removal of doubt, the Parties agree that references to the Project Agreement or the Construction Contract 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. It is specifically noted that Schedule 35 to the Project Agreement contemplates that the City and Subcontractor could enter into a direct contractual relationship with respect to the purchase of Additional Vehicles.

1.6 Appendices

The Appendices are as follows in the below chart. The classification of the Appendices in the chart has the following meaning:

"**Reference**" means that the Parties agreed that the content of the Appendix will form the basis of submittals that the Construction Contractor will make to the City, but remains subject to the Review Procedure and otherwise must be in compliance with this Subcontract. The Construction Contractor will support the Subcontractor's endeavours to have the submittal accepted by the City. The documents which form part of the submittal are subject to reasonable changes introduced by either Party, either prior to their submission or during the review procedure described in Sub-Clause 5.2.

"**Alstom**" means that the Appendix describes commitments made by Subcontractor, which are in addition to the obligations assumed by Subcontractor under the other provisions of this Subcontract.

"**Mutual**" means that the Appendix describes the mutual commitments of the Parties and any provisions therein will take precedence over the provisions of a document below it in the order of priority pursuant to Sub-Clause 1.5 (including the Construction Contract and the Project Agreement).

APPENDIX NO.	APPENDIX NAME	NAME AND NO. OF INCLUDED DOCUMENTS	CLASSIFI-CATION
Appendix A	TECHNICAL REQUIREMENTS	A1. Technical Documentation	Reference (except as below)

			Alstom (only in respect of the minimum horizontal turning radius provided at p. 10, and the drawings at Appendix C DYNAMIC GAUGE IN HORIZONTAL 35m CURVE, at pp. 59-61)
		A2. Documents from Annex A to the LOI: - (i) Vehicle Specification - (iv), (v), (vi), (vii) Technical Response Extracts (Sections 5.4.2, 5.4.3, 5.4.5.2, 5.4.5.9) - (viii) Light Rail Vehicle Appendix Summary Document	Alstom
		A3. Canadian Content Certificate	Alstom
		A4. Vehicle Compliance Matrix	Alstom
		A5. Vehicle Subcontract Deliverables List according to Schedule 10 – Review Procedure to the Project Agreement	Reference
Appendix B	PRICE BREAKDOWN		Mutual
Appendix C	OPTION AGREEMENT		Mutual
Appendix D	PLANNING	D1. Vehicle Planning	Mutual
		D2. Contractor Equipment Supply Dates	Mutual
Appendix E	PAYMENT SCHEDULE		Mutual
Appendix F	LETTER OF CREDIT AND GUARANTEE FORM	F1. Letter of Credit F2. Guarantee	Mutual

Appendix G	VEHICLE TESTING	G1. Vehicle Tests Flow Chart	Reference
		G2. Tests Planning	Reference
		G3. Energy Consumption Tests	Mutual
Appendix H	MSF USAGE	H1. Ottawa Vehicle assembly inside the MSF – rev6	Mutual
		H2. Plan building	Mutual
		H3. Plan process	Mutual
		H4. Pit specification – V1	Mutual
		H5. Security of the testing activities – V1	Mutual
		H6. Spraying ramp – V2	Mutual
		H7. Weighting track – V1	Mutual
Appendix I	SUBCONTRACT DISPUTE RESOLUTION PROCEDURE		Mutual
Appendix J	INSURANCE		Mutual
Appendix K	INTERFACE	K1. Interfaces K2. Vehicle – Onboard CBTC Scope Split K3. General Interface Requirement Specifications dated September 27, 2012 K4. Preliminary Rolling Stock / Signaling Interfaces Statements dated September 27, 2012	Mutual (in respect of Document 1. and Document 2.) Reference (in respect of Document 3. and Document 4.)
Appendix L	PRELIMINARY PROJECT MANAGEMENT PLAN		Alstom
Appendix M	PROJECT AGREEMENT AND CONSTRUCTION	M1. Back-to-back documents M2. Acknowledged documents	Mutual

	CONTRACT EXTRACTS		
Appendix N	DESIGN AND STYLE MANAGEMENT		Reference

1.7 **Coming into Force 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 the Construction Contractor may withhold in its sole discretion. Such consent is deemed granted to assignments to another, directly or indirectly, wholly-owned subsidiary of ALSTOM Holdings, provided that the Guarantee remains in place and the Subcontractor has demonstrated to the reasonable satisfaction of the Construction Contractor that the assignee possesses equivalent financial capacity and technical expertise and qualifications, upon delivery of substitute Performance Security from the assignee and documentation reasonably required by the Construction Contractor to give effect to the assignment.

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 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, in each case, the Subcontractor shall not be obligated to perform its obligations under this 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 Governmental Use and Disclosure

(a) The Parties acknowledge the use and disclosure rights of the City and IO and other governmental parties under the Project Agreement. The Construction Contractor will advise the Subcontractor of any request for Confidential Information under the *Municipal Freedom of Information and Protection of Privacy Act* (Ontario) or the *Freedom of Information and Protection of Privacy Act* (Ontario) 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 upon becoming aware thereof.

1.10.2 Use and Disclosure of Confidential Information

(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.

(b) It is acknowledged that:

i. Construction Contractor or 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;

ii. Construction Contractor or 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 the same of the Maintenance Contract or any subcontract of any tier under the Maintenance Contract;

iii. Construction Contractor or Project Co 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 Construction Contract or the performance by Project Co of the Project Scope under the Project Agreement;

iv. Construction Contractor or Project Co may disclose in confidence to the Lenders' Technical Advisor, the Lenders and their professional advisors such Confidential Information as is reasonably required by the Lenders or the Lenders' Technical Advisor in connection with the performance of the Construction Contract;

v. in consultation with the Construction Contractor, Project Co may disclose in confidence to prospective lenders or investors, such 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;

vi. 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 of its, or that Subcontractor Personnel of that Subcontractor Personnel's obligations under this Subcontract or in connection with the Subcontracted Work; and

vii. 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 Subcontractor 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 Construction Contract and approved by Project Co and the City, which protocol shall prescribe limitations on the use, disclosure and storage of this Agreement and any other Confidential Information specified by Project Co or the City.

1.10.3 Exceptions

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

i. 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;

ii. the information is as of Commercial Close, or becomes at any time thereafter, generally available to or accessible by the public through no fault or wrongdoing of the Confidant;

iii. the information is a matter of public record or in the public domain;

iv. 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;

v. 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;

vi. the information was independently developed by the Confidant without access to the Confidential Information, as evidenced by written records;

vii. 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;

viii. subject to the obligation set forth in Sub-Clause 1.11, the information is disclosed to the Construction Contractor, Project Co and/or the City upon a termination of this Agreement, or is otherwise required by the Construction Contractor, 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, or any other operations or services the same as, or similar to, the Project Scope; or

ix. the information would not be exempt from disclosure under FIPPA or MFIPPA.

1.10.4 Survival of Confidentiality

(a) The obligations in Sub-Clause 1.10 will cease on the date that is the earlier of (i) the expiry of the time periods established in the *Limitations Act, 2002* (Ontario), and (ii) 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 to the Construction Contract. The term "**Vehicle Intellectual Property**" means the CC Subcontractor Intellectual Property of the Subcontractor and all its 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 – CC Intellectual Property to the Construction Contract, 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 – CC Intellectual Property to the Construction Contract in respect of the Vehicle Intellectual Property. The specific provisions of this Sub-Clause 1.11 are not intended to limit the generality of this Sub-Clause 1.11.2.

1.11.3 The Subcontractor or its Sub-subcontractors, as applicable, shall be and remain the sole and exclusive Owner of the Vehicle 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 Vehicle Intellectual Property, except for the Licence granted under Sub-Clause 1.11.1.

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 Subcontractor any Ownership of, or grant to Subcontractor any right in respect of, the Vehicle 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 1.11.11.

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 provisions of Section 3.4 of Attachment 41 – CC Intellectual Property to the Construction Contract 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 – CC Intellectual Property to the Construction Contract and, where required in accordance with Attachment 41 – CC Intellectual Property to the Construction Contract to deposit or have deposited Escrow Materials for Deliverables supplied by its CC Subcontractors in accordance with section 4.5 of Attachment 41– CC Intellectual Property to the Construction Contract.

1.11.8 The Subcontractor shall and shall ensure that the Subcontractor Personnel:

(a) by duly executed written agreement or by operation of law, irrevocably and unconditionally sell, assign and transfer to the Subcontractor all right, title and interest, including all Intellectual Property Rights, that its Personnel may have in or to any and all Intellectual Property referred to in Attachment 41 – CC Intellectual Property to the Construction Contract and all Modifications thereto, such that the 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 the Subcontractor pursuant to Sub-Clause 1.11.11 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 assigned by such Personnel pursuant to Sub-Clause 1.11.8(a) in favour of the assignee and its successors, assigns and licensees.

1.11.9 The Subcontractor hereby grants to the Construction Contractor a Licence in respect of the Vehicle Intellectual Property that is equivalent to the Licence under Section 4.2 of Attachment 41 – CC Intellectual Property to the Construction Contract to the extent necessary for the Construction Contractor to perform its obligations under the Construction Contract.

1.11.10 The Subcontractor hereby grants to the Construction Contractor the right to grant the Licence under section 4.2 of Attachment 41 – CC Intellectual Property to the Construction Contract in respect of the Vehicle Intellectual Property.

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 this Subcontract, the Construction Contract, the Project Agreement 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.

They 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 Laws. Unless otherwise stated in the Subcontract:

(a) the Construction Contractor or Project Co or City, as the case may be, shall have obtained (or shall obtain) the planning, zoning or similar Permits for the Works, which will be sufficient to allow the Maintenance Services to be performed in the MSF and for the operation of the System;

(b) the Subcontractor shall have obtained (or shall obtain) any additional planning, zoning or similar Permits that may be required for the assembly of Vehicles in the MSF;

(c) the Subcontractor shall give all notices, pay all Taxes, and obtain all Permits (other than those described in paragraph (a)), as required by Applicable Law in relation to the design, execution and completion of the Subcontracted Works and the remedying of any defects; and

(d) the Subcontract shall comply with all Permits in accordance with their terms.

1.15 **SNC-Lavalin Code**

Subcontractor acknowledges having received a copy of SNC-Lavalin Constructors (Pacific) Inc. corporate Code of Ethics and Business Conduct (the "SNC-Lavalin Code"), which is available upon request or from SNC-Lavalin's website, at www.snclavalin.com, and which shall form an integral part hereof as if recited herein at length. Subcontractor undertakes to conduct itself, and will cause its employees, representatives and agents to

conduct themselves, in all matters concerning the Project, in a manner consistent with the SNC-Lavalin Code and not to do (or fail to do) anything that, if done (or failed to be done) by an SNC-Lavalin employee, would constitute a breach of the SNC-Lavalin Code.

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 corporation 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 design, manufacture, testing and commissioning of light rail vehicles and other work similar to the Subcontracted Work 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 extent that the Subcontractor Has 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 does not Have 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, those portions of the Construction Contract and the Project Agreement attached hereto as Appendix M (Project Agreement and Construction Contract Extracts) or incorporated by reference, and all other documents made available to the Subcontractor by or on behalf of the Construction Contractor, and, to the extent that the Subcontractor Has 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 able to meet its obligations as they generally become due;

(k) The Subcontractor is registered under Division V of Part IX of the *Excise Tax Act* (Canada) and its registration number is 804255149RT0001;

(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 corporation for purposes of the *Income Tax Act* (Canada);

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

(o) 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 Project;

(p) The Subcontractor is and shall be the sole and exclusive owner of Vehicle Intellectual Property that is Owned, created, developed or acquired by the Subcontractor or any Subcontractor Personnel and has and shall have the right to provide the Licences granted to the Construction Contractor, herein;

(q) None of the Vehicle Intellectual Property 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 the Vehicle Intellectual Property;

(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 the Subcontractor is, indirectly, a wholly-owned subsidiary of the ALSTOM Holdings;

(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 including without limitation that the Canadian Content Certificate submitted with the Response is true and correct in all material respects and that subject to Section 2.8 of Attachment 35 - CC Additional Vehicles to the Construction Contract, the Vehicles are expected to meet the Canadian Content Requirements upon delivery to the City;

(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 Work 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 extent the Subcontractor Has Knowledge, no steps have been taken to revoke or cancel any such Permit;

(x) all Applicable Laws 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 extent the Subcontractor Has 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.

(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 Vehicle 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 Sub-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), and (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 Completion. If at any other time the Subcontractor becomes aware of any information that would make either 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:

(a) 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;

(b) 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;

(c) This Subcontract has been duly authorized, executed, and delivered on behalf of each Construction Contractor Member and constitutes a legal, valid, and binding obligation of the Subcontractor, enforceable against each Construction Contractor Member 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;

(d) The execution, delivery, and performance by each Construction Contractor Member 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;

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

(f) There are no actions, suits, proceedings, or investigations pending or threatened against the Construction Contractor, the Construction Contractor Members or, to the extent that the Construction Contractor Has 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 does not Have 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;

(g) 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.

1.16.3 **Project Co and City Representations and Warranties**

In accordance with the provisions of this Subcontract, the Subcontractor will have the benefit of the representations and warranties provided by Project Co to the Construction Contractor, and by the City to Project Co, to the extent that any breach thereof constitutes a City Event or a Project Co Event.

2.0 SITE ACCESS AND USE

2.1 Licence to the MSF and Site

The Construction Contractor shall give the Subcontractor a non-exclusive licence, rights of use and access to those parts of the MSF within those times stated in Appendix H (MSF Usage) for the purpose of assembling and storing the Vehicles and the Vehicle Equipment as well as use and access to the Site, including the test track, for the purpose of the agreed-upon Vehicles tests. 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.

When entering the Site or the Lands or accessing the System, the Subcontractor will act in a manner consistent with the obligations of Project Co under the Project Agreement. On reasonable notice appropriate to the circumstances, the Subcontractor agrees to provide access to the part of the MSF where the Subcontractor is manufacturing the Vehicles and any workshop where materials or equipment are being manufactured, prepared or stored to the Construction Contractor, Project Co, the City or any third party in order to allow the Construction Contractor to comply with its obligations under the Construction 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, or the non-availability or non-suitability of on-Site access routes in accordance with Sub-Clause 2.2 (Access Routes), 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, and

(b) payment of any such Direct Loss;

provided that in the case of a City Event or a Project Co Event or interference by the Maintenance Contractor, the Subcontractor shall only be entitled to an extension of time and additional payment in accordance with Clause 9.

2.2 Access Routes

The Subcontractor shall be deemed to have satisfied itself as to the suitability and availability of all off-Site means of access up to the Site boundary. The Construction Contractor will provide the Subcontractor with suitable on-Site access from the Site boundary to the MSF, including suitable access into the MSF in accordance with

Appendix H (MSF Usage). The Subcontractor shall use reasonable efforts to prevent any road, bridge and other property from being damaged. These efforts shall include the proper use of appropriate vehicles and routes.

Except as otherwise stated in this Subcontract:

(a) the Construction Contractor shall be responsible for any maintenance which may be required for the Subcontractor's use of access routes on-Site and other means of access to the MSF;

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

(c) the Subcontractor shall not be responsible for any Claims which may arise from the use or otherwise of any on-Site access route.

2.3 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, unless such facilities are required as part of mitigation measures agreed to by the Parties due to failure of the Construction Contractor to provide the MSF and test track and infrastructure as required in the Subcontract and Appendix H (MSF Usage).

2.4 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 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.

2.5 Subcontractor's Operations in the MSF

The Subcontractor shall confine its operations at the MSF to those areas designated for its use and access in Appendix H (MSF Usage). The Subcontractor shall take all necessary precautions to keep Subcontractor Equipment and Subcontractor Personnel within the designated areas and to keep them off adjacent land.

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

Prior to the issue of the Completion Certificate for the Subcontracted Works, the Subcontractor shall clear away and remove all Subcontractor Equipment, surplus materials, wreckage, rubbish and Temporary Works from the MSF and Site. The Subcontractor shall leave the MSF and Site in a clean and safe condition. If all these items have not been removed within fourteen (14) days after the Construction Contractor issues the Completion Certificate, the Construction Contractor may sell or otherwise dispose of any remaining items. The Construction Contractor shall be entitled to be paid the direct cost incurred in connection with or attributable to, such sale or disposal and restoring the MSF and Site.

Any balance of the monies from the sale shall be paid to the Subcontractor. If these monies are less than the Construction Contractor's costs, the Subcontractor shall pay the outstanding balance to the Construction Contractor.

2.6 Subcontractor Equipment

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

2.7 Security of the Site

Unless otherwise stated in this Subcontract:

(a) the Construction Contractor shall be responsible for keeping unauthorized persons and creatures off of the Site consistent with Good Industry Practice for a construction site, and

(b) the Subcontractor shall be responsible for any additional security required in connection with its assembly of Vehicles in the MSF and the storage of valuable equipment and property on the Site.

The Parties will coordinate their security requirements and, to the extent practicable, jointly retain security services from a single provider.

2.8 Electricity, Water and Gas

The Subcontractor shall, except as set forth in Appendix H (MSF Usage), be responsible for the provision of all power, water and other services it may require for the performance of the Subcontracted Works in the MSF.

2.9 MSF Equipment; CBTC Equipment

The Construction Contractor shall make the MSF Equipment available for the use of the Subcontractor in the execution of the Subcontracted Works in accordance with the details and arrangements stated in Appendix H (MSF Usage). Unless otherwise stated in this Subcontract:

(a) the Construction Contractor shall be responsible for the MSF Equipment, except that
(b) the Subcontractor shall be responsible for each item of MSF Equipment while any of the Subcontractor's Personnel is operating it, driving it, directing it or in possession or control of it.

The Construction Contractor shall supply, free of charge, the CBTC Equipment and radio equipment. The Construction Contractor shall, provide the CBTC Equipment and radio equipment at the times and places specified in the Subcontract. The Subcontractor shall then visually inspect them, and shall promptly give notice to the Construction Contractor of any shortage, defect or default in these materials. After this visual inspection, the free-issue materials shall come under the care, custody and control of the Subcontractor. The Subcontractor will proceed to install the CBTC Equipment and radio equipment into the Vehicles as agreed between the Subcontractor and the CBTC System Provider or radio equipment supplier, or failing such agreement in accordance with the direction of the Construction Contractor.

The Subcontractor will perform its obligations under the Appendix K2 (Vehicle – Onboard CBTC Scope Split) in Appendix K (Interface) and will comply with specifications provided by other system providers in accordance with Appendix K1 (Interfaces). The Subcontractor will cooperate with all other subcontractors

The Subcontractor agrees to cooperate with the Independent Certifier, the Lenders' Technical Advisor, the City, IO and the Construction Contractor and with all other subcontractors working at the Site, in order to avoid any conflict and to ensure that all work on the Project proceeds without conflict, hindrance or delay.

2.10 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 Part 2 Section 19(b) of the Construction Contract, and shall comply with the instructions of the Construction Contractor in this regard.

2.11 Co-operation

The Subcontractor shall, as specified in the Subcontract or as instructed by the Construction Contractor, allow appropriate opportunities for carrying out other 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 of work on or near the Site.

Appendix H (MSF Usage) sets out the areas of the MSF in which the Subcontractor is entitled to execute the Subcontracted Work without interference from the Construction Contractor. If the Construction Contractor instructs the Subcontractor to allow the persons described in (a) or (b) above to carry out works in such portions of the MSF, which caused the Subcontract to be delayed or to suffer Direct Losses, the Subcontractor shall give written notice to the Construction Contractor of any Claim by the Subcontractor for:

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

(b) payment of any such Direct Loss.

Subject to its entitlement to relief as described above, the Subcontractor shall be responsible for its activities on the Site, and shall co-ordinate its own activities with those of other subcontractors specified in this Subcontract or otherwise identified in writing by the Construction Contractor, including by providing technical information reasonably required by such other subcontractors for the performance of their work, and with those of the City, the Lenders' Technical Advisor and other third parties with which the Construction Contractor is obligated to co-ordinate its activities, as specified in the Construction Contract, including in section 19(a) thereof, or otherwise identified in writing by the Construction Contractor. The Construction Contractor will likewise co-ordinate its own activities with those of the Subcontractor on the Site and will require its other subcontractors to do the same.

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.

2.12 Protection of the Environment

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 the Construction Contractor under Attachment 17 – Environmental Obligations of the Construction Contract wherever 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 Attachment 17 – Environmental Obligations to the Construction Contract:

(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.

2.13 Items of Geological, Historical or Archaeological Interest or Value

2.13.1 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.

2.13.2 Upon the discovery of any item referred to in Sub-Clause 2.13.1 during the performance of the Subcontract, the Subcontractor shall:

(a) if the Subcontractor has discovered the item, 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.

2.13.3 In the event that the Construction Contractor wishes the Subcontractor to perform actions which are in addition to any required pursuant to Sub-Clause 2.13.2, 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. For the avoidance of doubt, the Construction Contractor will not instruct Alstom to carry out any work that is outside of Alstom's area of expertise as a rolling stock provider.

2.13.4 If Sub-Clauses 2.13.2 and 2.13.3 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 during a continuous period of 5 Business Days or more with respect to each such discovery) shall be a Construction Contractor Variation, unless it is a City Event or a Project Co Event. Alstom will be relieved from the obligation to pay any Direct Losses or obligation to pay Delay Liquidated Damage arising solely out its compliance with a Variation.

2.13.5 The Parties acknowledge that under Part 2 Section 16.3(f) of the Construction Contract or Section 16.3(f) of the Project Agreement, a disagreement regarding the nature or extent of the actions required to be performed by the Construction Contractor or Project Co, respectively, may be referred for determination to an independent and suitably qualified and experienced person. Such person's decision shall be final and binding on the Subcontractor with respect to actions the Subcontractor is required to perform pursuant to Sub-Clauses 2.13.2(b), 2.13.2(c) or 2.13.2(d).

2.14 Encumbrances

2.14.1 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.

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

2.14.3 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 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.

2.15 *Construction Lien Act* (Ontario)

2.15.1 The Parties acknowledge that the foregoing provisions of Sub-Clauses 2.14.1 and 2.14.2 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 arising out of an act or omission of the Subcontractor or the Subcontractor Personnel as though such a claim were an Encumbrance against the Lands as referred to therein.

2.15.2 To the extent required pursuant to Applicable Law, the Subcontractor shall withhold from each of its Sub-subcontractor the holdbacks required under the CLA and shall deal with such holdbacks in accordance with the CLA.

2.15.3 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, where required.

2.15.4 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 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.

3.0 THE CONSTRUCTION CONTRACTOR'S ADMINISTRATION

3.1 The Construction Contractor's Representative

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 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 responsibility for errors, omissions, discrepancies and non-compliances;

(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 which may be necessary for the Subcontractor to perform its obligations under the Subcontract. Each instruction shall be given in writing and 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 shall apply.

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 shall proceed in accordance with this Sub-Clause 3.5 to agree or determine any matter, the Construction Contractor shall consult with the Subcontractor in an endeavour to reach agreement. If agreement is not achieved, the Construction Contractor shall make a fair determination in accordance with the Subcontract, having due regard to all relevant circumstances. If the determination relates to the appropriate mitigation measure to adopt in response to a delay for which the Construction Contractor is responsible, the determination will also provide a determination of the extension of the time and compensation to which the Subcontractor is entitled.

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 must be given as soon as reasonably possible given the nature of the matter and in any case within 14 days of receiving it. Either Party may then refer the dispute to the Subcontract Dispute Resolution Procedure. The Subcontractor shall comply with the Construction Contractor's determination pending a resolution of the Subcontract Dispute, which

resolution may be a finding that the Construction Contractor's determination constitutes a Variation.

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 this Subcontract and its Appendices, and shall remedy any defects in the Subcontracted Works. When completed, the Subcontracted Works shall be fit for the purposes for which the Subcontracted Works are intended.

4.1.2 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 is otherwise required to satisfy the Subcontractor's obligations under the Subcontract, and all works which (although not mentioned in the Subcontract) are necessary for stability or for the completion, or safe and proper operation, of the Subcontracted Works portion of the System.

4.1.4 The Subcontractor shall be responsible for the adequacy, stability and safety of all Site operations, of all methods of construction or installation and of all the Subcontracted Works.

4.1.5 The Subcontractor shall, whenever 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 **Not used**

4.1.7 **Bill of Sale and Warranties for Vehicles**

The Subcontractor shall execute and deliver to the Construction Contractor a bill of sale for each Vehicle, in form and terms satisfactory to the Construction Contractor (the "**Bill of Sale**") upon Acceptance of the Vehicle, in which the Subcontractor:

(a) represents and warrants that:

i. the Subcontractor is at the time of the delivery of such Bill of Sale rightfully and absolutely entitled to the Vehicle;

ii. the Subcontractor at such time has good right, title and authority to grant, bargain, sell, assign, transfer, convey and set over to the Construction Contractor the Vehicle; and

iii. the Construction Contractor shall immediately on the execution and delivery of such Bill of Sale have possession of and peaceably and quietly have, hold, possess and enjoy the Vehicle to and for its own use and benefit without any manner of hindrance, interruption, molestation, claim or demand whatsoever of, from or by the Subcontractor or any person whomsoever and with good title thereto, free and clear and absolutely released and discharged from and against all former and other bargains, sales, gifts, grants, mortgages, pledges, security interests, adverse claims, liens, charges and encumbrances of any nature or kind whatsoever;

(b) grants, bargains, sells, assigns, transfers, conveys and sets over to the Construction Contractor absolutely, all of the Subcontractor's right, title and interest in and to the Vehicle;

(c) covenants and agrees with the Construction Contractor that it will from time to time and at all times at the Subcontractor's expense, on every reasonable request of the Construction Contractor make, do and execute or cause and procure to be made, done and executed all further acts, deeds or assurances as may be reasonably required by the Construction Contractor, whether for more effectually and completely vesting in the Construction Contractor the Vehicles in accordance with the terms of such Bill of Sale or for the purpose of registration or otherwise.

Upon Acceptance of each Vehicle, the Subcontractor shall provide the Construction Contractor with the Vehicle manuals, certificates, log books and other applicable records relating to the Vehicle in the possession or control of the Subcontractor.

Upon Acceptance of each Vehicle, the Subcontractor shall provide the warranties with respect to the Vehicle contained in Schedule 34 – Vehicle and Fixed Equipment Warranties to the Project Agreement.

4.1.8 Vehicle Canadian Content Certification

Upon Acceptance of each Vehicle, the Subcontractor shall deliver to the Construction Contractor the Canadian Content Certificate updated with effect as of the such later date as the City may prescribe in accordance with the Project Agreement, which shall:

(a) demonstrate that the Vehicles meet the Canadian Content Requirements;

(b) include any necessary or desirable back-up information reasonably necessary to support the contents thereof;

(c) be true and correct in all material respects; and

(d) be in form and content satisfactory to the City.

The Parties acknowledge that the City's approval of Canadian Content Certificate in accordance with the Project Agreement will be a requirement for the issuance of a Completion Certificate; provided however that it will only be a requirement for the issuance of an Acceptance Certificate if the Canadian Content Certificate is being delivered to the City prior to or concurrently with Acceptance.

The Construction Contractor acknowledges that the Subcontractor requires further clarity from the City regarding (a), (b) and (d) above. The Construction Contractor will support the Subcontractor in this endeavour and will seek to meet with the City, with the Subcontractor, as early as practicable after commencement of the Project in order to achieve this clarity.

The Subcontractor commits to meeting the aggregate percentage of Canadian Content outlined in "Local Content" in Appendix A (Technical Requirements), provided however, that the specific breakdown of the Canadian Content among the various categories of content may change depending on the clarity received from the City.

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 Appendix F (Letter of Credit and Guarantee Forms).

The Performance Security shall comprise the following:

(a) a letter of credit in the amount 10% of the Subcontract Price with a stated expiry of no earlier than October 31, 2020, to be released upon expiry of the General Warranty Period; and

(b) a letter of credit in the amount 15% of the Subcontract Price with a stated expiry of no earlier than December 1, 2016, to be reduced to ten percent (10%) after the achievement of Payment Milestone 3 (Submittal and Approval of Final Design Package) under Appendix E (Payment Schedule and to be released after the achievement of Payment Milestones 1 through 4 (Sourcing orders of doors, HVAC, brake, gangway, pantograph).

The Performance Security shall be issued by a first class Canadian bank approved by the Construction Contractor. In the case where the issuer is downgraded by any recognized rating agency, the Construction Contractor may on fifteen (15) Business Days' written notice demand that the Subcontractor provide replacement Performance Security which meets the requirements of this Clause 4.2.

The Subcontractor shall ensure that the Performance Security is valid and enforceable until the Subcontractor has executed and completed the Subcontracted Works, remedied any defects and the Defects Notification Period has expired. 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 such 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:

(c) 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,

(d) failure by the Subcontractor to pay the Construction Contractor Delay Liquidated Damages when due within five (5) Business Days after receiving the Construction Contractor's notice requiring the amount to be paid,

(e) failure by the Subcontractor to pay the Construction Contractor any other amount due that is not being disputed by the Subcontractor in accordance with Clause 20 within ten (10) Business Days after receiving the Construction Contractor's notice requiring the amount to be paid,

(f) failure by the Subcontractor to commence to remedy a Subcontractor Event of Default within ten (10) Business Days after receiving the Construction Contractor's notice requiring the default to be remedied or to put forward a reasonable recovery programme under Sub-Clause 16.1.3(a)(ii) within the relevant time period specified therein, or such longer period as the Parties may agree,

(g) circumstances which entitle the Construction Contractor to termination under Sub-Clause 16.1, irrespective of whether notice of termination has been given, but not, for clarity, until the expiry of any applicable cure period described in this Subcontract.

4.3 Subcontractor's Representative

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, and consent to the replacement will not be unreasonably delayed or withheld.

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.

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) and fulfill his or her responsibilities in such capacity in a diligent manner and in accordance with any 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. Written notice, but no consent, shall be required to subcontract Work to affiliates of the Subcontractor, provided that Subcontracted Work performed by such affiliates would not cause Subcontractor to breach the Representations and Warranties set forth under Sub-clause 1.16.

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.

The Construction Contractor, acting reasonably, will agree to a shorter notice period for where the Subcontractor is replacing a Sub-subcontractor who has gone bankrupt or is otherwise in default of its subcontract.

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.

4.7 Not used

4.8 Not used

4.9 Not used

4.10 **Quality Assurance**

The Subcontractor will comply with the provisions of Schedule 11 – Quality Management to the Project Agreement in relation to the Subcontracted Works, and specifically, those obligations described in Sections 2.3, 2.4(a)(i), (ii) and (iv), and 2.5(c) and (d)(i)(E), Part 4, Sections 5.3, 5.4, 5.5, 5.6, and 5.7, and Parts 6 and 7 of such Schedule 11. The Subcontractor shall employ the quality assurance ("QA") system described in the Design and Specification Requirements to demonstrate compliance with the requirements of the Subcontract. 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.

4.13 **Unforeseeable Difficulties**

Except as expressly otherwise stated in the Subcontract:

(a) other than those inputs which it is the obligation of the Construction Contractor to provide under this Subcontract, the Subcontractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Subcontracted Works, including the conditions of the Site and any existing infrastructure;
(b) by signing the Subcontract, the Subcontractor accepts total responsibility for having foreseen all difficulties and costs of successfully completing the Subcontracted Works, except to the extent that such difficulties or costs are due to failure of the Construction Contractor to comply with its obligations under the Subcontract, or due to events that are otherwise stated to excuse performance under the Subcontract; and
(c) subject to paragraph (b) above, the Subcontract Price and the Time for Completion shall not be adjusted to take account of any unforeseen difficulties or costs.

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 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. The format of the Progress Report shall be as reasonably required by the Construction Contractor.

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 – Works Report to the Project Agreement 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 disputes related to the Subcontracted Works, including any action that has taken place over the relevant month to resolve such disputes;

(d) an update on those matters set out in Schedule 33 – Works Report to the Project Agreement;

(e) such other reports and information regarding the Subcontracted Work that the Construction Contractor may reasonably request from time to time;

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.

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

If for any reason the Subcontractor fails or refuses to deliver a Progress Report as required under this Section, then the Construction Contractor will be entitled to withhold payment of any monies owing to the Subcontractor under this Subcontract. The Subcontractor and the Construction Contractor will discuss at their monthly meetings the Progress Report relating to the previous calendar month. The meetings will be held in Ottawa, unless otherwise agreed upon in writing by the Parties, and each Party will bear its own costs of attendance.

4.23 Remedial Rights and Emergencies

The Subcontractor acknowledges that the City have certain remedial rights which they can exercise pursuant to Section 32 of the Project Agreement. The Subcontractor will indemnify the Construction Contractor where the City 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.

4.24 Emergency

Upon the occurrence of an Emergency, the Subcontractor will comply with any emergency response plan under the Project Agreement or adopted by the Construction Contractor.

4.25 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 to the Project Agreement and Schedule 39 – Operations Matters to the Project Agreement.

The inputs that the Subcontractor provided for the purposes of Schedule 8 – Energy Matters to the Project Agreement are set out in Appendix G3 (Energy Consumption Tests) to this Subcontract, and the Parties will carry out the tests described in Appendix G (Vehicle Testing), or such other tests as the Parties may agree, at Revenue Service Availability to measure the accuracy of the Subcontractor's inputs.

The inputs that the Subcontractor provided for the purposes of Schedule 39 – Operations Matters to the Project Agreement include the vehicle capacity, top speed, acceleration, deceleration and trip time. These are set out in Section 5.4.5.8 and Table 5.4-7 of the Technical Proposal, which forms part of Appendix A (Technical Requirements).

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) and to be responsible for the accuracy of same. The Subcontractor shall be responsible for the design of the Subcontracted Works, which for clarity includes responsibility for meeting all obligations of Project Co under the Project Agreement regarding the development of design of the Subcontracted Works, including those under 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.

The Parties' common understanding is that a redundant CAN network is not required for the Vehicles as stated in Section 3.32.g.iii of the Compliance Matrix in Appendix A (Technical Requirements), and they will take that position with the City, provided however that it is determined to be required, the Subcontractor will supply the redundant CAN network, and the Construction Contractor shall pay the Subcontractor the sum of $1,651,530, which amount will be added to the Subcontract Price and prorated over

Payment Milestones 3A through the Payment Milestone 10 and paid to the Subcontractor together with such Milestone Payments.

The Subcontractor will not be responsible for any delay in the design review process due to the failure of the Construction Contractor to provide input in a timely manner as specified in Appendix D (Vehicle Planning). In the absence of required inputs, the Subcontractor will generally be required to mitigate any such delay by proceeding on the basis of reasonable assumptions that it communicates to the Construction Contractor prior to proceeding. The Parties acknowledge that the contents of Appendix K3 (General Interface Requirement Specifications) and Appendix K4 (Preliminary Rolling Stock / Signaling Interfaces Statements) constitute such reasonable assumptions.

The Construction Contractor shall not be responsible for any error, inaccuracy or omission of any kind in the Design and Specification Requirements as originally included in the Subcontract and shall not be deemed to have given any representation of accuracy or completeness of any data or information, 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.

For certainty, if the City requires an increase in line capacity which necessitates an additional intermediate car, a Variation shall be required, subject to the provisions of Clause 9.

5.2 Subcontractor's Design Data

In addition 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 the documents specified in the Design and Specification Requirements as being the responsibility of the Subcontractor, as well as documents required to satisfy all Relevant Authority approvals. The Subcontractor's Design Data shall be written in English.

The Subcontractor shall prepare all Subcontractor's Design Data, and shall also prepare any other documents necessary to instruct the Subcontractor's Personnel or necessary to satisfy the Subcontractor's obligation to cooperate with the Onboard CBTC provider or for which the Subcontractor is responsible under the Appendix K2 (Vehicle-Onboard CBTC Scope Split).

The Subcontractor will submit the Subcontractor's Design Data to the Construction Contractor for review, they shall be submitted 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) "a submittal of Subcontractor's Design Data" exclude any documents which are not specified as being required to be submitted for review.

Each review period shall not exceed thirty (30) days (inclusive of the City's 10 Business Day review period under Schedule 10 – Review Procedure to the Project Agreement), plus the duration of an extension of time to which the City is entitled under the Project Agreement, calculated from the date on which the Construction Contractor receives a submittal of 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, give notice to the Subcontractor that a Subcontractor's Design Data fails (to the extent stated) to comply with the Subcontract. If a Subcontractor's Design Data so fails to comply, it shall be rectified, resubmitted and reviewed in accordance with this Sub-Clause, at the Subcontractor's cost. The Construction Contractor itself will only review resubmittals for items which were non-compliant and will support that position vis-à-vis the City.

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 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 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.

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 Applicable Laws (subject to the Subcontractor's rights in respect of a Change in Law),
(b) the documents forming the Subcontract, as altered or modified by Variations; and
(c) other technical standards specified in the Subcontract or otherwise applicable to the Subcontracted Works.

5.4 Technical Standards

Where this Subcontract requires the Subcontractor to comply with a technical standard in respect of the design and construction aspects of the Subcontracted Works, and that standard has changed between the date 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 Project 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, 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 Project Agreement, without a Variation therefor. This Sub-Clause 5.4 shall not apply where a change in a technical standard is also a Change in Law.

5.5 Not used

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 to the Construction Contract, 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) 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 or the Highway, 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 extent that the Subcontractor Has 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 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 Subcontractor'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) 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 Subcontractor 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 Project Co's or 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 shall be in addition to, and shall not limit, any other audit, 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 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) Not used

(j) 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 **Not used**

5.8 **Design Error**

The Subcontractor will be fully responsible for the Subcontractor's Design Data. None of the City, any City Party, Project Co, any Project Co Party, the Construction Contractor or any Construction Contractor Personnel will have any liability:

(a) if a document submitted by the Subcontractor and reviewed by the Construction Contractor, the Construction Contractor's Representative, Project Co, the Project Co Representative, the City, the City Representative or the City Design Team results in non-compliance with this Subcontract by the Subcontractor or a breach by the Subcontractor of Applicable Law; or

(b) for any loss or claim arising due to any defect in any documents, drawings, specifications or certificates submitted by the Subcontractor.

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**

Neither the Subcontractor nor the Construction Contractor shall recruit, or attempt to recruit, staff and labour from amongst the other's Personnel who have been assigned to the Project, for a period of one year after the termination or expiration of the Subcontract. This provision shall not apply to hiring candidates who have responded to a general solicitation for employees.

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 Laws, including those concerning safety at work.

6.4 **Working Hours**

No work shall be carried out on the Site on locally recognized days of rest or holidays, or outside normal working hours, unless:

(a) otherwise stated in the Subcontract,

(b) the Construction Contractor gives prior written consent, which shall not be unreasonably withheld, or

(c) the work is unavoidable, or necessary for the protection of life or property or for the safety of the Subcontracted Works, in which case the Subcontractor shall immediately advise the Construction Contractor.

6.5 Facilities for Staff and Labour

The Construction Contractor shall provide all necessary facilities for the Subcontractor's Personnel at the MSF in accordance with Appendix H (MSF Usage) to this Subcontract, but shall have no responsibility to provide facilities for Subcontractor Personnel who are not located at the MSF.

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 Laws, 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*. The Subcontractor will comply, or will cause to be complied, with all instructions of the Construction Contractor given in fulfilling its responsibilities in these roles.

6.6.2 Safety Procedures

The Subcontractor shall:

(a) comply with all applicable safety regulations required by Applicable 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 portion of the MSF in use by the Subcontractor,

(c) use reasonable efforts to keep the Site and the Subcontracted Works clear of unnecessary obstruction caused by Subcontractor so as to avoid danger to these persons,

(d) inform the Construction Contractor of the presence of any Protester and Trespassers of which it Has Knowledge and cooperate with the efforts of the Construction Contractor or any other party to manage or remove Protesters and Trespassers,

(e) 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.

6.6.3 The Subcontractor shall appoint an accident prevention officer at the Site, responsible for cooperating with the Construction Contractor's health and safety Personnel in maintaining safety and protection against accidents. This person shall be qualified for this responsibility, and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the execution of the Subcontracted Works, the Subcontractor shall provide whatever is required by this person to exercise this responsibility and authority.

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 The Subcontractor will provide evidence, satisfactory to the Construction Contractor's Representative, of compliance by the Subcontractor and all Sub-subcontractors 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 Acceptance Certificate or Completion 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 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 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, 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.

If the Subcontractor replaces any of its employees who are engaged in the Subcontracted Works, the replacement will be equally or more qualified than the employees who has been replaced. The Subcontractor will inform the Construction Contractor of any replacement of key personnel.

The Construction Contractor may require 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 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 the Project Agreement or 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

In its monthly Progress Report, the Subcontractor shall submit to the Construction Contractor details showing the number of each class of Subcontractor's Personnel and of each type of Subcontractor Equipment on the Site, in a form approved by the Construction Contractor.

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

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 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 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 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 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.

7.0 EQUIPMENT, MATERIALS AND WORKMANSHIP

7.1 Manner of Execution

The Subcontractor will ensure that the Vehicle Component, consumables and materials used or supplied by it in connection with the Subcontractor Works to be:

(a) of good quality, fit for their intended purpose and maintained in a safe, serviceable and clean condition in accordance with the Output Specifications and Good Industry Practice (Works);

(b) of the type specified in the Output Specifications, if applicable; and

(c) 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 cause sufficient stocks of goods, consumables, equipment and materials including those in connection with the Vehicles to be held in compliance with its obligations under this Subcontract.

7.2 Samples

The Subcontractor shall submit samples to the Construction Contractor, for review in accordance with the procedures for Subcontractor's Design Data described in Sub-Clause 5.2, 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. The description of the train mock-up to be provided by the Subcontractor is set out in Appendix N (Design and Style Management).

7.3 Inspection

Without limiting the access rights provided to the Construction Contractor in Clause 2.1, the Construction Contractor's Personnel shall at all reasonable times:

(a) have full access to the MSF and any workshop where materials or equipment are being manufactured, prepared or stored, and

(b) during production, manufacture, testing and commissioning, be entitled to examine, inspect, measure and witness tests of the materials and workmanship, and to check the progress of manufacture of Vehicle Equipment.

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.

In respect of the Subcontracted Works which Construction Contractor's Personnel are entitled to examine, inspect, or measure or witness the testing of, the Subcontractor shall give notice to the Construction Contractor whenever any such Subcontracted Works are ready and before they are covered up, put out of sight, or packaged for storage or transport. The Construction Contractor shall then either promptly carry out the examination, inspection, measurement or witness testing without unreasonable delay, or promptly give notice to the Subcontractor that the Construction Contractor does not require to do so. If the Subcontractor fails to give the notice, it shall, if and when required by the Construction Contractor, uncover the Subcontracted Works and thereafter reinstate and make good, all at the Subcontractor's cost. If at any other time the Construction Contractor reasonably believes that the Subcontracted Works is defective or not in compliance with the requirements of this Subcontract, the Construction Contractor may instruct the Subcontractor to uncover and inspect (or allow the Construction Contractor or its designee to inspect) any portion of the Subcontracted Works at the Subcontractor's cost if the Subcontracted Works is defective or not in compliance with this Subcontract or otherwise at the Construction Contractor's cost.

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 Construction Contract or the Project Agreement, as applicable, or over what it would be typically because, in their reasonable opinion, the Subcontracted Works contains 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 test requirements under this Subcontract, including those specified in the Master Test Plan described in Section 3.34 (Vehicle Testing) of Schedule 15-2, Part 4 – Design and Construction Requirements to the Project Agreement. All tests procedures will be developed by the Subcontractor and submitted to the Construction Contractor for review in accordance with Sub-Clause 5.2, with the

exception of Integration Tests, which will be developed jointly by the Construction Contractor and Subcontractor together with other subcontractors of the Construction Contractor as appropriate. The Subcontractor will perform all Acceptance Tests but not the Integration Tests, which will be performed by the Construction Contractor with the assistance of the Subcontractor.

Unless specifically stated otherwise in Appendix G (Vehicle Testing), the Subcontractor shall provide all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Subcontractor shall agree, with the Construction Contractor, upon the time and place for the specified testing of any Vehicle Equipment, materials and other parts of the Subcontracted Works. The Construction Contractor may vary the location of the test within the alignment with the consent of the Subcontractor, not to be unreasonably withheld.

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

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. The Construction Contractor may require the Subcontractor to postpone or delay one or more tests, the Subcontractor may submit a notice of claim for 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. Upon receipt of such notice, the Construction Contractor shall proceed in accordance with Sub-Clause 3.5 to agree or determine these matters, including agreement or determination on appropriate mitigation measures.

7.5 Independent Certifier's and Others' Attendance

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

7.6 Rejection

If, as a result of an examination, inspection, measurement or testing, any Vehicle Equipment, Materials, design or workmanship is found to be defective or otherwise not in accordance with the Subcontract, the Construction Contractor may reject the Vehicle Equipment, Materials, design or workmanship by giving notice to the Subcontractor, with reasons. 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 Vehicle Equipment, Materials, design or workmanship to be retested, the tests shall be repeated under the same terms and conditions. If the rejection and retesting cause the Construction Contractor to incur Direct Loss and/or Liquidated Damages, the Subcontractor shall, subject to Sub-Clause 2.5, pay such Direct Loss and/or Liquidated Damages to the Construction Contractor.

7.7 Remedial Work

Notwithstanding any previous test or certification, the Construction Contractor may, as appropriate in the circumstances, instruct the Subcontractor to:

(a) remove, replace, and/or correct any deficiencies in Equipment or Materials which are not in accordance with the Subcontract,

(b) 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 Subcontractor fails to comply with any such instruction, which complies with Sub-Clause 3.4, 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 Delay Liquidated Damages arising therefore from the Subcontractor.

7.8 Ownership of Equipment and Materials

The Subcontractor agrees that title to each item and part of the Subcontracted Works, including Vehicle Equipment and materials, will pass to the Construction Contract so as to enable it to comply with Section 55.1 of the Construction Contract, provided that the Subcontractor has received the Milestone Payment corresponding to the level of completion of the Subcontracted Work and any compensation on termination has been received in respect of Subcontracted Work beyond such level of completion.

8.0 COMMENCEMENT, DELAYS AND SUSPENSION

8.1 Commencement of Subcontracted Works

Subject to Sub-Clauses 8.1.1 and 8.1.2, the Subcontractor shall commence the design and execution of the Subcontracted Works immediately upon the Commencement Date, and shall then proceed with the Subcontracted Works with due expedition and without delay.

8.1.1 Vehicle Working Drawings

The Subcontractor shall prepare detailed plans and specifications:

(a) in conformity with the Vehicle Drawings; and

(b) in accordance with and as more particularly described in Appendix A (Technical Requirements) and the Output Specifications, and as may be amended from time to time in accordance with this Subcontract;

(the "**Vehicle Working Drawings**").

8.1.2 Vehicle Construction

Upon the completion of the Vehicle Working Drawings, the Subcontractor shall manufacture the Vehicles and the Vehicle Equipment in accordance with the Vehicle Working Drawings and this Subcontract.

8.2 Time for Completion

8.2.1 The Subcontractor shall complete the whole of the Subcontracted Works within the Time for Completion stated in Appendix D (Vehicle Planning) to this Subcontract including:

(a) achieving Acceptance for each Vehicle and the passing of the Integration Tests, including the acceptance of the Integration Test results by the City and the Independent Certifier, as applicable, under the Project Agreement,

(b) execution and delivery of the Bills of Sale,

(c) receipt by the Construction Contractor of the required Canadian Content Certificates (including any updated certificates required under the Project Agreement),

(d) completing all of the Subcontracted Works with the exception of Punch List Items but, for clarity, including any Defects discovered during the Integration Tests, and

(e) delivering all documentation 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 set out in Appendix D (Vehicle Planning). Within sixty (60) days after the date of this Subcontract the Subcontractor shall deliver to the Construction Contractor's Representative, in computer readable form (and in paper copy if required by the City), a proposed detailed schedule for review and approval by the Construction Contractor that

(a) conforms to the preliminary schedule in Appendix D (Vehicle Planning) (subject to adjustments agreed to pursuant to the second paragraph of this Sub-Clause 8.3.1),
(b) has been prepared using Oracle Primavera P6 Project,
(c) meets the requirements of Sections 22.2(e), (f) and (g) of the Project Agreement.

The Parties will make reasonable efforts to agree, within the 60 days of the coming into force of this Subcontract, on adjustments to the preliminary schedule contained in Appendix D (Vehicle Planning) to accommodate the Subcontractor's scheduling needs. Until the Parties agree on such adjustments, notwithstanding Sub-Clause 8.6, the grace period described in Sub-Clause 8.6 will be extended and will be a 60-day period for all Delay LD Milestones other than in respect of the final two Delay LD Milestones, which are linked, respectively, to achievement of Payment Milestone 9 (Acceptance of Vehicles) and Payment Milestone 10 (Revenue Service Commencement).

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, 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 that the Subcontractor make adjustments to the schedule or provide further detail based on the criteria in Sub-Clause 8.3.1. 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 Subcontractor will provide necessary assistance to the Construction Contractor in its development of this 6-Month Works Schedule and the Works Schedule in co-ordination with the City, including proposing revisions to the Approved Subcontract Schedule in response to City's comments and in consultation with the Construction Contractor. Any revisions agreed to by the Parties and the City will be incorporated into the Approved Subcontractor Schedule.

8.3.3 Not used

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, so as to achieve Completion and the other Milestone Dates by the dates indicated on the Approved Subcontract Schedule. The Subcontractor will not be responsible for any delay in performance of the Subcontracted Works due to the failure of the Construction Contractor to provide any inputs in a timely manner as specified in Appendix D (Vehicle Planning) to this Subcontract. In the absence of required inputs, the Subcontractor will generally be required to mitigate any such delay by proceeding on the basis of reasonable assumptions that it communicates to the Construction Contractor prior to proceeding.

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 the Completion Deadline, 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 Subcontract Dispute Resolution Procedure.

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

For clarity, where the Construction Contractor requires the Subcontractor to implement a recovery plan or other acceleration measure in response to a delay in the performance of the Subcontracted Works due to the failure of the Construction Contractor to provide inputs in a timely manner as specified in Appendix D (Vehicle Planning) to this Subcontract, then the Subcontractor will be entitled to a Variation.

8.3.6 Furthermore, the Subcontractor acknowledges that under Section 22.3 of the Project Agreement and Part 2 Section 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 Work in accordance with the approved recovery plan.

If the acceleration measures taken by the Subcontractor cause the Construction Contractor to incur Direct Losses, the Subcontractor shall pay such Direct Losses to the Construction Contractor, provided that the sum of such Direct Losses will not exceed the Delay Liquidated Damages that the Subcontractor would otherwise have had to pay under Sub-Clause 8.6 below.

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.

To the extent that the relevant delay has been caused by an act or omission of the Subcontractor, any measures taken by the Subcontractor under this Sub-Clause 8.3.6 will

be at the Subcontractor's expense, and otherwise, at the Construction Contractor's expense.

8.3.7 In accordance with Clause 14 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 Construction Contract, update and deliver to the Construction Contractor's Representative an updated Approved Subcontract Schedule which complies with the requirements of Sub-Clause 8.3.1

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 will apply to updates to the Approved Subcontract Schedule. The updated schedule will 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, or to update the Approved Subcontract Schedule as required under Sub-Clause 8.3.8, 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 provisions of Sub-Clause 16.1 of this Subcontract will apply.

8.3.10 The Progress Report submitted under Sub-Clause 4.22 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 Clause 20, to an extension of the Time for Completion if and to the extent that completion for the purposes of Sub-Clause 11.1 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 Project Co Event, or

(d) 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. When determining each extension of time under Sub-Clause 3.5, 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), 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 (c) or (d), the provisions of Clause 9 will apply.

8.5 **Not used**

8.6 **Delay Liquidated Damages**

The Subcontractor shall pay Delay Liquidated Damages to the Construction Contractor in accordance with the below chart in the case the relevant Delay LD Milestone is not achieved by the relevant Delay LD Milestone Date, provided in the case of the final Delay LD Milestone, it is not achieved due to the acts or omissions of the Subcontractor. The Delay Liquidated Damages listed in the below chart are daily amounts, which shall be assessed per calendar day, for each calendar day which shall elapse between the relevant Delay LD Milestone Date and the date on which the Delay LD Milestone is actually achieved. The Subcontractor will be entitled to a grace period of one month during which Delay Liquidated Damages will not be assessed for all Delay LD

Milestones other than the final Delay LD Milestone, which is linked to the achievement of Payment Milestone 10 (Revenue Service Commencement). The total amount due under this Sub-Clause shall not exceed the aggregate maximum amount of ten percent (10%) of the Subcontract Price.

Description of Delay LD Milestones	**Delay LD Milestone Date**	**Delay Liquidated Damages (per diem amount)**
Payment Milestone 3B (Final Submittal and Approval of Final Design Package) has been achieved	Date indicated in Appendix D1 for achievement of Payment Milestone 3B	**Component pricing**
Payment Milestone 8 (End of Serial Test) has been achieved with respect to Vehicles 1 and 2	Date indicated in Appendix D1 for achievement of Payment Milestone 8 with respect to Vehicle 2	
Payment Milestone 8 (End of Serial Test) has been achieved with respect to Vehicles 3 through 17	Date indicated in Appendix D1 for achievement of Payment Milestone 8 with respect to Vehicle 17	
Payment Milestone 8 (End of Serial Test) has been achieved with respect to Vehicles 18 through 34	Date indicated in Appendix D1 for achievement of Payment Milestone 8 with respect to Vehicle 34	
Payment Milestone 9 (Acceptance of Vehicles) has been achieved	Date indicated in Appendix D1 for achievement of Payment Milestone 9	
Payment Milestone 10 (Revenue Service Commencement) has been achieved	Date indicated in Appendix D1 for achievement of Payment Milestone 10	

These Delay Liquidated Damages shall be the only damages due from the Subcontractor for such default, other than in the event of termination under Sub-Clause 16.1.1 prior to Completion of the Subcontracted Works or any liability of the Subcontractor under the indemnity given under Clause 17.1(g) for liquidated damages ultimately payable under Section 26.7 of the Construction Contract. These Delay Liquidated Damages shall not relieve the Subcontractor from its obligation to complete the Subcontracted Works, or

from any other liabilities, duties, obligations or, responsibilities which it may have under the Subcontract.

Delay Liquidated Damages shall accrue daily and shall be payable monthly on the 25th day of each month.

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. Where the Construction Contractor requires the Subcontractor to suspend performance other than due to the fault of the Subcontractor, then the Subcontractor will be entitled to a Variation for protecting, store and secure the Subcontracted Works, which may include dynamic storage where the Vehicles are fully assembled.

If the Subcontractor has been instructed to suspend performance of the Subcontracted Works, other than due to a City Event or Project Co Event, and such suspension continues for twelve (12) months, the Subcontractor will have to right to terminate this Subcontract and to claim compensation pursuant to Sub-Clause 16.5.2 for termination as a result of a Construction Contractor Event of Default.

If the Subcontractor has been instructed to suspend performance of the Subcontractor Works due to a City Event, including for clarity an event of Force Majeure or a Relief Event under the Project Agreement, or a Project Co Event, the Subcontractor will have the right to terminate this Subcontract 60 days after the Construction Contractor's right to termination arises under the Construction Contract and to claim compensation pursuant to Sub-Clause 16.5.3 for termination as result of a City Event of Default, event of Force Majeure or Relief Event, as the case may be.

Prior to exercising either right to termination pursuant to this Sub-Clause, the Subcontractor will discuss in good faith with the Construction Contractor alternative measures to allow the continuation of the Subcontracted Works.

8.8 Consequences of Suspension

Except where the Subcontractor has been instructed to suspend performance due to the fault of the Subcontractor, if the Subcontractor suffers delay and/or incurs Direct Loss 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 Clause 9, to:

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

(b) payment of any such Direct Loss.

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

The Subcontractor shall not be entitled to an extension of time for, or to payment of Direct Loss 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 or to extent already provided for in a Variation.

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 Vehicles and Vehicle Equipment affected by the suspension. The Subcontractor shall make good any deterioration or defect in or loss of the Subcontracted Works and the Vehicles and Vehicle Equipment, which has occurred during the suspension, unless the protection, storage and securing of the Subcontracted Works is not the responsibility of the Subcontractor under Sub-Clause 8.7.

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, 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 of Default (as set forth in Sub-Clauses 9.6 and 16.5.2);
(e) any circumstance giving rise to an indemnity in favour of the Subcontractor under Sub-Clause 17.2;
(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, Project Co Event or claim arising due to the acts or omissions of the Maintenance Contractor or an MC Party, the Subcontractor's rights against the Construction Contractor will be limited to the Subcontractor's rights under Sub-Clause 9.3, 9.4 or 9.5, as applicable, or Sub-Clause 14.1, in the case of a City Variation or a Project Co Variation.

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 two (2) Business Days after it 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 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 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 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), the Construction Contractor will, in a diligent and timely manner, seek such remedies on behalf of the Subcontractor in accordance with Sub-Clause 9.9;

(c) Notwithstanding Sub-Clause 9.3(b), 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) Subject to Sub-Clause 9.3(c), 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 9.3 to any greater extent than the Construction Contractor actually receives under the provisions of the Construction Contract, and then only in such proportion as is equitable in the circumstances, or otherwise in accordance with Sub-Clause 9.9.

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 Maintenance Contractor has breached its obligations set out in this Sub-Clause 9.4, the Subcontractor may seek compensation for its Direct Losses and the provisions of Sub-Clauses 9.5 and 9.9 shall apply *mutatis mutandis* to any such claim.

Notwithstanding anything to the contrary in this Subcontract, the Subcontractor shall have no claim under or in connection with this Subcontractor in respect of loss or delay that is caused by the Subcontractor or any of its affiliates acting as a supplier of maintenance services or otherwise in connection with the Project.

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 two (2) Business 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 in accordance with Sub-Clause 9.9;

(c) Notwithstanding Sub-Clause 9.5(b), 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) Subject to Sub-Clause 9.5(c), 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 Construction Contract, and then only in such proportion as is equitable in the circumstances, or otherwise in accordance with Sub-Clause 9.9.

9.6 Claims Pursuant to a Construction Contractor Event of Default

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 Event of Default, the same procedure as set out above in Sub-Clause 9.5(a) shall be followed, except that each "Project Co Event" shall be read to mean "Construction Contractor Event of Default".

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

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 of Default;

ii. the Subcontractor shall be granted relief from its obligation to pay Delay Liquidated Damages or Construction Contract 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 of Default; 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 of Default.

9.7 Payment Dates

Any amounts payable to the Subcontractor:

(a) pursuant to Sub-Clauses 9.3 (other than Sub-Clause 9.3(c)), 9.4 or 9.5 (other than Sub-Clause 9.5(c)) shall be paid by the Construction Contractor within ten (10) Business Days of the receipt of payment by the Construction Contractor from Project Co;

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

(c) pursuant to Sub-Clauses 9.3(c), 9.5(c) or 9.9.1(c)(iv) shall be paid by the Construction Contractor to the Subcontractor within 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-Clauses 9.3, 9.4, 9.5 or 9.6, 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-Clauses 9.3, 9.4, 9.5 or 9.6, 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 Construction 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.

9.9 Procedural Requirements

9.9.1 If the Subcontractor has complied with Sub-Clause 9.3(a) in respect of a City Event or Sub-Clause 9.5(a) in respect of a Project Co Event, then, subject always to the provisions of Sub-Clause 9.9.10:

(a) unless the Construction Contractor elects to inform the Subcontractor under paragraph (c)(iii) below, the Construction Contractor shall, promptly (having regard to the timeframe required for the determination under paragraph (c)(iii) and the time limitations set out in the Project Agreement) 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, use its reasonable commercial efforts to pursue the Equivalent Claim with Project Co, provided that the Subcontractor shall (i) 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) keep the Construction Contractor informed (including providing copies of any documentation reasonably requested) at all times of any matter relevant to the pursuit of the Equivalent Claim of which the Subcontractor becomes aware; or

(ii) Not used

(iii) within 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 10 Business Days of receipt by the Construction Contractor of such further information) (or, in each case, such other reasonable period having regard to any time limit for submission of such Equivalent Claim by

the Construction Contractor to Project Co under the Construction 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, provided that, if the Subcontractor does not agree with the Construction Contractor, such matter shall be referred to the Subcontract Dispute Resolution Procedure and if it is determined pursuant to the Subcontract 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 shall apply; or

(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 9.9.10.

(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 9.9.1(d)(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; 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 9.10.4, 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) Not used

(f) the Construction Contractor shall, on receipt of any reasonable request to do so from the Subcontractor, invoke the CC Dispute Resolution Procedure 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 or a Project Co Event to the extent that the Construction Contractor is or becomes entitled under the Construction Contract as provided in Sub-Clauses 9.9.3, but in any event to no greater extent than the Construction Contractor's entitlement under the Construction Contract determined pursuant to either:

(a) an agreement between the Construction Contractor and Project Co effected in accordance with Sub-Clause 9.9.1(d)(iii) and subject to the provisions of Sub-Clause 9.9.3; or

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

9.9.3 Subject to Sub-Clause 9.9.10, 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 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 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) on what is a fair and reasonable proportion of such entitlement within 21 days of a written request by either party to agree on the same, either party may refer the matter to Subcontract Dispute Resolution Procedure.

9.9.5 Following agreement or determination of the entitlement of the Subcontractor under Sub-Clause 9.9.3 or 9.9.4, 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 Construction 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 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). The Construction Contractor shall not 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 will preclude the Subcontractor from commencing legal proceedings in the Courts of Ontario if such proceedings are necessary to preserve any 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 Subcontract 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 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 Sub-Clause 9.9.9, 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 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 15 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.

9.9.10 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 Subcontract 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 and as if the Construction Contractor had succeeded in obtaining the full entitlement from the Project Co under the Construction Contract. The Subcontractor shall, except where this Sub-Clause 9.9.10 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 15 Business Days of a written request by either party to agree on the same, either party may refer the matter to the Subcontract 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 the rights and remedies available to the Subcontractor in respect of any breach of contract or indemnity obligation of the Construction Contractor which does not arise due to a City Event, Project Co Event or act or omission of the Maintenance Contractor or an MC Party.

9.10 Project Co-Related Proceedings

9.10.1 This Sub-Clause 9.10 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 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 Project Agreement and in accordance with the Subcontractor's reasonable directions;

(b) the Subcontractor shall prepare and each 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 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 not to be unreasonably withheld or delayed (and any disputes relating to any such consent shall be resolved pursuant to the Subcontract 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, 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 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 Subcontract 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 CC Party to, provide the Construction Contractor with such information as is in the control or possession of the Subcontractor or a CC 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 and the Maintenance 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. For greater certainty, where such liability consists of a negative adjustment to payments due to Construction Contractor under the Construction Contract or the payment of a lump sum by the Construction Contractor to Project Co, as the case may be, the Subcontractor shall pay to the Construction Contractor the Subcontractor's proportion of such liability promptly and, in any event, no later than 3 Business Days prior to the date upon which the payment which is subject to the negative adjustment is due or such lump-sum amount is due to be paid by Construction Contractor to Project Co under the Construction Contract, as the case may be.

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, except to the extent that:

(a) they arise from any breach by the Construction Contractor of this Subcontract; or

(b) 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 ACCEPTANCE TESTS AND INTEGRATION TESTS

10.1 Performance of Tests

10.1.1 Acceptance Tests

The Subcontractor shall carry out the Acceptance Tests in accordance with this Sub-Clause and Sub-Clause 7.4. The Parties agree that the tests and principles expressed in

Appendix G (Vehicle Testing) to this Subcontract will form the basis of the Acceptance Tests submitted by the Subcontractor for review under Sub-Clause 5.2.

Unless otherwise specified in the Master Test Plan (or any other approved test plan), 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 Acceptance Tests. The Acceptance Test(s) will be carried out within 15 days after this date, on such day or days as the Parties will agree.

In considering the results of the Acceptance Tests, appropriate allowances shall be made for the effect of any use of the Vehicles by the City on the performance or other characteristics of the Vehicles. As soon as a Vehicle has passed each of the Acceptance Tests described in Master Test Plan (or any other approved test plan), the Subcontractor shall submit a certified report of the results of these Acceptance Tests to the Construction Contractor (the "Acceptance Test Report").

10.1.2 Integration Tests

The Construction Contractor shall carry out the testing and commissioning of the System, including Trial Running (as defined under the Project Agreement), in accordance with Schedule 14 to the Project Agreement and Sub-Clause 7.4. Such testing and commissioning shall be referred to as "Integration Tests". The Subcontractor will assist the Construction Contractor with the development of the Integration Tests and will assist the Construction Contractor in fulfilling its obligations under Sections of 1.1, 1.3 (other than 1.3(p)(v) and (p)(vi)), 1.4 (in particular the supply of a member of the Commissioning Team), 1.5, 1.6, 1.7 and 1.8(ii) of such Schedule 14.

Unless otherwise agreed to by the Parties, the Construction Contractor shall give to the Subcontractor not less than fifteen (15) days' notice of the date after which the Construction Contractor will be ready to carry out each of the Integration Tests. Each Integration Test will be carried out within thirty (30) days after this date, on such day or days as the Construction Contractor shall instruct.

In considering the results of the Integration Tests, appropriate allowances shall be made for the effect of any use of the Vehicles by the City on the performance or other characteristics of the Vehicles. As soon as all Vehicles have passed each of the Integration Tests, the Construction Contractor shall submit a certified report of the results of these Integration Tests to the Subcontractor.

10.2 Delayed Tests

If an Acceptance Test or an Integration Test is being unduly delayed by the Subcontractor, the Construction Contractor may by notice require the Subcontractor to carry out such Acceptance Test or to participate as required in the carrying out of the Integration Test within ten (10) days after receiving the notice. The Subcontractor shall

carry out such Acceptance Test or participate in the carrying out of the Integration Test 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 Acceptance Test or to participate as required in the carrying out of the Integration Test within such period of ten (10) days, the Construction Contractor's Personnel may proceed with the Acceptance Test or Integration Test at the risk and cost of the Subcontractor. In such circumstances, this Acceptance Test or Integration Test shall then be deemed to have been carried out in the presence of the Subcontractor and the results of the Acceptance Test or Integration Test shall be accepted as accurate.

10.3 **Retesting**

10.3.1 **Acceptance Tests**

If a Vehicle fails to pass the Acceptance Tests, Sub-Clause 7.6 shall apply, and the Construction Contractor or the Subcontractor may require the failed Acceptance Tests, and Acceptance Tests on any related work, to be repeated under the same terms and conditions.

10.3.2 **Integration Tests**

If a Defect in the Subcontracted Works caused the failure of an Integration Test, Sub-Clause 7.6 shall apply, and the Construction Contractor may require the failed Integration Test, and Integration Tests on any related work, to be repeated under the same terms and conditions.

10.4 **Failure to Pass Tests**

10.4.1 **Acceptance Tests**

If a Vehicle fails to pass the Acceptance Tests repeated under Sub-Clause 10.3, the Construction Contractor shall be entitled to:

(a) order further repetition of Acceptance Tests under Sub-Clause 10.3;

(b) if the failure deprives the Construction Contractor of substantially the whole benefit of the Vehicle, reject the Vehicle, 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 an Acceptance Certificate.

In the event of sub-paragraph (c), the Subcontractor shall proceed in accordance with all other obligations under the Subcontract, and the Subcontract Price shall be reduced by

such amount as shall be appropriate to cover the reduced value to the Construction Contractor as a result of this failure. Unless the relevant reduction for this failure is stated (or its method of calculation is defined) in the Subcontract, the Construction Contractor may require the reduction to be (i) agreed by both Parties (in full satisfaction of this failure only) and paid before this Acceptance Certificate is issued, or (ii) determined and paid under Sub-Clause 3.5.

10.4.1 **Integration Tests**

If a Defect in the Subcontracted Works causes the failure of an Integration Test repeated under Sub-Clause 10.3, the Construction Contractor shall be entitled to:

(a) order further repetition of Integration Tests under Sub-Clause 10.3; or

(b) if the failure deprives the Construction Contractor of substantially the whole benefit of the Vehicles, reject the Vehicles, 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.

11.0 ACCEPTANCE AND COMPLETION

11.1 Acceptance of the Vehicles

Except as stated in Sub-Clause 10.4, each Vehicle shall be accepted by the Construction Contractor when, firstly, the Subcontracted Works have been completed in accordance with the Subcontract, including the matters described in Sub-Clause 8.2 and except as allowed in sub-paragraph (a) below, and, secondly, an Acceptance Certificate for the Subcontracted Works has been issued, or is deemed to have been issued in accordance with this Sub-Clause.

The Construction Contractor shall, within fifteen (15) days of the Acceptance Tests Report date:

(a) issue the Acceptance Certificate to the Subcontractor, stating the date on which the Vehicle was 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 which will not substantially affect the use of the Vehicle for their intended purpose (either until or whilst this work is completed and these Defects are remedied); or

(b) reject the application, giving reasons and specifying the work required to be done by the Subcontractor to enable the Acceptance Certificate to be issued. The Subcontractor shall then complete this work before issuing a further notice under this Sub-Clause.

Failure of the Construction Contractor to respond within fifteen (15) days of the Acceptance Tests Report shall constitute a deemed acceptance and the Acceptance Tests Report shall constitute the Acceptance Certificate.

11.2 **Transfer of Risks**

Upon issuance of the Acceptance Certificate, all risks on the Vehicle shall be transferred to the Construction Contractor.

11.3 **Completion Certificate**

Five (5) Business Days after the passing of the final Integration Test, which shall include the acceptance of the Integration Test results by the City and the Independent Certifier, as applicable, under the Project Agreement, the Completion Notice shall be deemed to have given, without prejudice to the Construction Contractor's right to require performance of any outstanding obligations.

11.4 **Interference with Tests**

If the Subcontractor is prevented from carrying out an Acceptance Test, or an Integration Test is delayed, for more than thirty (30) days, by a cause for which the Construction Contractor is responsible, the Subcontractor shall carry out the Acceptance Test or be available to participate in carrying out of the Integration Test as soon as practicable thereafter.

If the Subcontractor suffers delay and/or incurs Direct Loss as a result of this delay in carrying out an Acceptance Test or Integration Test, 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.

11.5 **Punch List Items**

Minor Deficiencies which are included in the Minor Deficiencies List issued by the Independent Certifier and which are in respect of the Subcontracted Works will be

included within the Punch List Items for the purposes of this Subcontract. With the exception of Minor Deficiencies, the identification of Punch List Items shall have been agreed upon prior to the Construction Contractor issuing the Acceptance Certificate for any of the Subcontracted Works, or where the Punch List Items have been identified in carrying out the Integration Tests, prior to issuance of the Completion Certificate. The Construction Contractor will be entitled to retain from payments owing to the Subcontractor, or to require payment from the Subcontractor to the extent such payments owing to the Subcontractor are insufficient:

(a) 200% of the cost of completing the Punch List Items for items which are included in the Minor Deficiencies List issued by the Independent Certified, as such costs estimated by the Independent Certifier under the Project Agreement or

(b) 100% of the cost of completing the Punch List Items for all other item, as estimated by the Construction Contractor under Sub-Clause 3.5.

The Subcontractor will complete the Punch List Items no later than 15 days prior to the date by which the Construction Contractor must complete the corresponding Minor Deficiencies under the Construction Contract or within the time for remediation determined by the Construction Contractor under Sub-Clause 3.5.

12.0 DEFECTS LIABILITY WARRANTY

12.1 General and Extended 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 an Acceptance Certificate for each respective Vehicle and ending two (2) years following the Revenue Service Commencement Date (the "**General Warranty Period**").

If the Subcontractor is obliged to carry out work to remedy any Defects during the General Warranty Period, the General Warranty Period shall be extended in respect of the work required to be carried out to remedy the relevant Defect and any asset or element of the Subcontracted Work affected by the Defect from the date on which the relevant remedial work is completed to the satisfaction of the Construction Contractor for a single additional one-year period.

12.2 Epidemic Defect Warranty

Subject to Sub-Clause 12.5, for any Epidemic Defect in respect of which a Claim is made by the Construction Contractor in writing to the Subcontractor within the period commencing at the end of the General Warranty Period and ending on the fourth (4th) anniversary of the Revenue Service Commencement Date (the "**Epidemic Defect Warranty Period**"), the Subcontractor shall:

(a) at its own expense, supply and deliver in a timely manner such part(s) or component(s) that is or are the subject of the Epidemic Defect and require replacement; and

(b) subject to Clause 19, indemnify and keep indemnified the Construction Contractor for all expenses or costs properly incurred by the Construction Contractor as a consequence of the Epidemic Defect in respect of the installation and commissioning or the repair of any part or component referred to in this Sub-Clause 12.2.

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 were in existence at the time of acceptance of the relevant Vehicle and that, at the end of the General Warranty Period, could not reasonably have been ascertained by a competent person during an inspection of the Subcontracted Works in accordance with Good Industry Practice 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 **Not used**

12.5 **Indemnity in favour of Maintenance Contractor**

(a) 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 CC Defect and such costs), as a result of a CC Defect during the CC Warranty Period.

(b) 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.

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, 12.2 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 commence compliance with any notice served under Sub-Clause 12.6(a) within ten (10) Business Days, or to remedy any Defect within a reasonable period of time, 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 all 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), or where the Subcontractor has paid the Construction Contractor for undertaking this responsibility on the Subcontractor's behalf pursuant to Sub-Clause 12.6(e), 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.

Notwithstanding anything else in this Agreement, after Revenue Service Availability, the Subcontractor's obligation to repair Defects pursuant to this Clause 12, does not extend to defects resulting from a system integration issue for which the Subcontractor is not responsible, the effects of events of Force Majeure, corrosion, erosion (other than corrosion or erosion due to defects in design and/or construction) or wear and tear upon any portion of the System or failure of any portion of the System due to faulty operations or maintenance by the City, Project Co or the Maintenance Contractor, provided that, if the Construction Contractor directs the to perform work and there is a Subcontract Dispute as to whether this paragraph applies, the Subcontractor shall promptly carry out the work in accordance with the Construction Contractor's direction pending resolution of the Subcontract Dispute.

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 Construction Contractor 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 Construction Contractor will forward any such notice received from the Maintenance Contractor as soon as practicable and provide to the Subcontractor the same opportunity in the place of Construction Contractor to remedy the Defect as it receives from the Maintenance Contractor. 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 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 Vehicles or items of Vehicle Equipment as contain the Defect.

12.9 Further Tests

If the work of remedying of any Defect may affect 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 Acceptance Tests or Integration Tests after the Defect is remedied.

12.10 Right of Access

Where the Subcontractor is required to remedy a Defect pursuant to this Subcontract, the Construction Contractor shall ensure that the Maintenance Contractor cooperates to facilitate the efficient and effective carrying out of such works, and, following the Revenue Service Availability Date, allow the Subcontractor reasonable access to the Site to carry out any relevant remedial work, provided such access does not interfere with, hinder or delay in any material respect its performance of the Maintenance Contractor's obligations to Project Co. Notwithstanding the foregoing, upon consultation with the Construction Contractor and the Maintenance Contractor, the Subcontractor may interfere in a material respect with the performance of the Maintenance Contractor's obligations to Project Co in the event there is no commercially reasonable alternative to performing the relevant remedial work. Subject to the duty to mitigate, the Subcontractor shall pay to the Maintenance Contractor its reasonable costs, losses, damages, fees and/or expenses incurred because of any such material interference.

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 Design Data 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**

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 NOT USED

14.0 VARIATIONS AND ADJUSTMENTS

14.1 **Variation Required by the Construction Contractor**

The Construction Contractor may, without invalidating this Subcontract, require a Construction Contractor Variation (including a Variation applicable to the scope of the Subcontracted Works) 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 Construction Contract, including to the extent that the Variation Procedure requires the Construction Contractor to minimize the cost and impact of a Variation, provided that the Subcontractor is advised of such Variation

and its input is requested in a timely manner and that the input that it has provided in accordance with the Variation Procedure of the Construction Contract has been included in any response or estimate provided to Project Co.

In the case of a Construction Contractor Variation, the provisions of Sub-Clauses 14.3 through 14.12 shall apply.

14.2 **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.

14.3 **Not used**

14.4 **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.

14.5 **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.

14.6 **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 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 10 days of receipt of the

Preliminary Variation Instruction, 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;

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

v. any adverse effect on the Subcontractor's ability to meet its obligations under this Subcontract (e.g., the performance requirements of the Vehicles) which the Subcontractor does not expect it will be able to mitigate; 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 required for the preparation of the Variation Report 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 Subcontract Dispute Resolution Procedure, pending a decision thereunder, and if so instructed by the Construction Contractor, the Subcontractor will implement the direction.

14.7 **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;

(f) any adverse effect on the Subcontractor's ability to meet its obligations under this Subcontract (e.g., the performance requirements of the Vehicles) which cannot be mitigated by the Subcontractor and the modification of its obligations that would be required to allow the Subcontractor to perform the Variation; and

(g) the identity of the Sub-subcontractors which the Subcontractor intends to engage for the purposes of implementing the Variation.

Each Variation Report shall also include the foregoing information with respect to any Vehicles which may be acquired pursuant to the Option Agreement.

14.8 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 net estimated hourly amount (based on salary) paid to Design and engineering staff, multiplied by a multiplier at market rates or such other rate as may have been agreed by the Subcontractor and the Construction Contractor for Design services. If the Construction Contractor requests to

review the mark-up provisions on design or engineering costs under a Sub-subcontract as part of its review and evaluation, the Subcontractor will make available all data that are relevant to the amount of the mark-up;

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, or if no such agreed rates exist at the then current rates set out in the B.C. Road Builders and Heavy Construction Association Equipment Rental Rate Guide (or any successor guide) where applicable, or as are reasonably commercially available, 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; and

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).

(f) Mark-up on costs associated with a Construction Contractor Variation will be calculated as follows:

i. Design Personnel: the entity actually undertaking the Design, including pursuant to Sub-Clause 14.8(d)(vi), shall not be entitled to add a mark-up for its Design personnel over and above the mark-up set out in Sub-Clause 14.8(d)(ii);

ii. Construction: regarding the costs of Construction involved in the Construction Contractor Variation, the Subcontractor may include a mark-up for head office overhead and profit calculated at existing market rates multiplied by the direct costs incurred in such Construction (excluding Design personnel referred to in Sub-Clause 14.8(d)(ii));

iii. Sub-subcontract Mark-ups: regarding costs of management and supervision:

A. the Subcontractor will be entitled to charge a mark-up for overhead and profit equal to a reasonable margin on the price to be charged to the Sub-subcontractor for the performance of a Variation or part thereof by a Sub-subcontractor; and

B. if the Works or supply is being carried out by a Sub-subcontractor, the Subcontractor will in the Variation Report, demonstrate that the Sub-subcontract is reasonable, considering market demands, and is arms-length.

14.9 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 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-Clauses 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 Subcontract Dispute Notice, and the Subcontractor will, without prejudice to its rights

with respect to such Subcontract Dispute, implement the Variation as directed in the Variation Certificate.

14.10 **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-Clauses 14.8(c) or 14.9(a), as the case may be, in accordance with Sub-Clause 15.3.

14.11 **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. Upon receipt of a Variation Certificate, subject to the Subcontractor's right to dispute pursuant to Sub-Clause14.9(c), the Subcontractor will implement the Variation.

14.12 **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 default or negligence of the Subcontractor), provided that the Subcontractor objected in writing to the incorporation of such item 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 Subcontract Dispute Resolution Procedure, to be reasonable.

14.13 **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 Appendix A (Technical Requirements) to this Subcontract, and (ii) any changes, other than changes necessary in order to reach a

finalized design, to the structures, elements and designs set forth in Appendix A (Technical Requirements) to this Subcontract hereto shall be treated as a Subcontractor's Variation pursuant to Sub-Clauses 14.13 through 14.15 and be subject to the terms thereof.

14.14 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.

14.15 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. 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

15.1 The Subcontract Price

(a) Payment for the Subcontracted Works shall be made on the basis of the fixed, lump sum Subcontract Price, subject to adjustments in accordance with the Subcontract.

(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*, to the extent applicable.

15.3 Payment Terms

The Construction Contractor shall pay the Subcontract Price in accordance with the terms set out in Appendix E (Payment Schedule).

Upon achieving a Payment Milestone, but not before the schedule date for achieving such Payment Milestone set forth in Appendix E (Payment Schedule) or, if not detailed therein, in Appendix D (Vehicle Planning), or upon any sum becoming due pursuant to 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 Construction Contract for inclusion with the Construction Contractor's payment application under the Construction Contract.

The Construction Contractor will pay any undisputed amounts within 5 Business Days of a receipt of payment from Project Co, unless payment is withheld in accordance with the Construction Contract for reasons not due to the Subcontractor, in which case payment will be made within 30 days of the last day of the month in which the completed payment application is received.

If there is a delay in achieving Revenue Service Commencement, the expiry of the warranties periods for the Vehicles and the achievement of Payment Milestone 10 (Revenue Service Commencement) will be delayed accordingly. If the delay is not caused by Subcontractor, Subcontractor will be entitled to its Direct Costs associated with the delay to the commencement of the warranty period and the delay in receiving the Payment Milestone 10 (Revenue Service Commencement) payment, including interest charges at the Default Interest Rate. Compensation will be subject to the Equivalent Project Relief provisions of the Subcontract (Clause 9), as appropriate.

15.4 Delayed Payment

If the Subcontractor does not receive payments which are due and owing, in accordance with Sub-Clause 15.3, the Subcontractor shall be entitled to receive interest at the Default Interest Rate.

15.5 **Currency of 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 which is not being disputed by the Subcontract in accordance with the Subcontract Dispute Resolution Procedure, when due and owing hereunder, and such failure is not remedied within 10 Business Days of notice from the Construction Contractor;

(b) the Subcontractor, or any of the Persons for whom the Subcontractor is responsible under Sub-Clauses 4.3 through 4.6 and Clause 6, fails to perform or observe any term, condition, covenant or undertaking to the Construction Contractor contained in this Subcontract, and such failure is likely to prevent timely Completion of the Subcontracted Works;

(c) any 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 incorrect 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) and such incorrect representation or warranty has resulted in a 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 Construction Contract;

(d) the Subcontractor commits any breach of the terms of any Permit, and such 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 Construction Contract; or

(e) the Subcontractor breaches Sub-Clause 1.8;

(f) the Subcontractor abandons the Subcontracted Works;

(g) at any time, the Construction Contractor, acting reasonably, is of the opinion that Completion is unlikely to be achieved in accordance with the Approved Subcontract Schedule, or the Subcontractor fails to fulfill any obligation under Sub-Clause 8.3.5;

(h) any of the following events occurs in respect of the Subcontractor or the Guarantor:

(i) any arrangement or composition with or for the benefit of creditors being entered into by or in relation to the Subcontractor or Guarantor 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 or Guarantor;

(iii) the Subcontractor or the Guarantor 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 or the Guarantor 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, the Companies' Creditors Arrangement Act, the Winding Up and Restructuring Act 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 or Guarantor under any Insolvency Legislation and, if commenced against the Subcontractor or the Guarantor, 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 or the Guarantor;

(vi) any legal proceedings are taken by any Person (and not stayed within 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 or the Guarantor 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, which action is not stayed or dismissed within 30 days of commencement;

(i) insurance required to be obtained by the Subcontractor under this Subcontract or the Performance Security or the Guarantee ceases to be in full force and effect and in the case of insurance is not replaced within 5 Business Days, in the case of the Guarantee is not replaced within 10 Business Days; and in the case of the Performance Security is not replaced in accordance with Sub-Clause 4.2, the Construction Contractor has presented a draw request to draw upon the Performance Security pursuant to Sub-Clause 4.2, and the proceeds of such draw (if any) are insufficient to replace the full amount of the Performance Security with cash security;

(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) 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) 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 Subcontract Dispute Resolution Procedure or against the Construction Contractor pursuant to Attachment 27 – CC Dispute Resolution Procedure to the Construction Contract 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 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 Sub-Clause 16.1.1(e), the Construction Contractor shall be entitled with any determination or exercise of discretion of Project Co under the Construction 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) the Subcontractor fails to comply with Sub-Clause 1.15 or 6.7;

(n) the Subcontractor fails to comply with Sub-Clause 6.11 or 6.12;

(o) the Subcontractor or the Guarantor ceasing to be, directly or indirectly, controlled by ALSTOM Holdings (within the meaning of the *Canada Business Corporations Act*;

(p) a default by the Guarantor under the terms of the Guarantee, which default has not been cured within the applicable cure period or the Guarantor taking the position that the Guarantee is invalid or unenforceable;

(q) 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

(r) 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 or carry out its rights under this Subcontract or on the ability of the Construction Contractor to perform its obligations under this Subcontract or the Construction Contract.

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(b), (c), (d), (g), (k), (m), (n) or (r) 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, in the case of a Subcontractor Event of Default referred to in Sub-Clause 16.1.1(m) in respect of a failure to comply with Sub-Clause 1.15, to take appropriate action in a timely manner with regard to any employee of the Subcontractor whose actions resulted in such Subcontractor Event of Default; or

(ii) to put forward within ten (10) 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 comply with such program. The program will specify in reasonable detail the manner in which and the latest date by which such Subcontractor Event of Default is proposed to be remedied. In the case of a Subcontractor Event of Default referred to in Sub-Clause 16.1.1(n), the time period for putting forward the program shall be two (2) Business Days and the latest date by

which the default will be remedied shall be 15 days unless the Construction Contractor agrees to a later date in its sole discretion; and

(b) in the case of a Subcontractor Event of Default other than one referred to in Sub-Clause 16.1.3(a), or a Subcontractor Event of Default referred to in Sub-Clause 16.1.3(a) which has resulted in a Construction Contractor Event of Default under the Construction Contract, the Construction Contractor may terminate this Agreement in its entirety by issuing a notice of termination to the Subcontractor with immediate effect.

16.1.4 **Remedy Provisions**

Where the Subcontractor puts forward a program in accordance with Sub-Clause 16.1.3(a), the Construction Contractor will have thirty (30) Business Days from receipt of the program within which to notify the Subcontractor that the Construction Contractor (or Project Co, as the case may be), acting reasonably, does not accept the program. Where the Construction Contractor notifies the Subcontractor that it (or Project Co, as the case may be) does not accept the program as being reasonable, the Parties will use commercially reasonable efforts within the following five (5) Business Days to agree, among themselves and, if applicable pursuant to the Construction Contract, with Project Co, to any necessary amendments to the program put forward. In the absence of agreement within such five (5) Business Days, the question of whether the program (as it may have been amended by agreement) will remedy the Subcontractor Event of Default in a reasonable manner and within a reasonable time period (and, if not, what would be a reasonable program) may be referred by either Party for resolution in accordance with the Subcontract Dispute Resolution Procedure.

16.1.5 **Construction Contractor Termination Right**

If:

(a) a Subcontractor Event of Default notified in a notice of default served under Sub-Clause 16.1.3(a) is not remedied before the expiry of the period referred to in Sub-Clause 16.1.3(a)(i) and no program has been put forward by the Subcontractor under Sub-Clause 16.1.3(a)(ii);

(b) the Subcontractor puts forward a program pursuant to Sub-Clause 16.1.3(a)(ii) which has been accepted by the Construction Contractor or has been determined to be reasonable and the Subcontractor fails to achieve any material element of the program or the end date for the program (as the case may be); or

(c) any program put forward by the Subcontractor pursuant to Sub-Clause 16.1.3(a)(ii) is rejected by the Construction Contractor as not being reasonable,

then the Construction Contractor may terminate this Agreement in its entirety by notice to the Subcontractor with immediate effect.

16.1.6 **Construction Contractor Costs**

The Subcontractor will reimburse the Construction Contractor for all Direct Losses incurred by the Construction Contractor in exercising any of its rights (including any relevant increased administrative expenses and legal expenses) under Sub-Clauses 16.1.3, 16.1.4 and 16.1.5.

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 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 65 days of receiving written notice from the Subcontractor or, if such breach cannot reasonably be cured within such 65-day period, such longer period as is reasonably required to cure such breach provided the Construction Contractor continuously makes diligent efforts to cure such breach until so cured;

(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 canceled within 30 days;

(iii) 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 will have a material adverse effect on the Construction Contractor's ability to perform its obligations under any this Subcontract; or

(iv) 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 SNC, Dragados and EllisDon have not undergone such an event and are not otherwise in default hereunder, provided the Construction Contract has not been terminated.

16.2.2 **Notification of Event of Default**

Whichever Party Has Knowledge of any Construction Contractor Event of Default, will notify the other Party of the occurrence, and details, of any such Event of Default promptly upon becoming aware of its occurrence.

16.2.3 **Subcontractor's Remedies**

On the occurrence of a Construction Contractor Event of Default, 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 reasonable satisfaction of the Subcontractor that it will perform and is capable of performing its obligations under the Subcontract; and

(b) if the relevant matter or circumstance has not been rectified or remedied within thirty (30) Business Days of the Subcontractor's notice, the Subcontractor may serve a further notice on the Construction Contractor terminating this Agreement with immediate effect.

16.2.4 **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.

16.2.5 **Subcontractor Costs**

The Construction Contractor will reimburse the Subcontractor for all Direct Losses incurred by the Subcontractor in exercising any of its rights (including any relevant increased administrative expenses and legal expenses) under Sub-Clause 16.2.4.

16.3 **Construction Contract Termination**

This Subcontract will terminate automatically forthwith on any termination of the Construction Contract, provided that the Construction 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 Construction Contract under its Contractor Direct Agreement with the City or the Lenders' CC Direct Agreement or any agreement contemplated thereunder to replace the Construction Contract.

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 Construction Contract pursuant to Sub-Clause 16.3(a), this Sub-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

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 Construction Contract pursuant to Sub-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:

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 Subcontracted 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 for the Subcontracted Works;

(c) not used;

(d) the Construction Contractor will, subject to Sub-Clause 1.11, be entitled to retain all Vehicle Intellectual Property and Third Party Intellectual Property that has been Delivered up to the Termination Date or that is Delivered pursuant to this Sub-Clause 16.6, which may thereafter be Used by the Construction Contractor, 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 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)

i. in the case where termination arises due to termination of the Construction Contract, if Project Co so elects, the Subcontract, the Performance Security and the Guarantee shall be novated or assigned to Project Co, its nominee, the City or the City's nominee (as Project Co directs), provided that where termination of the Construction Contract arises other than as a result of a Construction Contractor Event of Default thereunder, the consent of the Subcontractor shall be required;

ii. 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 Subcontract Disputes as to such fair value being resolved in accordance with the Subcontract 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 to 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);

(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 the rights of the Subcontractor pursuant to Sub-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.

16.4.7 **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:

(a) not used

(b) 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, and if the Subcontractor has not done so within 30 days after any notice from the Construction Contractor requiring it to do so, the Construction Contractor may (without being responsible for any loss, damage, costs or expenses) remove and sell any such property and will hold any proceeds, less all costs incurred, to the credit of the Subcontractor; and

(c) 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 Sub-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

(d) 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 Sub-Clause 16.4, this Subcontract shall terminate and, except as provided in Sub-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 Project Agreement, termination of this Project Agreement 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, 2.14, 4.25, 5.6, 7.8, 9, 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 Construction Contract or Project Agreement that are incorporated by reference into this Agreement and are stated to survive the termination of the Construction Contract or Project Agreement in Part 2 Section 48.9 of the Construction 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, included any termination of the Construction Contractor caused by a Subcontractor Event of Default, 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, including but not limited to:

(a) where the Construction Contract continues, the additional expenses attributable to the employment of a different Subcontractor to complete the Design and the Construction of the Subcontracted Works and any loss of revenue attributable to the delay and disruption of the Works as a result of such termination; and

(b) where the Construction Contract has also been terminated, all Direct Losses incurred by the Construction Contractor due to such termination including without limitation, the compensation on termination payable by the Construction Contractor to Project Co pursuant to the Construction Contract and amounts owed to other Project subcontractors.

16.5.2 **Construction Contractor Default**

If this Subcontract is terminated as a result of a Construction Contractor Event of Default, including any termination of the Construction Contract caused by a Construction Contractor Event of Default, the Construction Contractor shall pay to the Subcontractor the sum of:

(a) all amounts due and payable to the Subcontractor under this Subcontract prior to such termination, but unpaid;

(b) the value of Subcontracted Works carried out by the Subcontractor prior to such termination but not yet certified as being complete; and

(c) the Direct Costs flowing from the termination including any demobilization costs and any redundancy payments.

16.5.3 **City Events of Default, other Project Agreement Termination, and/or Force Majeure**

If this Subcontract is terminated as a result a termination of the Construction Contract due to a Project Co Event of Default under the Construction Contract or Project Agreement, but not including any Project Co Event of Default caused by a Construction Contractor Event of Default or a Subcontractor Event of Default, 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 from Project Co and in proportion to the claims of the Construction Contractor and other subcontractors to the amounts received.

If this Subcontract is terminated due to a City Event of Default, an event of Force Majeure or a Relief Event, 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 subcontractors 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 tis 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 Sub-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

17.1 **Subcontractor Indemnities to Construction Contractor**

The Subcontractor shall indemnify and save harmless the Construction Contractor and the Construction Contractor Indemnified Parties from and against any and all Direct Losses which may be suffered, sustained, incurred or brought against them as a result of in respect of, or arising out of any one or more of the following:

(a) not used

(b) any physical loss of or damage to all or any part of the Site, the Highway Site, the System or the Highway or to any equipment, assets or other property related thereto to the extent occurring directly or indirectly caused by an act or omission of the Subcontractor or any Subcontractor Personnel;

(c) the death or personal injury of any person directly or indirectly caused by an act or omission of the Subcontractor or any Subcontractor Personnel;

(d) any physical loss of or damage to property or assets of any third party directly or indirectly caused by an act or omission of the Subcontractor or any Subcontractor Personnel;

(e) any other loss or damage of any third party including injurious affection arising from or in consequence of any act or omission of the Subcontractor in respect of the Subcontracted Works that are not in compliance with the requirements set out in this Subcontract and in the Applicable Law including the City's by-laws;

(f) any negligent acts or omissions or willful misconduct of the Subcontractor or any Subcontractor Personnel;

(g) any liability incurred by the Construction Contractor under the Construction Contract or any CC Project Document (as defined in the Construction Contract) that, in each case, arises as a result of any breach by the Subcontractor under the Subcontract;

(h) the costs of enforcement incurred by the Construction Contractor in enforcing any Performance Security or the Guarantee provided or procured by the Subcontractor pursuant to the Subcontract;

(i) any increases in insurance premiums payable by the Construction Contractor or Project Co, or any loss of insurance coverage or denial of claims, under any policies of insurance that either party or Project Co is required to procure under this Subcontract or the Construction Contract, which, in either case, is directly attributable to an act or omission of the Subcontractor or any Subcontractor Personnel;

(j) the exercise by the City of any step-in rights under the Project Agreement as a result of any breach by the Subcontractor under the Subcontract;

(k) the exercise by the City of any remedy under Section 45 of the Project Agreement as a result of any breach by the Subcontractor under the Subcontract;

(l) the performance by the Subcontractor of the Subcontract not in accordance with or in breach of the requirements of any Permits, Licences and Approvals, Applicable Law or requirements of Governmental Authorities, or the failure of Subcontractor to obtain all necessary Project Co Permits, Licences and Approvals in relation to the Subcontracted Works that the Subcontractor is required to obtain in accordance with the Subcontract;

(m) any Contamination for which the Subcontractor is responsible; and

(n) any amount payable by the Construction Contractor to Project Co pursuant to the Construction Contract in relation to a Change in Law affecting the recoverability of the HST or an irrecoverable sales tax levied by the Legislative Assembly of Ontario in lieu of all or a portion of HST, but only to the extent that the Subcontractor is able to recover or be credited with input tax credits, refunds, rebates or exemptions for such HST or other irrecoverable sales tax.

in each case, except to the extent caused, or contributed to, by breach of the Subcontract by the Construction Contractor or any deliberate or negligent act or omission of the Construction Contractor or any Person for whom the Construction Contractor is responsible under Clause 3.

The Subcontractor shall indemnify and save harmless the Construction Contractor and the Construction Contractor Indemnified Parties from and against any and all Direct Losses which may be suffered, sustained, incurred or brought against them as a result of, in respect of, or arising out of any breach of a representation or warranty by the Subcontractor herein or in any document, instrument or agreement delivered by the Subcontractor to the Construction Contractor as specifically required by the terms of this Subcontract.

Where a demand, claim, action or proceeding is made or brought against the Construction Contractor or any Construction Contractor Indemnified Party that any Vehicle Intellectual Property or the Use thereof by the City, any City Party, Project Co, any Project Co Party, the Construction Contractor or the Construction Contractor's Personnel or the use in connection with the Project Scope of any materials, machinery or equipment provided by the Subcontractor or Subcontractor Personnel infringes an Intellectual Property Right of a third party or misappropriates any confidential information or otherwise violates any right of a third party, unless such infringement has arisen out of the use of the allegedly infringing Vehicle Intellectual Property, materials, machinery or equipment by the City, any City Party, Project Co, any Project Co Party, the Construction Contractor or the Construction Contractor Personnel otherwise than in accordance with the terms of this Subcontract, the Subcontractor shall defend the Construction Contractor and such Construction Contractor Indemnified Party from and against all such demands, claims, actions and proceedings in accordance with Sub-Clause 17.3; and shall indemnify and save harmless the Construction Contractor and such Construction Contractor

Indemnified Party from and against all Direct Losses arising out of or relating to such demands, claims, actions and proceedings or the settlement thereof.

17.2 **Construction Contractor's Indemnities to Subcontractor**

The Construction Contractor will indemnify and keep the Subcontractor and the Subcontractor Indemnified Parties indemnified at all times from and against all Direct Losses that any of them may sustain in connection with:

(a) negligent act or omission or wilful misconduct of the Construction Contractor or any Person for whom the Construction Contractor is responsible under Clause 3; and

(b) non-compliance by the Construction Contractor or any Person for whom the Construction Contractor is responsible under Clause 3 with any of its obligations under any Law.

17.3 **Conduct of Claims**

(a) This Sub-Clause 17.3 will apply to the conduct of Claims made by a third person against a Party having, or claiming to have, the benefit of an indemnity under this Subcontract. 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".

(b) 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 Subcontract, the Beneficiary will give notice in writing to the Indemnifier as soon as reasonably practicable and in any event within 10 Business Days of receipt of the same if the Beneficiary is the Construction Contractor and within 5 Business Days if the Beneficiary is the Subcontractor and the matter is subject to an indemnity by the City in favour of Project Co under the Project Agreement, or by Project Co in favour of the Construction Contractor under the Construction Contract, and otherwise within 10 Business Days. 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.

(c) Subject to Sub-Clauses 17.3(d), (e) and (f), on the giving of a notice by the Beneficiary pursuant to Sub-Clause 17.3(b), if it appears that the Beneficiary is or may be entitled to indemnification from the Indemnifier in respect of all (but not less than all) of the liability arising out of the Claim, the Indemnifier will (subject to providing the Beneficiary with a secured indemnity to its reasonable satisfaction against all costs and expenses that it 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 will give the Indemnifier all reasonable co-operation, 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.

(d) with respect to any Claim conducted by the Indemnifier pursuant to Sub-Clause 17.3(c):

(i) the Indemnifier will keep the Beneficiary fully informed and consult with it about material elements of the conduct of the Claim;

(ii) the Indemnifier shall not bring the name or reputation of the Beneficiary into disrepute;

(iii) the Indemnifier will not pay or settle such Claims without the prior consent of the Beneficiary, such consent not to be unreasonably withheld or delayed;

(iv) 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

(v) 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.

(e) 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 Project Agreement if:

(iv) the Indemnifier is not entitled to take conduct of the Claim in accordance with Sub-Clause 17.3(c);

(v) the Indemnifier fails to notify the Beneficiary of its intention to take conduct of the relevant Claim within 10 Business Days of the notice from the Beneficiary under Sub-Clause 17.3(b) if the Beneficiary is the Construction Contractor and within 20 Business Days of the receipt of such if the Beneficiary is the Subcontractor and the matter is subject to an indemnity by the City in favour of Project Co under the Project Agreement, or by Project Co in favour

of the Construction Contractor under the Construction Contract and otherwise within 10 Business Days of receipt of such notice, or if the Indemnifier notifies the Beneficiary that it does not intend to take conduct of the Claim; or

(vi) the Indemnifier fails to comply in any material respect with the provisions of Sub-Clause 17.3(d) above.

(f) The Beneficiary may at any time give notice to the Indemnifier that it is retaining or taking over, as the case may be, the conduct of any defence, dispute, compromise or appeal of any Claim, or of any incidental negotiations, to which Sub-Clause 17.3(c) above applies. For greater certainty, the Subcontractor acknowledges and agrees that where the City is the Beneficiary, the City may retain or take over such conduct in any matter involving Personal Information or any matter involving public policy. On receipt of such notice the Indemnifier will promptly take all steps necessary to transfer the conduct of such Claim to the Beneficiary, and will provide to the Beneficiary all reasonable co-operation, access and assistance for the purposes of considering and resisting such Claim. If the Beneficiary gives notice pursuant to this Sub-Clause 17.3(f) then the Indemnifier will be released from any liability under the applicable indemnity hereunder in respect of the applicable claim.

(g) If the Indemnifier pays to the Beneficiary an amount in respect of any indemnity hereunder 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 will forthwith repay to the Indemnifier 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 such sum; and

(ii) the amount paid to the Beneficiary by the Indemnifier in respect of the Claim under the relevant indemnity,

provided that there will be no obligation on the Beneficiary to pursue any Recovery Amount and that the Indemnifier is repaid only to the extent that the amount of such recovery aggregated with any sum recovered from the Indemnifier exceeds any 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.

(h) Any Person taking any of the steps contemplated by Sub-Clause 17.3 will 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

The Subcontractor shall take full responsibility for the care of the Subcontracted Works, Goods and Subcontractor's Design Data from the Commencement Date until a Acceptance Certificate is issued (or is deemed to be issued under Sub-Clause 11.1) for a Vehicle, or with respect to Subcontractor's Design Data until Acceptance Certificates for all Vehicles have been issued, when responsibility for the care of the Vehicle or Subcontractor's Design Data shall pass to the Construction Contractor.

After the Acceptance Certificate(s) is (are) issued, the Subcontractor shall remain responsible for the care of the Vehicle and Subcontractor's Design Data in but only in respect of any Punch List Items or any Defects notified 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 Vehicles and Subcontractor's Design Data that are actually in the custody of the Subcontractor.

If any loss or damage happens to the Subcontracted Works, Goods or Subcontractor's Design Data during the period when the Subcontractor is responsible for their care, 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 any 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 to the Project Agreement except to the extent necessary to address any emergency or public safety needs. The Subcontractor will comply with any Reinstatement Plan consented to by the City Representative.

In the event any Insurance Proceeds under Insurance Policies as referred to in Schedule 30 – Insurance Trust Agreement to the Project Agreement are available to carry out the Reinstatement Work (as defined in the Project Agreement), such Insurance Proceeds shall be paid into the Insurance Trust Account and shall be dispensed in accordance with the provisions of the Insurance Trust Agreement to carry out the Reinstatement Work.

Notwithstanding the foregoing allocation of responsibility, the Subcontractor will have no responsibility for Site security.

17.5 Limitation of Liability

17.5.1 The total liability of the Subcontractor to the Construction Contractor, under or in connection with the Subcontract, including liability under any indemnity, shall not exceed the Subcontract Price.

17.5.2 To the extent that the liability of the Construction Contractor for indemnity claims is limited by Part 2, Section 57.4(a) to the Construction Contract, the Subcontractor's liability will be limited according to the proportion that the Subcontractor's liability for claims that result from the flow-down of claims arising the City under 56 of the Project Agreement bears to the Construction Contractor's total liability for such claims.

17.5.3 The limitation of liability in Sub-Clause 17.5.1 shall not apply to, nor shall the calculation thereof include:

(a) any liabilities or obligations to the extent that:

(i) the amount thereof is paid from the proceeds of insurance maintained by the City, Project Co or the Construction Contractor or 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;

(b) liabilities that arise out of third-party claims (other than claims from the City or the Lenders or Project Co or the Maintenance Contractor) associated with the Subcontracted Works or the performance by the Subcontractor or any Subcontractor Personnel of any obligations under this Subcontract (including, without limitation, any third-party (other than claims from the City or the Lenders or Project Co or the Maintenance Contractor) claims for any damage or destruction of property, death or personal injury or third-party Intellectual Property);

(c) liabilities that arise out of abandonment (other than as a consequence of a Construction Contractor Event of Default), gross negligence, willful misconduct or fraud of the Subcontractor or any Subcontractor Personnel;

(d) liabilities that arise out of any failure on the part of the Subcontractor to make payment to the Construction Contractor when the same is due to the extent that such failure gives rise to any liability on the part of the Construction Contractor to pay interest, fees or penalties on overdue amounts;

(e) fines and penalties under statute or any costs incurred by the Construction Contractor in complying with statutory obligations that arise out of any breach by the Subcontractor of any applicable laws, regulations, or rules or guidelines having the force of law (including breaches relating to workman's compensation, employment or health and safety laws or regulations);

(f) any amount paid to Construction Contractor by the Subcontractor, to the extent that same is subsequently recovered by the Subcontractor from the Maintenance Contractor; and/or

(g) any reasonable amount incurred by the Construction Contractor in enforcing any claim against the Subcontractor under or in connection with this Subcontract, including any costs, losses, fees, expenses or damages incurred in the enforcement of any of the Performance Security or the Guarantee.

17.6 **Indirect Losses**

Without prejudice to the Construction Contractor's rights to receive Delay Liquidated Damages, the Parties' rights in respect of payments provided for herein or the Construction Contractor's right to recover from the Subcontractor losses suffered under a CC Project Document (as defined in Construction Contract), the indemnities under this Subcontract shall not apply and there shall be no right to claim damages for breach of this Subcontract, in tort or on any other basis whatsoever, to the extent that any loss claimed by either Party is:

(a) for punitive, exemplary or aggravated damages;

(b) for loss of profits, loss of use, loss of production, loss of business or loss of business opportunity sustained by either Party, the City or the Lenders or Project Co or the Maintenance Contractor and not by third parties; or

(c) a claim for consequential loss or for indirect loss of any nature suffered or allegedly suffered by either Party,

(collectively, "Indirect Losses").

18.0 INSURANCE

The Parties will comply with their respective obligations under Appendix J (Insurance).

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 and the Subcontractor will take all commercially reasonable steps to mitigate the consequences of any right it may have to make a Claim under Clause 9 or otherwise under 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 to the extent they could have been avoided by the Beneficiary (as defined under Sub-Clause 17.3) complying with this Clause.

20.0 SUBCONTRACT DISPUTE RESOLUTION PROCEDURE

The Subcontract Dispute Resolution Procedure is set out in Appendix I (Subcontract Dispute Resolution Procedure).

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
Email: David.Whyte@snclavalin.com
Fax: 416.231.5356

With copies to:

Dragados Canada, Inc.
150 King Street West, Suite 2103, P.O. Box 48
Toronto, Ontario M5H 1J9

Attention: Jaime Hurtado, General Counsel
Email: jhurtado@dragados-canada.com
Fax: +1 647-260-5002

EllisDon Corporation
2680 Queensview Drive

Ottawa, Ontario K2B 8J9

Attention: Mark Fazio
Fax: 613-565-9267
Email: mfazio@ellisdon.com

With copy to:

EllisDon Corporation
800-89 Queensway Avenue
Mississauga, ON, N5B 2V2
Attention: Vice President, Civil Division

If to the Subcontractor:

ALSTOM Transportation Inc.
1025 John Street
W Henrietta, New York 14586, USA

Attention: Derek Hurst, Project Manager
Office: (585) 279-2020
Cell: (607) 765-0415

With copy to:

ALSTOM Transportation Inc.
801 Pennsylvania Ave NW
8th Floor, Suite 855
Washington, DC 20004, USA

Attention: Isabelle Melody, VP Legal and Contract Management North America
Fax: +1 202-495-4961
e-mail: isabelle.melody@transport.alstom.com
Cell: +1-202-420-9773

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written:

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name:
Title:

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

ALSTOM POWER & TRANSPORT CANADA INC.

Per:

Name:
Title:

Name:
Title:

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written:

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name:
Title:

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

ALSTOM POWER & TRANSPORT CANADA INC.

Per:

Name:
Title:

Name:
Title:

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written:

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name:
Title:

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name: RON AITKEN
Title: VP

Name: ALAIN CEMAY
Title: VP

On behalf of the Subcontractor:

ALSTOM POWER & TRANSPORT CANADA INC.

Per:

Name:
Title:

Name:
Title:

In Witness whereof the Parties have caused this Subcontract to be executed the day and year first before written:

On behalf of the Construction Contractor:

OLRT CONSTRUCTORS, an unincorporated joint venture consisting of:

DRAGADOS CANADA, INC.
Per:

Name:
Title:

ELLISDON CORPORATION
Per:

Name:
Title:

SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC.
Per:

Name:
Title:

Name:
Title:

On behalf of the Subcontractor:

ALSTOM POWER & TRANSPORT CANADA INC.

Per:

Name: Guillaume Mehlman
Title: VP Transport NAM

Name: Stephenie Beun-Brunet
Title: SVP BDA Sales

APPENDIX A
TECHNICAL REQUIREMENTS

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

APPENDIX A1
TECHNICAL DOCUMENTATION

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

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Inquiry n° : 507528-P001

OTTAWA LIGHT RAILTRANSIT PROJECT

Inquiry n° : 507528-P001

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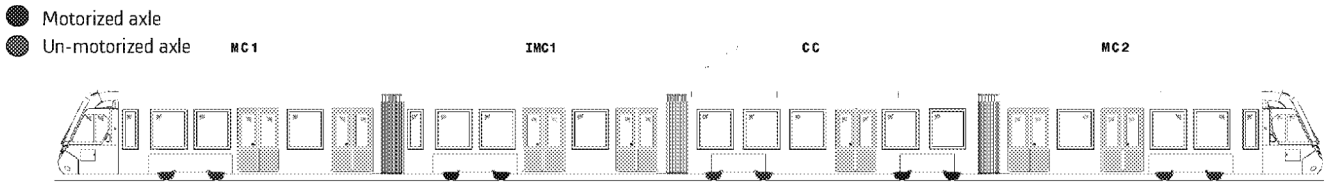
1 VEHICLE PRESENTATION

The proposed vehicle is part of the CITADIS product range and is composed of the following articulating section.



- 1 extremity section with driver's cabin and motor truck (MC1)
- 1 intermediate section with one trailer truck (IMC1)
- 1 centre car with one motor truck and one trailer truck (CC)
- 1 extremity section with driver's cabin and motor truck (MC2)

It features **Full Low Floor (FLF)** through the passenger area for an improved ride experience:

Other vehicle key features are the following:

- Maximum operating speed of 100 km/h
- Large window passenger
- Fourteen dual leaf sliding plug passenger doors are distributed throughout the train for quicker exchange time.
- An HVAC unit located on each car to ensure optimum thermal comfort in the passenger compartment
- Major sub-systems, such as HVAC, traction cubicle or air compressor, are roof-mounted and concealed by lateral roof fairing profiles with a uniform appearance when seen from road level.
- Vehicles are operated in multiple unit of two vehicles
- Proposed vehicle is designed for a service life of 30 years while running 100,000km per year.
- Proposed vehicle is fitted with an automatic coupler at each end.
- Brake discs are provided on each axle and two track brakes are provided on each truck.

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- Vehicle Layout is given in Appendix A. Other vehicle main characteristics are given in the chart below

Characteristics / Performances	
Main Dimensions	
Length between coupler faces	48.5 m
Vehicle Width	2.65 m
Vehicle Tare weight	78 Tonnes
Train architecture	
Number of sections	4
Number of trucks	5
Number of motor trucks	3
Passenger capacity with usual configuration	
Seated passengers with 3.33 Pass. /m²	104+16 flip-ups
Standing passengers with3.33 Pass. /m²	180
Total passengers/ vehicle with 3.33 Pass. /m²	300
Total passengers/ vehicle with 4 Pass. /m²	336
Comfort rate in normal load (3.33 Pass. /m²)	40%
Comfort rate in ultimate system capacity (4 Pass./m²)	36%
Wheelchair areas	4
Doors	
Double doors : number per side	7
Performances	
Maximum operational speed	100 km/h
Minimum horizontal turning radius	25m

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2 VEHICLE CAPACITY

Capacity of vehicle in various loading scenarios is summarized in chart below

SINGLE UNIT CAPACITY					
Passenger capacity	Normal load (3.33 p/m²)		AW2 (4 p/m²)		AW4 (8 p/m²)
	Seats folded up	Seats unfolded	Seats folded up	Seats unfolded	Seats folded up
Seated passengers	104	120	104	120	104
Standing passengers	193	180	233	216	465
Total passengers/ vehicle	297	300	337	336	569
Comfort rate in normal load %	35%	40%	31%	36%	18%

3 OPERATING ENVIRONMENT

Proposed vehicles are compliant to operate safely over the OLRT alignment in conformity with documents listed in OLRT Schedule 15-2 Part 4 §3.3

4 ENVIRONMENTAL CONDITIONS

4.1 Environmental Conditions

For the Ottawa LRV design the following environmental conditions will be taken in account.

ELEMENT		UNITS
Maximum ambient outdoor air temperature	38	°C
Minimum ambient air temperature	-38	°C
Thermal Shock	58	°C
Maximum ambient relative humidity	100	%
Continuous rainfall rate	60	mm/h
Maximum daily rainfall	95	mm
Continuous snowfall rate	55	mm/h
Maximum daily snowfall	560	mm
Freezing rain accretion	5	mm/hr
Maximum daily freezing rain accretion	30	mm
Continuous Wind	126	km/h

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ELEMENT		UNITS
Gusting Wind	135	km/h
Fording – water (above TOR)	75	mm
Fording – Snow (above TOR)	40	mm
Solar Radiation	1120	W/m2

4.2 Operational Hypothesis

Based on experience we gathered from the Edmonton and Toronto LRT property, the following hypotheses were taken for cold weather condition operation:

In case of extreme cold temperature (below -25°C) and/or heavy snow, parked trains will be either:

- Parked in a heated/covered area (maintenance depot)
- Parked in a covered area under catenary power or plugged to wayside power with vehicle in park heating mode.

In case a train is parked outside without power the following procedure will be required:

- If outside temperature is above -25°C, train can be started-up without any particular preparation
- If outside temperature is below -25°C, train pre-heating in heated depot will be necessary before train is fully operational.

In addition, regular de-icing of underframe equipment should be performed.

4.3 Winter environment design solutions

4.3.1 Solutions to ensure passenger safety and comfort:

4.3.1.1 Thermal insulation of passenger compartment and driver's cab

Insulating material will be used on walls, ceiling and floor of passenger compartment and driver's cab and thermal coefficient will be increased to meet requirement of Ottawa specification for thermal comfort.

4.3.1.2 Safety of passenger access

Heating will be located at floor level to prevent snow or ice accumulation to reduce the passenger risk of slipping. Door thresholds will be heated to prevent ice and snow accumulation in this sensitive area.

4.3.1.3 Passenger compartment heating

To provide thermal comfort performances required by the ORLT specification, heating will be provided by the roof mounted HVAC unit. Heaters and/or a heating floor will provide additional heating.

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4.3.1.4 Door adaptation to cold climate

Specific door feature and door operating mode will be proposed to the city of Ottawa in extreme cold conditions:

- Freezing rain in the Ottawa region will cause the formation of an ice layer on the train car-body. In order to ensure proper operation of the access doors in extreme cold conditions, the power of the motor actuators will be reinforced, thus allowing the actuator to open the door in case of ice formation around the door area on the vehicle side
- For an outside stop: driver will enable door opening upon train stop and door will only open when requested by a passenger through a push button located inside or outside the door. This will prevent cold air from entering the vehicle if no passenger needs to get in and out the vehicle, thus increasing passenger overhaul comfort.
- Twice per round trip (once in each driving direction), during a tunnel stop, the driver will open all doors located on the platform side to ensure each door on the train is open at least once per round trip, thus preventing significant accumulation of freezing rain on the door.

4.3.1.5 Ensure proper braking performances of the train

Train will be equipped with a state of the art wheel slip/slide protection system as described in the braking equipment section of the present document.

Sanders and sand-boxes will be heated to prevent ice clogging of the sand ejector circuit thus ensuring availability of the function in cold weather and snowy conditions.

4.3.2 Solutions to ensure proper vehicle operation

4.3.2.1 Solutions to deal with condensation

The following measures will be taken to mitigate the effects of condensation on vehicle components:

- Structural elements will be hermetically sealed or will contain drainage holes of at least 20mm located in order to prevent condensation water from accumulating and freezing inside of structure. Drainage holes will be located to prevent water projection on sensitive equipment
- External equipment will contain provisions (insulation, drainage holes) to reduce thermal shock and/or evacuate condensation water
- Vehicle design will provide proper water draining inside each section of the vehicle to evacuate condensation water.
- Electrical and electronic apparatus will be treated via varnish and sealers to improve resistance to humidity related failures

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4.3.2.2 Operational considerations in selecting materials

All material used on the train (including oil, grease, rubbers, plastics) will be selected to ensure performances in the ORLT operational environment.

4.3.2.3 Protection against ice impacts

Screen and covers will be used to protect under frame equipment, wiring and connectors from ice impacts. Components' locations will be defined in order to minimize exposure.

Area where protection screens cannot be installed (around truck) will be protected against impact by a protective coating.

4.3.2.4 Removal of snow on track

A snowplough can be mounted at each end of the vehicle. Maximum snow accumulation considered in snowplough design will be 40 cm.

4.3.2.5 Adapt pantograph to deal with snow accumulation on catenary

Pantograph raising and lowering will be done electrically. In order to ensure a good electrical contact between the pantograph and the catenary, the proposed pantograph will be fitted with an ice scraper. The ice scraper will ensure ice removal from the catenary.

4.3.2.6 Adapt coupler to presence of snow and ice

Heated coupler faces will be used to prevent accumulation of ice and snow. When folded, coupler will be protected from external pollution such as snow, ice, dust and salt.

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5 VEHICLE DIMENSIONS

Dimensions of the vehicle are.

Description	Proposed trains
Width at threshold	2,650 mm
Vehicle Maximum width (excluding side mounted equipment)	2,650 mm
Maximum Height over roof shrouds ATOR	3,600 mm
Maximum Height over roof equipment ATOR	3,800 mm
Height at entrance ATOR	356 mm
Maximum Height over truck ATOR	580 mm
Minimum Aisle width at articulation joints	1,200 mm
Aisle width	600 mm
Side door width with open doors	1,300 mm
Minimum Height – floor to top of door opening	2,000 mm
Minimum Height – floor to ceiling	2,200 mm
Maximum Door protrusion	75 mm
Truck Wheel base	1,900 mm
Wheel Diameter new	640mm
Wheel wear allowable diameter reduction	70 mm

6 CLEARANCE

Proposed vehicle will be compliant with clearance requirement of OLRT Schedule 15-2 Part 4 § 3.7

7 WEIGHT DISTRIBUTION

	MC1		IMC1		CC				MC2		
(Tonnes)	Motor Truck		Trailer Truck		Motor Truck		Trailer Truck		Motor Truck		
Condition	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Axle 7	Axle 8	Axle 11	Axle 12	Total
Tare Load	8.470	8.470	6.839	6.839	7.971	7.971	6.127	6.127	8.405	8.405	76
3.33pass/m²	10.220	10.220	9.699	9.699	9.744	9.744	8.409	8.409	10.154	10.154	96
4 pass/m²	10.397	10.397	10.117	10.117	9.981	9.981	8.760	8.760	10.332	10.332	99
8 pass/m²	11.459	11.459	12.614	12.614	11.398	11.398	10.857	10.857	11.394	11.394	115

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8 NOISE, SHOCK AND VIBRATION REQUIREMENTS

8.1 Acoustic Comfort

Noise internal to the Vehicle will be less than:

- 68dBA with the Vehicle stationary and all Equipment running in Revenue Service conditions;
- 78dBA at Vehicle speeds up to 100km/h;
- 80dBA in the Tunnel sections of the right of way, at Vehicle speeds up to 65km/h.

Noise external to the Vehicle, will be less than:

- 70dBA, when measured 20m from a stationary LRT;
- 80dBA, when measured 20m from a Train traveling at 100km/h, and braking.

Values given assume track roughness and decay rate at minimum according to Prn ISO 3095-2010.

8.2 Vibration/Ride Quality

Levels of longitudinal and lateral acceleration according to ISO2631 standard will be less than 0.32 m/s² and vertical acceleration levels less than 0.40 m/s² if the track quality follows these conditions:

	min peak (0 to peak)	max peak (0 to peak)	min peak (0 to peak)	max peak (0 to peak)	RMS	RMS
Wavelength band	*0.5m-250m*		*3m-25m*		*0.5m-250m*	*3m-25m*
lateral (mm)	-24	+26	-5	+5	15.0	1.5
vertical (mm)	-25	+28	-9	+9	16.0	2.1
gauge (mm)	-6	14	-6	+6	9.0	2.0

In addition, it is considered that track gauge will remain within 1435mm -1/+2mm

8.3 Shocks

All subsystems are designed for proper operation with the following shock loads:

- Lateral: 2g
- Vertical: 3g
- Longitudinal : 5g

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9 CATENARY SYSTEM

9.1 Electrical Interface with OCS

System has been designed to work under 1500 VDC Overhead Catenary System according to IEEE 1833. All train subsystems function throughout voltage ranges allowed by EN 50155.
Input filter inductance value is designed to allow traction subsystem to meet EN50121-3 EMI/EMC requirements.

9.2 Mechanical Interface with OCS

- Minimum catenary height: 3,900 mm
- Maximum catenary height: 6,500 mm
- Maximum misalignment between catenary and track (alignment) 200 mm
- Maximum misalignment between catenary and track (curve) 300 mm

10 ELECTRICAL EQUIPMENT ENVIRONMENTAL CONDITIONS

All electronic equipment used on proposed vehicles has been designed to function reliably under environmental conditions described in EN 50155.

11 VEHICLE PERFORMANCES

The following performances are applicable for the 48.5 m train architectures.

Parameter (1)	**Performance**
Maximum speed	100km/h
Acceleration	
Initial maximum vehicle acceleration (OCS voltage>1500V, AW2 loading)	1.34m/s² +/-5%
Speed for initial tractive effort for OCS voltage> 1500 Volts	31 km/h
Electric braking	
Full service electric brake rate at AW3 loading from 64km/h to 5km/h (average braking rate from 64km/h to stop)	1.34m/s² +/-5%
Blended braking	
Full service blended (electric/friction) at AW3 from 80km/h to standstill	1.34m/s²
Maximum service blended (electric/friction) + track brake up to AW3 from 88km/h to standstill	2m/s²
Friction Brakes	
Full service friction brake rate at AW3 loading from 80km/h to standstill	1.34m/s²
Emergency Brakes	
At AW3 load from 48km/h to standstill	≥2.5 m/s²

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Friction only at loads up to AW3 load from 80km/h to standstill	1.78 m/s² +20%/-10%
Parking brake	
Parking brake holds an AW3 train on a 6% grade indefinitely	Yes
Jerk Rates	
Jerk rate	From 0.8 to 1.2m/s³

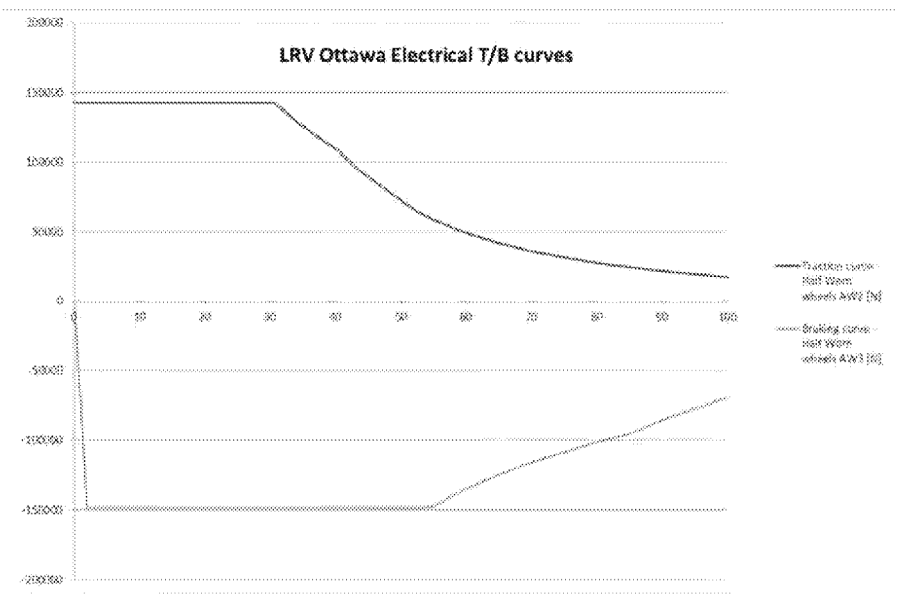
(1) Note: Acceleration and braking rates assume that adhesion is not the limiting factor. Some requested performances require unusual adhesion levels.

Except where otherwise specified, the vehicle traction/braking performances and curves are defined with the following conditions:

- Maximal load 4 pass/m²,
- Power supply voltage: 1500 V,
- Inverter filter voltage: 1650 V or higher in braking modes,
- Half worn wheels,
- Jerk limitation to 1.2 m/s³
- Braking performances are given as average deceleration on the speed range considered based on vehicle stopping distance.

The figures hereafter present the traction train level curves of the CITADIS in single unit. The values specified below are to be assigned with a tolerance of ±5%

Single Unit nominal traction characteristic



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12 SAFETY

For the Ottawa LRT project, safety studies will be conducted in accordance with industry standards. For each hazard identified in the PHA (Preliminary Hazard Analysis), Alstom will submit the proofs that the Ottawa CITADIS LRT complies with the safety target.

Our proposal is based on the usual Safety critical items and systems shown in Appendix C and considered hazards hereunder

1. Emergency brakes fail to apply when requested;
2. Service brakes fail to apply when requested;
3. Propulsion fails to cease when requested;
4. Propulsion fails to cease when Emergency Brake is requested.
5. No-motion detection system indicates no-motion when Train is moving;
6. Door opens spontaneously when not commanded;
7. Door opens on wrong side of car;
8. Door closes on person's object and indicates door closed and locked to the control system;
9. Door interlocks erroneously indicate door is closed and locked;
10. Excessive currents or overheated equipment cause fire hazard;
11. Indication of uncoupled when not uncoupled;
12. Train moves in wrong direction;
13. Slide control does not reapply brakes after slide correction;
14. Cars in Train separate when not commanded; and
15. Train regenerates into dead section of catenary.

The subsystems or equipment liable to create events identified PHA will undergo detailed analyses. The detailed analyses will be conducted mainly in accordance with at least one of the following methods:

- Fault Tree Analysis taking in consideration the different events.

  A deductive method starting from a single and well identified event, leading to basic events that are each other independent and amenable to calculation of their probabilities (breakdowns, human mistakes, external conditions).

- FMECA (Failure Mode Effects and Criticality Analysis).

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This consists of an inductive method whereby, starting from the exact definition of the functions of a device or assembly, one can systematically seek out the failure modes and their consequences or effects on the CITADIS set.

These analyses will demonstrate that the steps taken to deal with risks are or will be set up in order to reduce the probabilities of occurrence related to the events in categories of gravity. These analyses will be entered in the "Rolling stock safety level justification file".

13 RELIABILITY

As every product developed by Alstom, the CITADIS range and Ottawa vehicle are designed to get a high level of reliability and to allow easy maintenance operations. For reliability calculation, it was considered that a vehicle will operate 100,000km/year.

On the Ottawa LRT, reliability will be measured through Mean Distance Between Train Delays (MDBTD) over a 12 month period. A train delay is defined as an incident causing a revenue train to be:

- More than 5 minutes late at its final destination,
- Cancelled either at its original terminal or en route; or
- Rerouted

To calculate target MDBTD, the following operational hypothesis were taken:

- Operation will be in multiple unit of two vehicles;
- Failure of two adjacent doors will cause a train delay;
- Loss of two or more powered truck on a train will cause train delay;
- Failure of HVAC on a vehicle will not cause train delay as long as ventilation is maintained;
- Failure of levelling system on a vehicle will not cause train delays;
- Loss of brake on three or more bogie on a train will result in train delays;
- ATO, communication and platform monitoring system are excluded from this estimation.

Based on the above hypothesis, a vehicle will achieve a MDBTD of 52,000 vehicle kilometers.

Other failures will be considered as non-service-disrupting failures. Over a 12-month period, the mean-distance between non-service-disrupting-failures will be 3,100 vehicle kilometers.

14 ELECTROMAGNETIC COMPATIBILITY

In terms of human exposure to magnetic fields, measurements will be performed according to the IEC 61000-2008: "Electromagnetic compatibility, Testing and measurement techniques" inside and outside the train. The train complies with:

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- IEEE C95.1-2005: IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 3 to 300 GHz

- IEEE C95.6-2002: IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz

15 FIRE SAFETY

All non-metallic components used on the LRT are smoke, flame and toxicity tested to NFPA 130, 49 CFR part 238 and BSS 7239. Equipment will meet the requirements of NFPA 130. All materials used on the LRT, along with their weight, location and their fire/smoke/toxicity test report will be recorded in a data base and maintained through the life cycle of the vehicle.

Underframe and roof are made of steel to ensure sufficient fire resistance. Design will be validated by performing tests in accordance with ASTM E119, NFPA 130 and 49 CFR part 238.

The vehicle will be equipped with 6 smoke detectors.

- One Smoke detector are located in fresh air intake of each section. Should smoke be detected, fresh air intake will be automatically closed to prevent external smoke from entering the vehicle.

- Two smoke detectors will also be located in the passenger compartment.

To ensure proper vehicle evacuation in case of fire, all doors are equipped with an external and an internal manual door release.

16 TWO FIRE EXTINGUISHERS WILL BE PROVIDED FOR EACH VEHICLE, ONE IN EACH DRIVER'S CAB CARBODY

The car-body will meet requirements of ASME-RT1 to ensure maximum safety to passengers.

A CITADIS is made of several standard pre-equipped (i.e. fitted out, wired and tested) sections, linked between themselves at the end of the manufacturing cycle to produce the finished vehicle.

Several lifting and jacking points are present in each vehicle, designed and calculated to ensure correct performance for re-railing and maintenance operations. The exact position and design of the support surfaces shall be developed to ensure compatibility with existing and service-proven elements.

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16.1 Car-Body

Supplied CITADIS cars will be dimensioned as per the client's specification and ASME RT-1.

Cars are composed of the following equipped sub-assemblies:

- Underframe
- Driver's cabins (in end vehicle only),
- Roof,
- Sidewalls.

Final assembly of modules is done using rivets and fasteners as required by structural, manufacturability and maintenance requirements.

16.2 Sub-assemblies

16.2.1 End cabins

From the structural point of view, the driver's cabin shall be divided into two main elements:

- A top frame composed of corner posts and a top structural shelf.
- An underframe integrating the crash absorption elements, the conductor's survival cell, anti-climber, and the interfaces with the top frame..

16.2.2 Vehicle underframe

A CITADIS vehicle underframe is composed of carbon steel elements:

- Low-floor passenger platform
- Truck underframe area containing a low-floor corridor, the truck interface, relevant technical equipment supports..
- End sills supporting the lower articulations.

Typical CITADIS car underframe is shown below (element is upside-down preparing for equipment integration).

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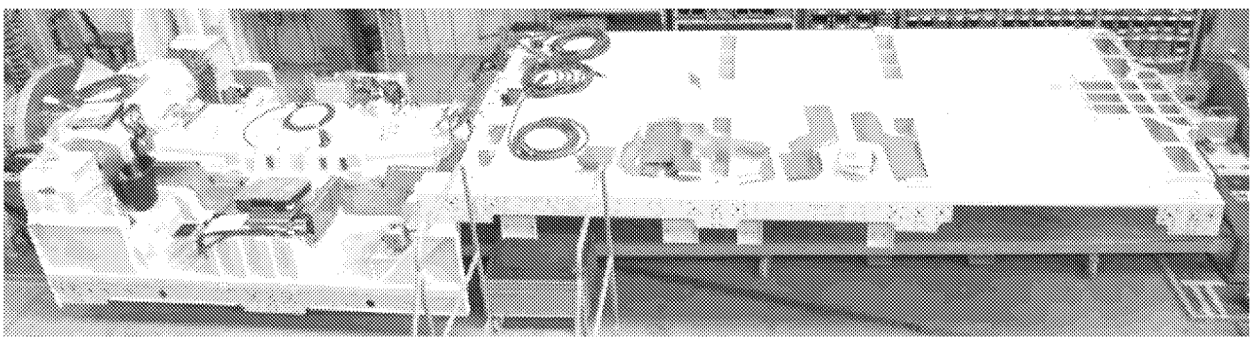

16.2.3 **Roof**

The roof is made of steel providing a rigid and watertight sub-assembly.

Since the majority of the technical equipment is overslung on the vehicle, the roof is reinforced as required to withstand service requirements.

16.2.4 **End rings**

The steel end rings perform structural functions by both serving as equipment supports and stiffening the assembly of the underframe, sidewalls and roof.

They are also used as the support surfaces for the assembly of either the gangways or the end cabins.

16.2.5 **Sidewalls**

The sidewalls are flat modules composed of steel elements arranged and dimensioned to withstand the technical requirements and to support all attached equipment.

16.3 Carbody-side and Windows

The passenger compartment walls are covered by flat lining panels. . The installation principles and fixation modes allow for quick and easy maintenance operations.

The windows allow a high visibility level from inside to outside. All window glass panels include a black silk screen printing all around the edges, in order to round off their aesthetic appearance and protect the bonded areas from UV radiation and are made of laminated glasses.

16.4 Vehicle layout

16.4.1 **Exterior layout**

The exterior surface areas of the vehicle are designed to be smooth and risk-preventive. The surfaces will be suitable to be covered by an antigraffiti film. But the antigraffiti film is not part of Alstom's scope of supply.

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16.4.2 **Roof layout**

The equipment is distributed over the vehicle roofs, taking into account the following criteria:

- Weight distribution
- Reduction in the amount of wiring
- Thermal dissipation,
- Relative movements in curves (pantograph is mounted over a truck),
- Accessibility for maintenance.

All of the roof-mounted equipment is secured on fastening brackets of the roof. Roof panelling will be installed to offer a smooth design and prevent snow accumulation on the roof as shown in picture below.



16.4.3 **Underframe layout**

The following items are installed below the car-body, in the areas close to the trucks:

- Sanding devices,
- Flange lubrication equipment,
- Central hydraulic braking units and associated pump units.

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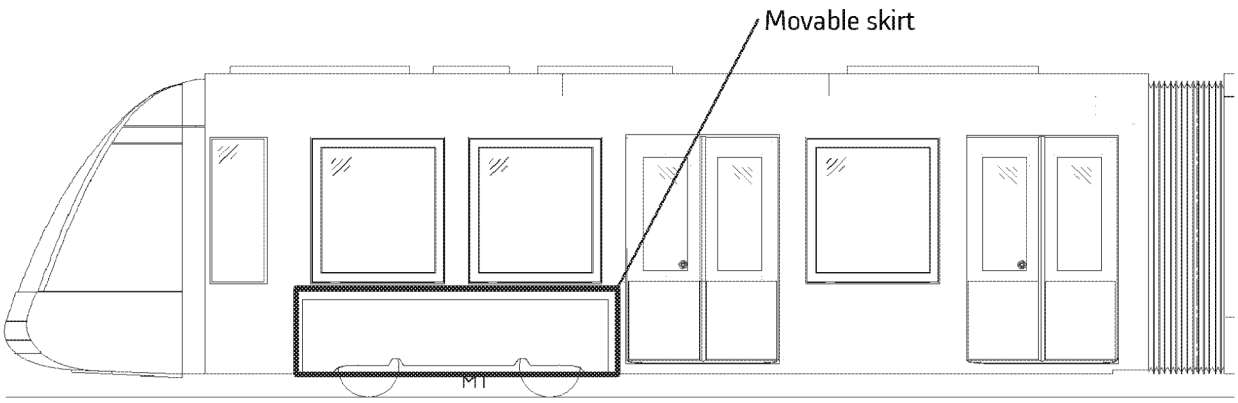
The side skirts may be folded up to provide direct and convenient access to the control and adjustment devices for sanding, braking equipment, gear-box and traction motor that are conveniently located on the side of the truck. (cf. following picture representing the side truck skirts).



The areas in the truck vicinity are protected by specific metal sheets and acoustic rubber guards which hang as low as possible over the track, in order to reduce the propagation of running noise and improve acoustic performance.

16.5 Articulation between modules

All articulations type listed in this section are service proven and compliance with ASME RT-1 will be demonstrated by the mean of tests (for static compression) or calculation (collision requirements).

The sections are connected to each other by means of:

- lower bearing called "articulation A-type" hinges between each module,
- higher hinge called "articulation C-type" in order to allow horizontal rotation,
- longitudinal dampers called "articulation D-type" in order to avoid the anti-pitch and the anti-yaw movements,
- transversal dampers for the railway dynamic comfort (transversal movement).
    - **One lower semi-circular intercommunication gangway:** allows for rotational movements in curves and ensures the continuity of low floor in the passenger area with a guaranteed width of 1215 mm. A reinforced intercommunication with round pleats and reinforced fabric ensures interior and exterior lining in the articulation area as well as thermal and acoustic insulation.

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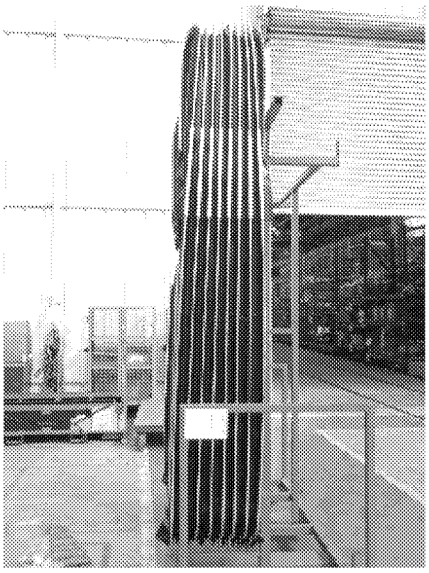

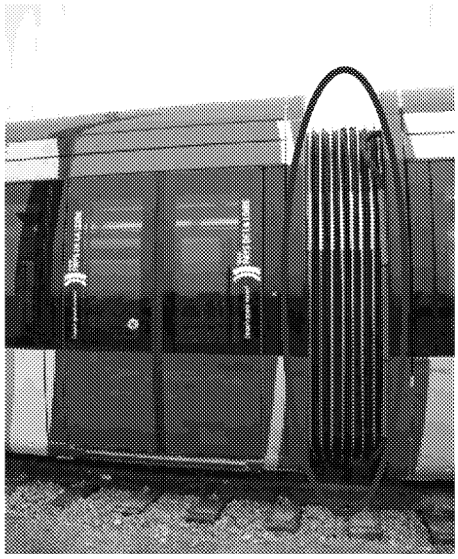

17 COUPLER AND DRAFT GEAR

17.1 Main Features.

The proposed CITADIS is equipped with an automatic coupler providing fully automatic mechanical and electrical connection. The coupler is self-centring and equipped with a draft gear. It will allow normal operation of train made of up to two vehicles. For rescue operation, multiple units can be made of up to four vehicles.

The coupler is manually-foldable and is locked in folded or unfolded position. When folded, the coupler is concealed by an easily removable coupler cover. Coupler face is heated to ensure proper operation in winter conditions.

All train-lines necessary for proper multiple unit operation, including network connection and battery power line to energize low voltage loads of an adjacent vehicle, goes through the automatic coupler. At first vehicle delivery, 10% spare pins will be provided at the electrical head.

17.2 Safety

In order to prevent un-coupling while in motion, the coupler control is interlocked with the no motion relay.

In event of collision, coupler is designed to retreat thus allowing anti-climber to engage and collapsing of crash energy management zones.

17.3 Coupler testing:

Coupler will be tested in accordance with ORLT Schedule 15-2 §3.18 (d) and (e) or proposed equivalent.

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18 CAB EQUIPMENT AND CONTROLS

18.1 Driving Cabin Characteristics

Ergonomics of the driver's working environment were addressed and validated during the initial conceptual design of the CITADIS based on our return of experience and the feedback from train operators. Generic ergonomics of the driving position are therefore a value to be preserved when considering a new project.

18.2 Visibility and passenger compartment access

The driver cabin is designed to respect the specific "exterior vision" cones specified in the UIC 651.

The spatial constraints of the driver's cabin, as well as those related to the arrangement of the main interior elements (i.e. driver's desk, seat, and windscreen) are defined taking in account a driver's height ranging between 1.95m (95th percentile) and 1.52m (5th percentile).

The arrangement of the interior fittings is compliant with the recommendations of standard UIC 651-OR.

18.2.1 **Windscreen and side windows**

The driver's cabin windscreen is made of clear laminated safety glass and meets requirement of 49 CFR 223, FRA Type I rating.

The central section of the windscreen has built-in heating strips over an area of around 1.08 m^2. The strips run horizontally and are supplied at low voltage.

The driver's cabin side windows are made of laminated safety glass.

The side windows are divided by a side post. For each window, the vertical pane adjacent to the windscreen is bonded to the cab polyester cell. To protect the adhesive against ultraviolet radiation as well as to improve aesthetic a black silk screen print is affixed on the borders of the panes.

The rear lateral cab side window is a horizontal sliding panel.

18.2.2 **Sun visor**

The upper part of the windscreen is fitted with fabric-made solar protected roll-up blinds that are fitted with a ratchet-less return spring. The upward or downward movement of the sun blind is performed by slightly moving the mobile sun blind bar, allowing the sun blind to be positioned where convenient, and then to be held in position by the friction of the lateral guide bars on the cables that provide lateral guidance. The fabric is horizontally held on the mobile sun visor bar. The sun visor is operated manually from a standing position.

Visors will also be provided on the side windows.

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18.2.3 **Passenger compartment access**

The driver is physically separated from the passenger area by a partition. The door can be opened from both sides and is locked by the driver's key. The door is fitted with a panic bar to allow fast evacuation of the driver. This limits the access from the outside to service personnel having a service key at their disposal while ensuring driver safety

The driver access to the cabin is done through the passenger area by a cabin door. The width for this access is 530 mm.

18.3 Air conditioning equipment

The ventilation, heating and cooling functions are ensured by:

- an overhead air diffusers with volume and directional adjustability fed from the HVAC passenger
- Two thermostatically controlled cab heaters
- Side window defrost
- Electrically heated windshield

18.4 Miscellaneous Facilities

18.4.1 **Driver seat**

Cab will be provided with a fully adjustable driver seat with adjustable foot and arm rest.

18.4.2 **Windscreen wiper**

The windscreen is fitted with a vertical-position single-blade windscreen wiper visible when at rest. A windscreen washer tank of at least 15 litters will be provided.

18.4.3 **Other facilities**

Additional facilities will be included in the cab.

- Lockable storage cabinet
- A coat hook
- A lockable convenience outlet
- Flip-up assistant seat
- Flashlight
- Emergency lighting

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- Fire extinguishers.

18.5 External Lighting

The train includes the following external lighting signal:

- Three headlights at each vehicle end with high and low beam function
- Dual color marker lights
- Provision for turn signals
- Brake lights

18.6 Audible warning

The driver can control:

- A bell tone in case of common warning, (85dBA)
- A horn in case of critical warning (100dBA)

18.7 Language

The human-machine-interfaces of the driver's desk will be in Canadian English and French.

19 PASSENGER DOORS AND CONTROLS

19.1 Main characteristics

The train is equipped with electrically operated sliding plug double-leaf doors.

The opening dimensions of the doors are described as follows:

- Clear width: at minimum 1300 mm,
- Clear height: at minimum 2006 mm.

The doors can be controlled to be opened or closed. They can also be disabled (locally forced to a locked/closed state). The inhibition of the opening of a door is possible locally with a specific key. The door opening enable signal is contingent on the following requirements being simultaneously met:

- Selection of one side (or both sides) by the driver or CBTC system,
- Opening authorization,

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- Train speed equal to zero.

Doors will be considered as in "self-service" mode.

Opening may then be controlled as follows:

- General opening: by the driver, by actuating the «general opening» lock-on push button,
- Individual opening by passengers from the inside or outside of the train, by actuating the opening buttons of the doors located on right leaf of the double doors when the passenger is inside the train,
- Local opening by the driver, for the doors of Mobility-impaired passengers areas, by pressing a touch key on the DDU.

The door system is made of one single operator (door mechanism) per doorway that moves simultaneously both door panels. The operator is powered from the Low Voltage Power System.

Each door mechanism is provided with a door control unit, which responds to trainlines and local door control. The DCU includes provisions for adjusting door opening and closing speed. The controls are either relay, discrete or microprocessor-based logic. The DCU continuously monitors door status and logs faults and events which are communicated to the central MPU via network connection.

19.1.1 The self-service (local control for opening)

In this "self-service" mode, the doors self-close 10 seconds after being fully open. This time is a parameter which can be modified by the maintenance crew.

A pushbutton in the zone available for wheelchair users enables them to inform the driver that they intend to alight from the train.

Each door is equipped with a pushbutton on inside and outside accessible to passengers and fitted to stanchions of the door leaf.

19.1.2 Control by the driver (general control)

General opening of all doors in "self-service" mode is made by the driver, by actuating the «general opening» lock-on push button located in the driver's desk.

19.1.3 Degraded mode

If the normal closing function is out of service or if the driver has selected the wrong side, he can cancel side selection for an immediate closing. Only obstruction detection by over current is active.

When a door failure occurs, the driver can lock it out of service locally enabling the CITADIS to continue its service, with the door isolated mechanically.

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19.2 Door type testing.

Doors will be tested in accordance with Schedule 15-2 Part 4 §3.20 (g) or proposed equivalent.

20 HEATING, VENTILATION AND AIR CONDITIONING

The passenger compartment air conditioning is ensured by a roof-mounted fully unitized air conditioning units on each car. All units can be maintained from the roof.

20.1 Equipment Description

The HVAC unit is a fully unitized roof mounted unit that has been developed to achieve heating and cooling performances while minimizing noise emissions.

The cooling circuit is hermetically sealed and uses homologated refrigerant liquid (R407C) in accordance with current European Standards, Montreal protocol and complies with Canadian laws and regulations.

HVAC has been designed to provide eight m^3/hr of fresh air per passenger in AW2 loading conditions. Fresh air damper can be closed by the operator for faster warm-up and cool down of the passenger compartment.

In case over temperature is detected, thermostatic and electrical protection is provided. An emergency shutdown switch is also provided in the driver's cabin.

20.2 Energy supply

The three-phase voltage production for air conditioning units is ensured by a specific output of the auxiliary inverter of the train. The converter frequency is controlled by HVAC units.

20.3 System capacity

HVAC capacity has been designed to achieve optimum comfort. Proposed unit offers 35kW of cooling power and 30kW of heating power.

To ensure system capacity in terms of temperature stratification, treated air will be distributed to passenger compartment by air outlets located on the ceiling and at floor level.

20.4 Air treatment

The evaporator blower ensures the air flow in the compartment by means of air grills in the passenger compartment ceiling and side walls. Guards will be provided to ensure that passengers are not exposed to unsafe surface temperature.

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20.5 Controller

The controller regulates the temperature in the vehicle through multiple operating modes. These operating modes are determined by the system configuration, analogue input values, digital input states, and the system set point.

The following functions are provided by the controller:

- Safety and shutdown protection,
- Diagnostics,
- Fault monitoring and annunciation to MPU,
- Self-health check,
- Sequential starting of motors,
- Includes a +/-2°C set point adjustment for all switching points.

20.6 Park heating mode

The system will be provided with a park heating mode. The purpose of park heating mode is, in cold weather conditions, to maintain passenger compartment temperature between 4°C and 8°C. This function ensures that the passenger compartment temperature can be rapidly raised to an acceptable level for passenger after long storage outside, while reducing energy consumption.

20.7 Cabin equipment

Cabin equipment is described in §19.3.

20.8 System testing

System and sub-systems will be tested according to Schedule 15-2 Part 4 § 3.21 (h), (i) and (j) or proposed equivalent.

21 LIGHTING

21.1 Interior Lighting

The passenger-compartment lighting is a LED "indirect type", which avoids passenger dazzling. It operates entirely from the vehicle low voltage system. It is designed for normal and emergency modes and the system is controlled from the leading vehicle cab section as all lighting controls switches and circuit breakers. The luminosity level in passenger compartments and at doors is compatible with AODA/ADA requirements.

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The passenger area lighting intensity meets the requirements of EN 13272 or equivalent. On the doors platform aera the luminosity is superior to the minimum required by the standard EN 13272. Lighting is supplied from the low voltage DC network.

During the emergency lightning the intensity in the passenger compartments is compliant to the EN 13272. Emergency lighting is automatically activated as soon as the vehicle is powering up. The driver can turn on additional lighting by a two-way push button in the cabin. The additional lighting is activated if the static converter generating low voltage power is running. The additional lighting circuit is automatically taken out of service if operations of the both static converters are interrupted for more than 5 minutes. Emergency lighting is available for 90 minutes after loss of the low voltage power supply and meets the requirements of APTA SS-E-013-99, Rev. 1.

In case of high voltage loss or failure of APS, energy will be sufficient to ensure 40 minutes of emergency light.

To guide the passengers, the lightning system provides luminosity along the aisle and vestibules leading to the doorways, and the floor is equipped with HPPL material strip embedded into the floor.

An interior LED indicator light is provided over each door to indicate that the door is not closed and locked.

A small LED backlit sign shall be provided over each side door to indicate when the door is locked out of service.

21.2 Cab area lighting

Lighting is provided for driver's desk indicator and instrument as well as for equipment compartment.

Overhead lighting is provided by two dimmable and directionally adjustable lights.

Cab area lighting intensity is compliant with EN 13272

Overhead and equipment compartment lighting is included in the emergency lighting system.

Cab lighting will be controlled through a switch with dimmer control.

21.3 Exterior lighting

In addition to lights described in §19.5, each vehicle is provided with the following external lights:

- Propulsion fault lights
- Door open LED indicator on each door
- LED backlight sign over each door to indicate when door is locked out of service

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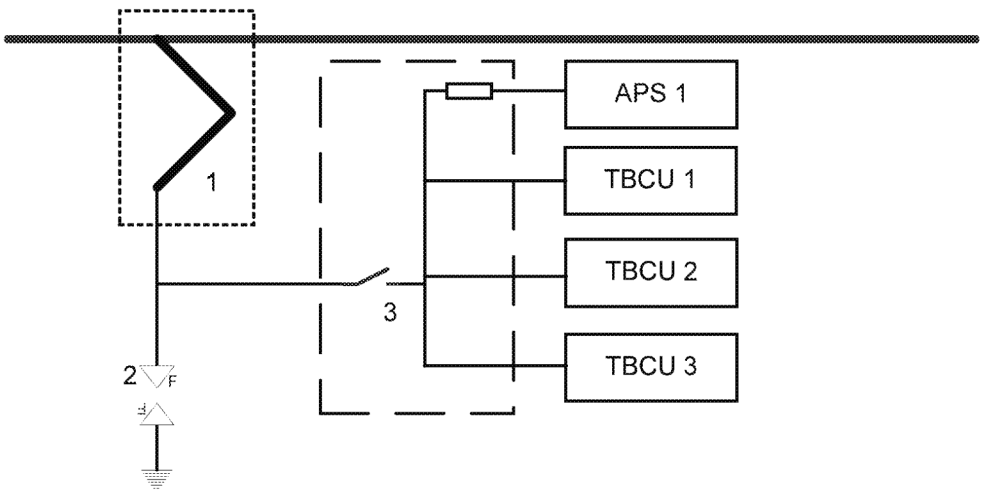
- ATP bypass signal
- Vehicle door summary status light visible from longitudinal and transverse direction

All traffic related lights will meet requirement of Canadian Motor Vehicle Safety Regulation, Technical Standard 108 and are interlocked with the direction train lights so that they are only active at the end of the train in accordance with train direction.

22 HIGH VOLTAGE DISTRIBUTION AND AUXILIARY ELECTRICAL EQUIPMENT

22.1 High voltage distribution

The high voltage distribution diagram is the following:



Both systems consist of:

- The power supply (1) collected by the bi-directional pantograph.
- The lightning arrester (PF) (2), protecting the high voltage equipment against over-voltages.
- The circuit-breaker box containing:
  - The ultra-fast circuit-breaker (3) protecting and isolating the traction chain.
  - The HV presence indicator.
  - The auxiliary protection fuse

All equipment listed above is located on the CC.

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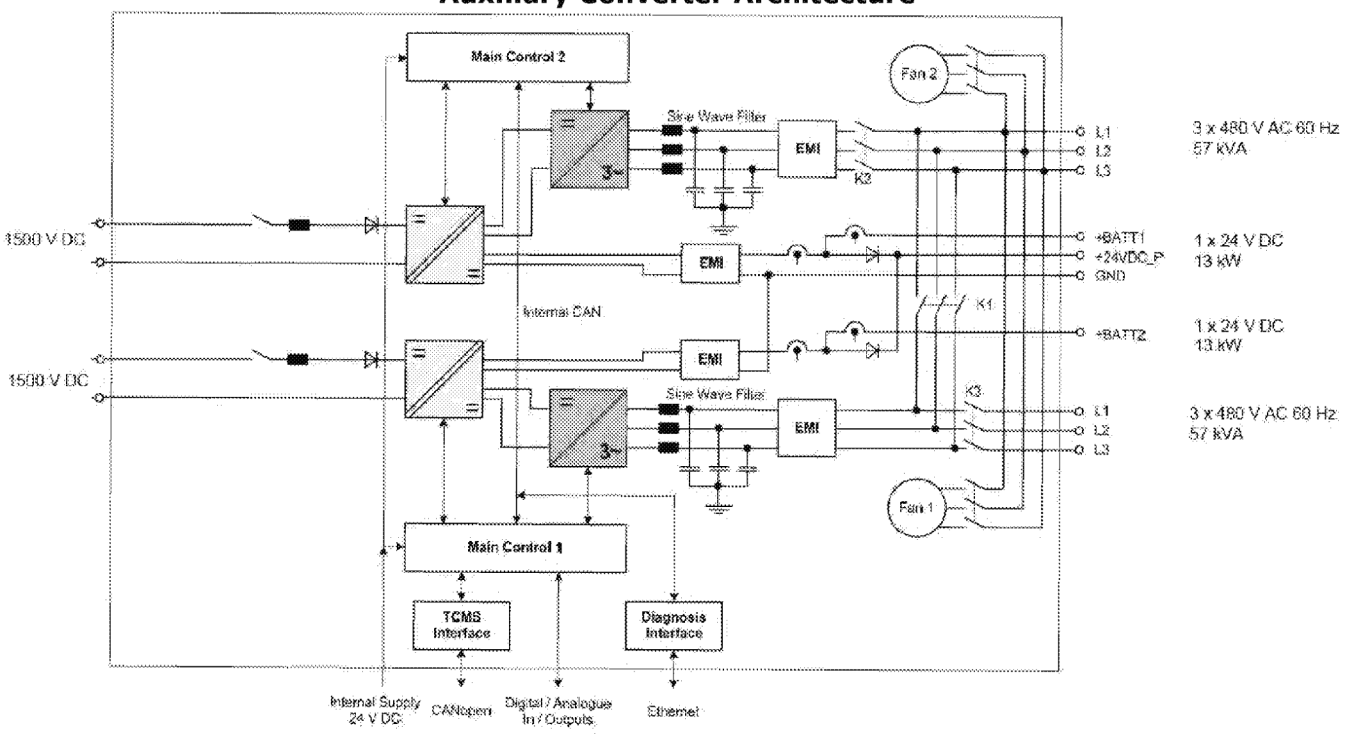
22.2 Auxiliary power

22.2.1 Architecture of Auxiliary Converter

The figure below presents a typical energy supply architecture which provides all the energy necessary for the operation of the various on-board systems and devices.

Auxiliary Converter Architecture



The auxiliary converters delivers different types of power output each dedicated to specific type of equipment:

- 24 Volts dc that supplies all Low Voltage equipment
- 480 Volts 60Hz, three-phase, fixed frequency that supplies:
  - driver's cabin heater
  - passenger compartment heaters
  - air compressors
- 480 V 60 Hz three-phase with variable frequency from 45 Hz to 60 Hz (U/f constant) that supplies the compartment HVAC units.

Upon failure of the auxiliary converters or loss of the OHL voltage, the 24 Volts batteries provide back-up power supply to critical loads for up to 90 minutes.

In normal operation the battery chargers charge the batteries to ensure that are kept at full load all the time.

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22.2.2 **Batteries**

22.2.2.1 General information

The Nickel-Cadmium batteries, trickle-charged up by the static converters delivers:

- energy for low voltage circuits (e.g., track brakes)
- emergency loads
- various devices (e.g., pantograph motor, windshield wiper motor)

The battery capacity was calculated taking the following design criteria into account:

- Restart the LRV after a period of 48 hours in the stabling yard with the parking lights turned on
- Supply essential loads in operation following a loss of power for 90 minutes,
- Supply energy in stabling for at least 3 hours.

22.3 Auxiliary and low voltage distribution

All auxiliary loads are circuit breaker protected.

22.4 Qualification testing

System will be tested as per Schedule 15-2 Part 4 §3.23 (i) or proposed equivalent.

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ALSTOM

OLRT - Technical Description

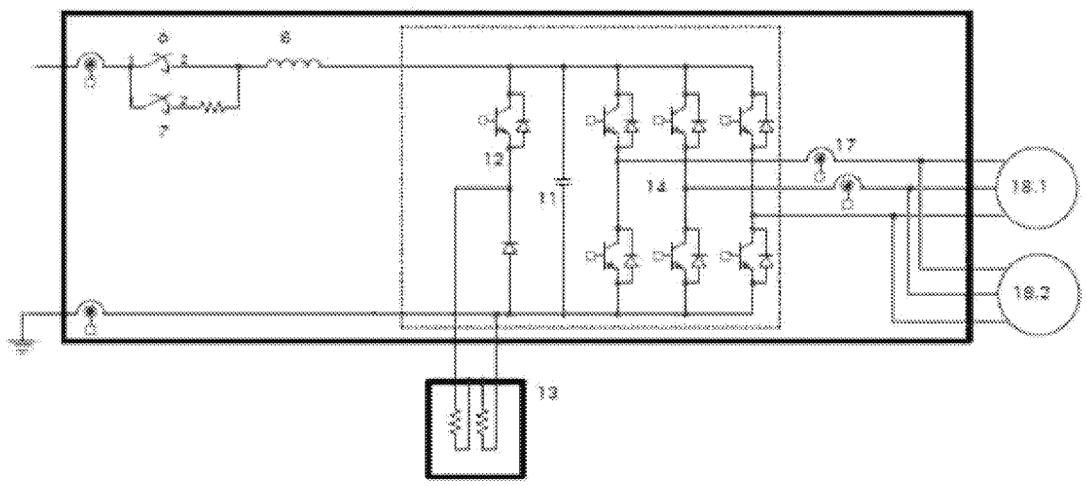
Rev 6

Inquiry n° : 507528-P001

23 PROPULSION AND DYNAMIC BRAKING

23.1 General description

Traction blocks are roof mounted. A traction block is associated with each motorized truck. The general diagram of a traction block is the following.



Each traction/braking box contains the following equipment:

- Pre-charge circuit (6 and 7).
- A filtering unit (8 and 11) the purpose of which is to limit the effects of over-voltages on the inverter and reduce emission of high frequency harmonic currents on the line. The filters are designed to bring the traction/braking equipment in compliance with European regulations on electromagnetic compatibility.
- The sensors (9) for protecting the equipment in the converter housing.
- A power module.
- An electronic control system (15) for the IGBTs supplying the two traction motors of a truck, together with the control/monitoring system of the equipment located in the converter housing.
- The electrical connexion for the static converter

Lastly, natural convection-cooled brake rheostats (13) are used. It is installed on an independent frame and is equipped with appropriate mechanical protection systems..

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23.2 Traction system operating limits

The operating limits of the traction chain comply with European standard EN 50163 "traction network power supply voltages". This standard sets limits on the primary high voltage supply.

The traction chain operates for inverter voltages ranging from 1000 V to 1950 V.

The traction performance is guaranteed for primary high voltage supply exceeding 1500 V defined inside the standard EN 50163.

The electric braking performances are guaranteed for catenary voltages exceeding 1800 Vdc. Regenerative braking alone is ensured up to 1800 Vdc. Above this voltage, resistor braking cuts in and regulates the inverter voltage between 1850 V and 1950 V. Priority is being given to regenerative braking.

23.3 Power circuit protection systems

Power circuit protection is provided by the lightning arrester (2), the high speed circuit-breaker (3) and by measuring the differential currents (5 and 9).

The high speed circuit-breaker ensures intrinsic protection of the high voltage power circuit in the event of an overvoltage or short-circuits. Some of the faults detected by the current and voltage monitoring systems built into the electronic controls open the circuit-breaker in order to protect the power equipment.

Should the circuit-breaker trip out because of an anomaly (depending on the failure), it automatically closes after a few seconds. Should the anomaly recur several times, the isolating contactor isolates the defective traction equipment. In this case, traction is still active on the other motor truck. The isolating contactor is reset in the workshop.

23.4 Traction Motors characteristics

The proposed motor is a closed and self-ventilated and has 4-poles. Its maximum power 220 kW in traction and 360 kW in electro-dynamic braking.

23.5 Traction control equipment characteristics

23.5.1 **Main functions realised**

Situated in the inverter box, the electronic controls supervise all the Traction-Braking functions of each truck. The electronic controls fulfil the following main functions:

- Control of the HSCB, the line and pre-charge contactor.
- Set point management with associated load correction and jerk limitation.

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- PWM control of the inverter to supply the motor in both traction and braking modes.
- Control of the electric brake.
- Control of the rheostatic chopper to fulfil the crowbar resistance function.
- Monitoring, protection and status feedback: the control system permanently monitors operation of the equipment, taking appropriate action should a fault occur.
- Assistance in maintenance by using built-in tools.
- Anti-slide/anti-slip of the motor truck.
- Cooling management.
- Self-tests.

23.5.2 Electrical / Electronic equipment characteristics

The control electronics for the power converters used in railway traction consists of a modular system comprising both general functions (logic inputs/outputs, logic processing circuits, maintenance functions) and functions dedicated to the inverter, motors and braking chopper (regulation, PWM, monitoring, etc.).

Each electronic unit consists of a large dimension (3U x 21) mother board, itself equipped with plug-in "daughter" boards removable from the rear face; the daughter cards are in 3U x 220 mm format.

The connections to the low voltage circuits are made directly at the "daughter" boards level.

24 TRUCKS

24.1 General information

The proposed truck is part of IXEGE truck range, which is used on CITADIS- tram and tram-train vehicles. The design is adapted for the North American Market.

The motor truck is a bi-motor type with motors directly suspended on truck frame and each driving an axle. There is a direct connection (drive shaft) between the 2 wheels, as for a conventional axle.

The IXEGE motor truck architecture is principally composed of:

- Conventional elastic wheels that provide good comfort and quiet running of the tram by reducing the transmission of vibration into the track and noise into the carbody,
- this stage either a helicoidal spring or an elastomer primary suspension are considered. Suspension type will be chosen based on dynamic simulations in the project phase,

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- A compact truck frame that gives a truck that is both light and structurally efficient, and provides good vehicle behaviour particularly under track twist conditions,
- Self-ventilated fully enclosed induction motors rigidly fitted longitudinally on the outside of the truck frame, thus being fully suspended,
- Compact gearboxes fitted on the wheel hub and connected to the motors by a toothed coupling,
- A pneumatic secondary suspensions, from Alstom Metro MP89 type, made with cushions fitted in parallel with helicoidal spring in order to limit cushion dimension and to limit stiffness increase in case of deflated suspension conditions,
- A bolster equipped with a slewing ring, which is the unique mechanical interface between the truck and the carbody, allows the free rotation of the truck and transmits loads between the truck and the carbody,
- Anti-yaw dampers,
- Disc brakes and callipers located close to the wheels on the outside of the truck and therefore easily accessible,
- Magnetic track brakes only used for maximum service and emergency braking.

The trailer truck retains a maximum of commonality of components with the motor truck.

24.2 Technical Data

24.2.1 **General Characteristics**

– Maximum operation speed	100 km/h
– Wheel base	1,900 mm
– Track gauge : normal - new track	1 435 mm
– Wheel diameter - new wheel	640 mm
– Wheel diameter - worn wheel	570 mm
– Maximum wear / radius	35 mm
– Wheel rim width	110 mm

24.2.1.1 Elastic Wheel

– Wheel radial stiffness (reacting vertical load)	~ 200 kN/mm
– Maximal load	
– Vertical	6,5 ton / wheel

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– Transversal	~ 4,5 ton / wheel
– Wheel rim hardness (new rim)	310 – 350 HB

24.2.1.2 Axle

– Axle material	cast iron
– Axle boxes	
– bearings	2 conical / side
– lubrication	grease
– sealing	dynamic

24.2.1.3 Truck Frame

– Type	inboard
– Elaboration	cast iron or welding + cast parts

24.2.1.4 Truck-Carbody drive

– Type of link	Bolster + Slewing ring + Yaw-dampers

24.2.1.5 Transmission

– Type	1 motor per axle
– Motor cooling	air
– Couplings	
– Between motor and gearbox	teeth coupling
– Between gearbox and axle	direct
– Gearbox	
– Type	conical single stage
– Maximum rotational speed (new wheel)	4550 rpm

24.3 Technical Description of trailer Truck

The configuration of the trailer truck is similar to that of the motor truck.

25 FRICTION BRAKES, TRACK BRAKES

This chapter describes the friction braking function and its associated design provisions. The technical solutions that are laid out in the sections of this Technical Description are an adaptation to the North American market of our standard and service proven CITADIS solutions currently in use.

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25.1 General

- **Friction brake**

  All the axles of motor and trailer trucks are fitted with friction disc brakes that are electro-hydraulically actuated. Braking discs are cast-iron material and are self-ventilated. Two discs can be installed on a motor truck (one per axle) and four on a trailer truck (one per wheel).

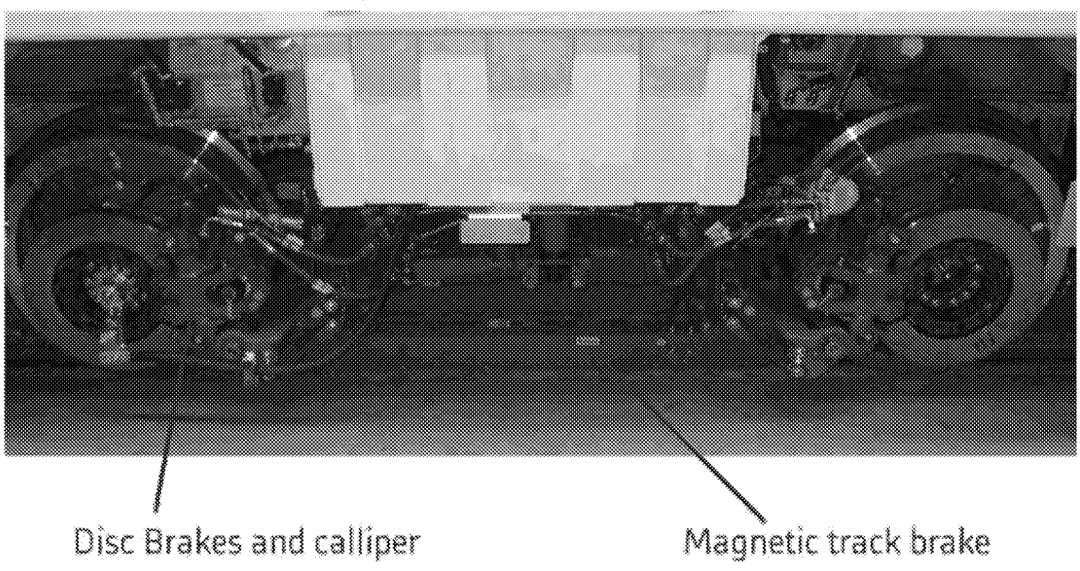
- **Magnetic track brake**

  Magnetic track brakes operate only during maximum service brake or emergency braking or on specific request of the driver.

  They are of the spring release low suspension type. When they are not activated, the magnetic track brakes are maintained in high position by springs.

  Their associated performances are detailed in chapter 12 Performance Requirements.

Picture provided for information only



25.2 Brake control system architecture

The traction-braking control/monitoring equipment consist of:

- a central traction/braking control unit (the MPU) at each carbody end,
- an dynamic traction-braking control unit (the TBCU) for each motor truck,
- an independent electronic brake control unit (BCU) for each motor or trailer truck.

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Each of the above systems receives in particular:

- braking requests on the traction/braking master controller by the TCMS via the MVB network (TBCU and trailer truck BCU),
- the additional friction braking orders in blending (motor truck BCU),
- the emergency braking information generated by the emergency loop (TBCU and BCU),
- the maximum service braking information generated by the maximum service braking loop (TBCU and BCU of the trailer truck).

In addition, a set of electro-hydraulic controls is associated with each truck (motor or trailer) ensuring:

- the necessary hydraulic power supply for braking or (and) brake release,
- control of the actuators of the disc brake units of the truck.

On each truck (motor and trailer), control of all the truck actuators takes place simultaneously.

25.2.1 **Normal operating mode**

The following operating mode will be available on the OLRT vehicle:

Initiation Method	Brake Function
Master controller handle to FSB	**Full service brake (FSB)** • Motor truck: dynamic + friction (as required) • Trailer truck: friction • Slide protection active
Master controller handle to MSB	**Maximum service brake (MSB)** • Motor truck: dynamic + friction (as required) • Trailer truck: friction (as required) • Track brakes • Sand • Slide protection active • Retrievable prior to reaching zero speed
Emergency stop button	**Emergency brake (EB)** • Motor truck: friction (pressure equivalent to full service brake) • Trailer truck: friction (pressure equivalent to full service brake) • No slide protection • Track brakes • May not be released until zero speed

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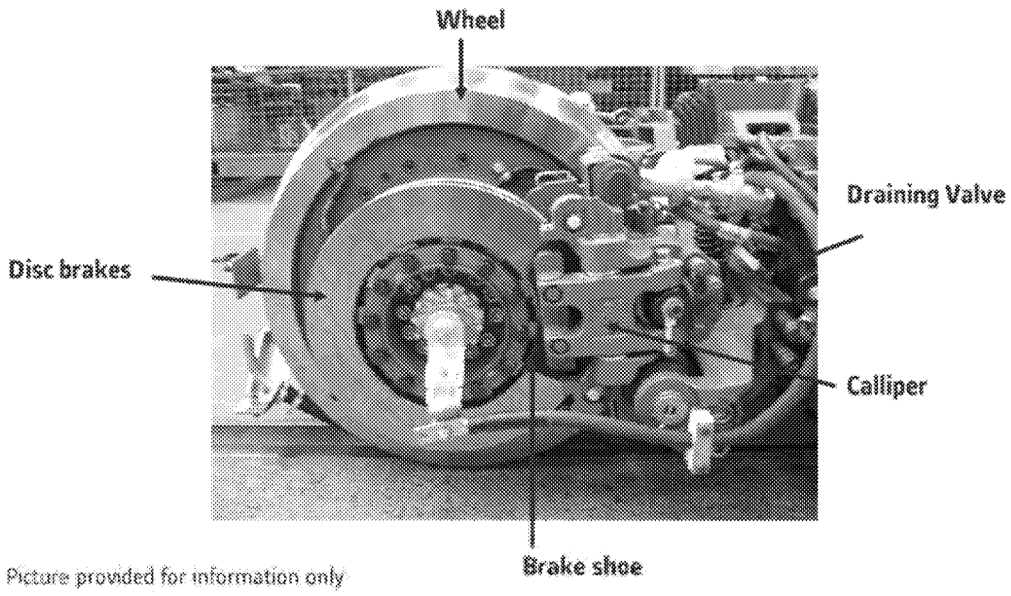
25.3 Friction brake system main components

25.3.1 Disc brakes and Calipers

Each motor truck is fitted with 2 disc-calliper assemblies. The trailer trucks are fitted with 4 disc-calliper assemblies.



Picture provided for information only

Each assembly is located close to wheels outside of the truck, and therefore easy accessible. They are made of:

- one self-ventilated disc bolted to the wheel hub,
- one passive type hydraulic calliper (for parking brake application) or active type hydraulic calliper (allocation of active or passive type done according to truck type and vehicle architecture).
- one calliper support securing the calliper to the truck frame, which allows the displacements of the primary suspension.

The calliper may be mechanically released independently from its hydraulic control.

The brake calliper is a self-adjusting device which caters for wear of brake pads and disc,

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25.3.2 Electro-Hydraulic Unit

The hydraulic central unit is resiliently installed under the carbody frame and above the secondary suspension, with shock and vibration insulation. The hydraulic supply for the calliper is made by flexible piping. External connections are self-sealing with quick-connect couplers.

25.3.3 Accumulators

As far as requested in OLRT specification Schedule 15-2 Part 4 §3.26(e), accumulators of hydraulic energy are sized to ensure requested performances (pressure, braking effort and response time for all operating conditions, including emergency and system cut-out) such as sufficient pressure to supply two AW3 full service and one AW3 emergency brake applications with 30 second applications and 2 minutes between applications.

A manual cut-out valve let hydraulic depressurization of the accumulator for maintenance.

25.3.4 Brake Control Unit

Brake Control Unit (BCU) is commanding friction brake application at truck level as well as described here above. In addition, Brake Control Unit provides additional monitoring functions:

- Collect fault and equipment status from other friction brake components (EHU especially)
- Apply brake and inhibit propulsion in case of major fault detected (i.e. accumulator pressure drop down below required level for emergency brake application)
- Record of events and fault
- Provide interface for events and fault easy download for system troubleshooting as far as required in OLRT specification Schedule 15-2 Part 4 §3.26(f)
- Monitor train speed and wheel slide

25.3.5 Magnetic track brake

Each truck is equipped with 2 magnetic track brakes fixed in parallel with the side members of the truck frame. The two equipment of a same truck are connected in parallel and protected together. All the magnetic track brakes are supplied by the LV battery of the vehicle. The track brake is suspended underneath the axle boxes by intermediate springs, whose system of adjustment ensures a constant clearance between track brake and rail after each re-profiling..

25.3.6 Sanding device

Sanding device is mounted in front of the first and last truck of each vehicle. in order to sand at wheel/rail interface.

Automatic sanding is provided down to zero speed during emergency brake application and during slip/slide detection.

Manual sanding by train driver actuation is possible through a dedicated switch on driver desk.

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25.4 Qualification tests

Braking system will be tested according to OLRT specifications Schedule 15-2 Part 4 §3.26(i) or proposed equivalent.

26 COMMUNICATION AND PASSENGER INFORMATION SYSTEM

26.1 General

Passenger information and communication system is designed to:

- Provide synchronized audio and visual passenger information announcements including at least destination, station stops, time, and emergency announcements according to train route.
- Provide emergency announcements on the Vehicle.
- Provide a passenger emergency intercom system.
- Provide interface for downloading maintenance data passenger count information and for updating passenger announcements.
- Provide an internal CCTV video monitoring and recording system.
- Provide a display that shall provide a view of all train doors viewed by the internal CCTV cameras and any passenger compartments in which there is an Emergency.
- Provide fault recording and diagnostics for system troubleshooting.
- Include a silent alarm reporting function.

It is considered that all equipment required to provide communication with the wayside networks will be provided by the Construction Contractors.

26.2 Radio

Radio will be provided by the Construction Contractor.

26.3 Public Address System

The public address system is interfaced with the radio. The following functions are accomplished by the public address system and related equipment (listed in descending order of broadcasting priority).

26.3.1 **Passengers/driver intercom**

This function is activated whenever a passenger triggers the emergency alarm handle or push PEI button. Upon acknowledgement of the request by the driver on the Radio, a link is established between the driver and the passenger. In case of several PEI are triggered, the communication is established with the first triggered one. The others are put into a queue for next communication.

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26.3.2 **Passengers/OCC intercom**

All on board emergency calls requests initiated either through the PEI button or through the emergency handle are first directed to the driver of the train.

26.3.3 **Cabin-to-cabin intercom**

This function is activated by pressing the cabin-to-cabin intercom icon on the Radio from any cabin.

26.3.4 **Broadcasting of driver/passenger messages**

This is achieved when the driver holds down the driver/passenger message control button. This establishes an audio link is between the driver microphone and the loudspeakers of the passenger announcement system. Messages are broadcasted on internal loudspeakers along whole train and/or external loudspeakers on demand. Prior to message broadcast, emission of a dedicated chime is possible. For external broadcasted messages, platform side is selected automatically.

26.3.5 **Broadcasting of Automatic messages**

Automatic messages are broadcasted through internal and external loudspeakers and displayed on internal/external LED displays. Prior to message broadcast, emission of a dedicated chime is possible. For external broadcasted messages, platform side is selected automatically.

Automatic messages are pre-recorded and concern:

- Train route : broadcast is automatic according to train location
- Special announcement: broadcast is triggered by the driver

List and contents of pre-recorded messages will be defined during project phase. The system allows provisions for new pre-recorded messages to be uploaded in the future.

26.3.6 **Safety Information**

An emergency control handle is provided at proximity of each vehicle door.
Action on this handle has the following consequences:

- a lighting of a warning lamp on the signalling panel
- a broadcast into the driver cabin
- a pictogram appearance onto the driver display unit.

Once activated, the emergency control system maintains the passenger's demand activated.

26.4 Passenger compartment equipment

The following equipment is installed in the passenger compartment,

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- two Passenger Alarm Handle with Passenger emergency intercom per section,
- four interior LED displays,
- one front LED display on each cabin,
- four destination lateral displays (2 per face),
- four loud-speakers per section.

26.5 Closed Circuit Television

26.5.1 **Exterior surveillance**

As requested by the Construction Contractor the train will not be equipped with an on-board exterior surveillance system.

The platform camera system will be used to monitor vehicle sides at station. The platform camera system will be provided by the Construction contractor. The on-board equipment of the platform camera system will be provided by the Construction Contractor. It will include, as a minimum:

- Equipment to be installed in cabin (screen, ...);
- Receiver and associated Wi-Fi antennas;
- Any additional equipment required to perform the function.

26.5.2 **Interior surveillance**

The video-surveillance system is based on a complete digital technology system. The CCTV function is integrated with the Ethernet backbone. This CCTV system consists of the following elements:

- Eight cameras to monitor the passenger compartment,
- One cameras per cabin to monitor the view out of the front window,
- One hard-drive recorder.

26.5.3 **Information to operation staff**

26.5.3.1 Frontal display unit

The frontal display units are used to indicate the destination and the line number.
The frontal display unit proposes, uses monochromic LEDs which are amber.

26.5.3.2 Lateral display unit

The lateral display units are used to indicate the destination for passengers outside the train.

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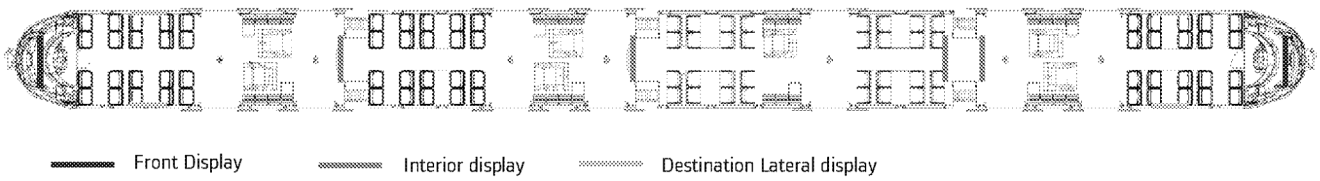
The lateral display unit proposed uses monochromic LEDs which are amber.

26.5.3.3 Arrangement

Exact location of external and internal displays will be discussed with the operator.
A possible arrangement is shown hereafter:



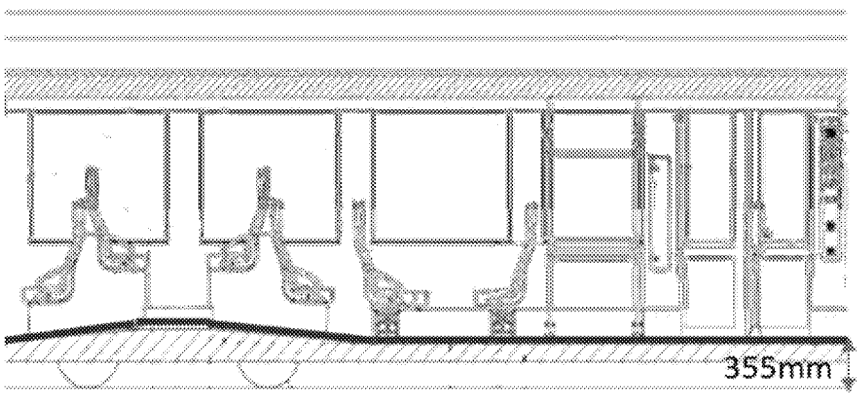
27 INTERIOR AND EXTERIOR APPOINTMENTS

27.1 General interior design

27.1.1 **Accessibility**

The vehicle interior is designed with full low floor with slopes through passenger area and seats arrangement (longitudinal and transversal) to provide full accessibility to AODA/ADA requirements.

The floor layout is as shown in the diagram below. Maximum slope is in line with requirements from ADA.



Wheelchair areas are provided at each doors vestibule.

27.1.2 **Seats**

We propose the urban standard seat, which has been developed for our tramway vehicle range with a colour adapted to the Ottawa needs.

The seat width which was specially adapted to the proposed vehicle width of 2 650 mm is 457 mm.

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The seats equipped with a grab handle are located in the corridor of each vehicle.

The colours and patterns of the fabric will be chosen within the supplier's standard range and will be set during project phase.

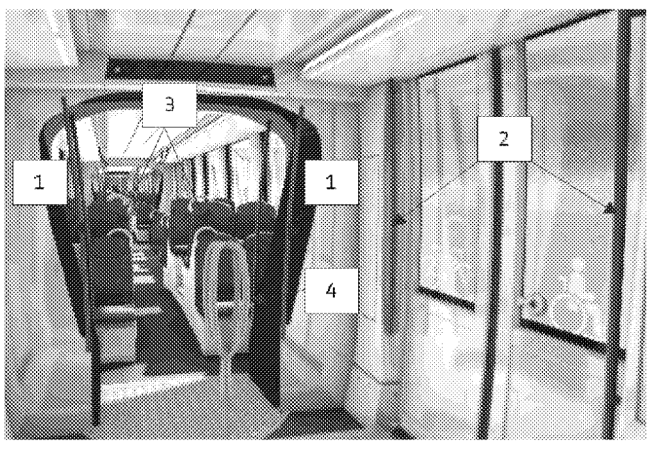
27.1.3 Stanchions, Handrails and Grab Bars

The hand holds, grab bars and stanchions are painted or in stainless steel depending on the City's needs. The following picture shows an example of car arrangement. Final position will be agreed during design reviews.

Details on passenger support point references (common to all layouts):

- Vertical handles on carbody-end rings on passenger-compartment side (2 per ring). *See reference 1 on the following picture.*
- Vertical handgrips on both sides of the access doors (2 per door). *See reference 2 on the following picture.*
- Grab handles on the backrests of seats on aisle side (one per seat only in the corridor). S*ee reference 3 on the following picture.*
- A central bar in front of the doors in the vestibule area. See reference 4 on the following picture.

This is only an example. The handling points are defined during the project phase.



27.1.4 Flooring

The design of the floor is realized to prevent snow or ice or water from accumulating on the vehicle floor and at thresholds. The thresholds are arranged to allow drainage of melted snow and ice. The floor panel materials are in aluminium or composite construction. The floor covering includes high friction material in both wet and dry conditions and is non-ribbed.

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27.2 General exterior design

As described here above, exterior design is developed specifically for the City of Ottawa with modern, attractive shape and suitable livery.

All electrical and mechanical equipment are hidden behind easily replaceable roof shrouds, truck skirts, cab side skirts and the coupler cover. The pantograph and the ice scraper are the only visible mechanical device on the vehicle. Articulation sections are covered with internal and external bellows. Inter car dampers and linkage are located undercar or on the roof. All electrical connections between sub-systems, as far as feasible, are fitted with connectors.

27.2.1 **Exterior roof equipment**

Roof Equipment includes:

Item	Qty
Unitized HVAC units	4
Traction blocks	3
Auxiliary Power Supply	1
High voltage collection system	1
Battery Box	1
Braking resistors	3

All roof mounted equipment allows the use of cleaning agents that are reclaimed and controlled.

27.2.2 **Exterior underframe equipment**

Underframe equipment includes:

Item	Qty
Foldable couplers	2
Electro hydraulic unit	5
Motor truck	3
Trailer truck	2
Horn	2

Sandboxes are located under seats of extremity cars.

27.2.3 **Exterior appointments**

Refill of sandboxes can be done from outside through dedicated trap.

Car number will be prominently displayed on both ends of the LRT.

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27.3 Qualification testing

System will be validated according to test listed in OLRT specification Schedule 15-2 Part 4 §3.28(c) or proposed equivalent.

28 COMMUNICATION BASED TRAIN CONTROL

The CBTC on-board equipment will be provided by the Construction Contractor. It will use its own dedicated network. All equipment linked with the on-board CBTC system (electronics, display, sensors, antennas, connectors...) will be supplied by the Construction Contractor.

29 EVENT RECORDER

An event recorder will be fitted in each vehicle.

30 MONITORING & DIAGNOSTICS SYSTEM

The proposed configuration forms part of the standard CITADIS product range. It is based on the latest generation of ALSTOM computerised processing software known as the TCMS Platform (Train Control & Monitoring System).

The proposed architecture is designed to be operated in multiple units of 2 vehicles.

30.1 Architecture of the Train Control-Monitoring System (TCMS)

The main architecture deployed is based on:

- train lines (TL) in order to perform safety train commands functions (traction/braking, doors opening/closing authorisation) and controls (all doors closed status), at train and unit level,
- a redundant MVB vehicle network allowing the communication between all electronics equipment inside a same unit (Traction Unit, Brake Control Unit, etc),
- a WTB train network linked (via the unit coupling cable) with the MVB network of each unit via a Gateway WTB/MVB, and allowing the communication between train units (when in multiple unit mode),
- An Ethernet vehicle network interfaced with major sub-systems for collection of maintenance and diagnosis data, at train unit level (when in multiple unit mode).

Some electronic components are not directly connected on the MVB network but, through a RIOM via local networks.

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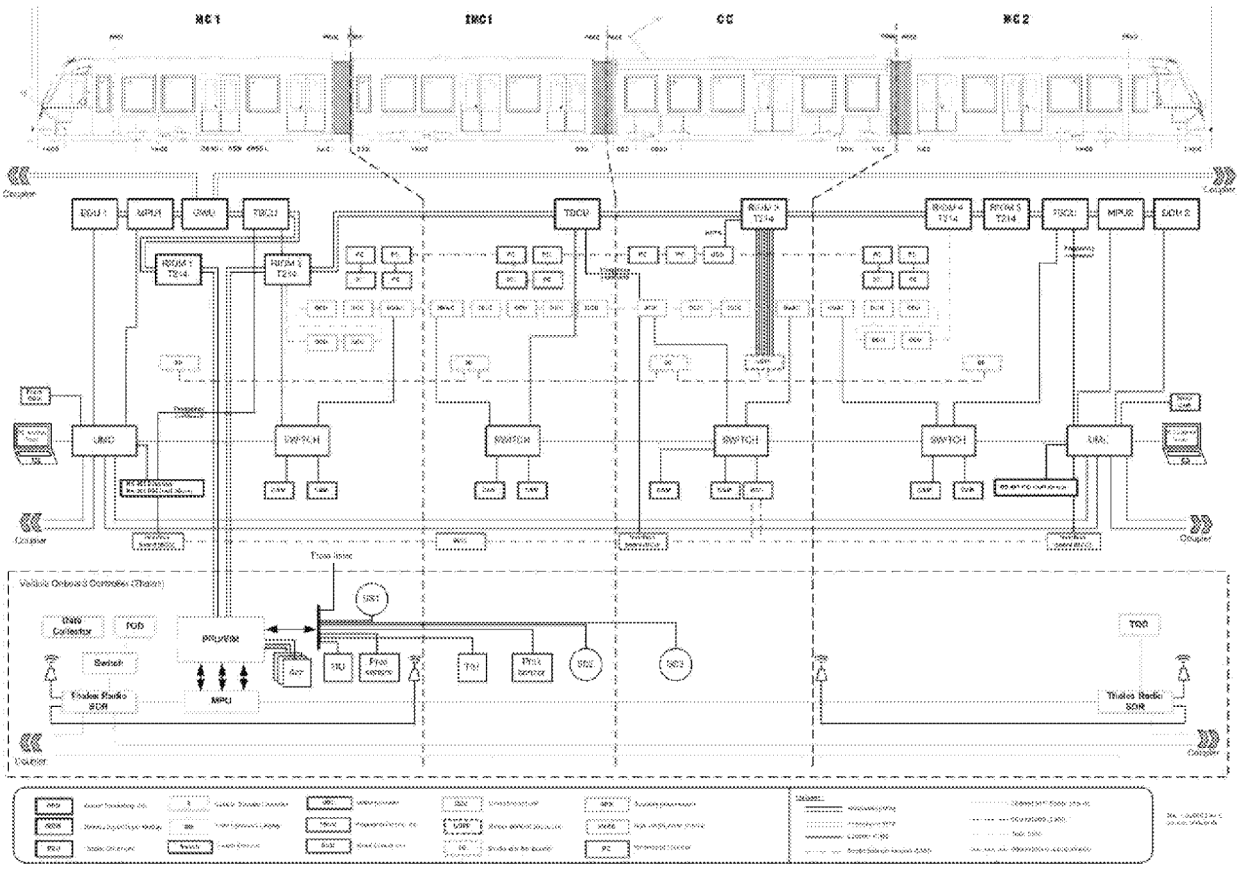
The following figure presents a typical TCMS architecture. This architecture is given for information and may be subject to change. It indicates the various types of equipment connected to the networks but does not represent an exhaustive quantitative list.



30.2 TCMS Hardware components

All TCMS hardware components are service proven and will be qualified according to OLRT specification Schedule 15-2 Part 4 v2.3 §3.31(h) or proposed equivalent.

30.2.1 Main Processor Unit (MPU)

Each train unit is equipped with 2 Main Processor Unit (MPU) specifically designed for the execution of the TCMS application software implementing the train function.

MPU uses non-volatile solid state memory to store data and is powered from LV Battery supply. Transfer of stored data does not refresh the memory. MPU will store data with FIFO principle (first in first out). Available memory will permit storage of up to 60 days of data.

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30.2.2 Driver Display Unit (DDU) Train Display Screen (TDS)

Each DDU located in driver's desk provides the interface between operators (Drivers & Maintenance crews) and the On Board Computer System through a full colour screen, controlled by a resistive touch sensitive screen.

In Operation, the Driver Display Unit (DDU) displays real-time information about the train status. Information is displayed to the driver through alphanumeric messages and icons combined with different shape and colours.

The brightness of the screen is automatically adjusted according to the ambient light level.

30.2.3 Remote input/output modules (RIOM)

RIOM are distributed section by section throughout the train, in order to connect all the electrical equipment (such as push buttons, relays, switches, contactors, train lines) interfaced with the TCMS.

The remote input/output modules (RIOM) provide the logic data and analogue (4-20mA or 0-10V) acquisition functions and the logic output orders (Low Voltage binary Signal). They also provide the interface with equipment in serial link and CAN OPEN.

The input/output modules constitute the LRUs.

30.2.4 Gateway MVB/WTB

Each train unit is fitted with a redundant MVB/WTB gateway allowing the data transfer between the MVB and the WTB network for multiple unit mode needed a communication between unit.

31 VEHICLE TESTING

Refer to document: OLRT - Vehicle testing schedule.

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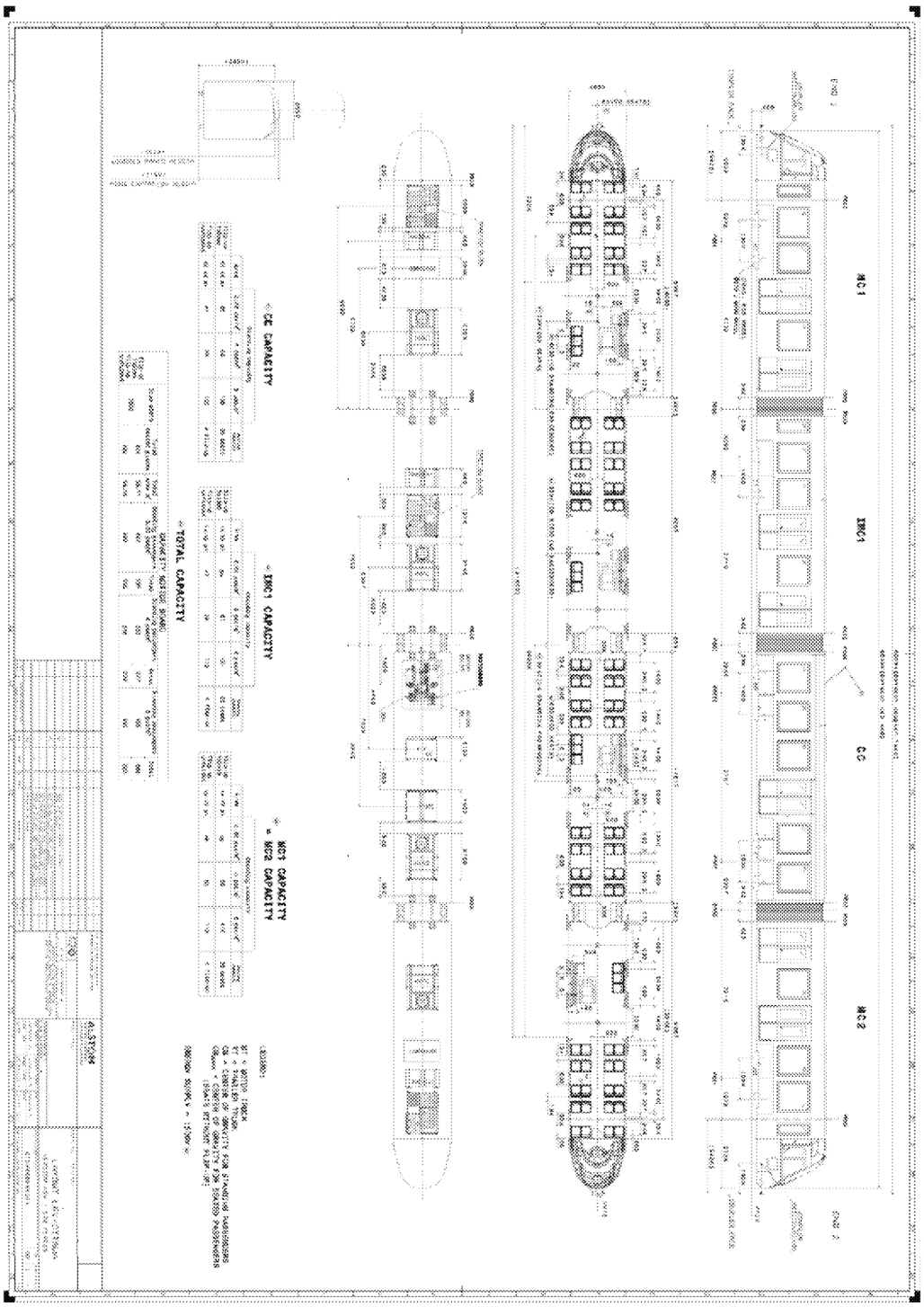
APPENDICE A - LAYOUT



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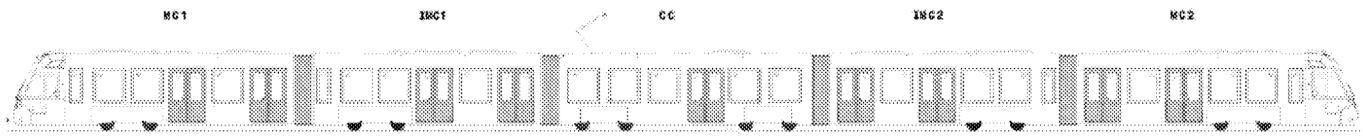
APPENDICE B – TRAIN EXTENSION

Vehicle description

To deal with future line capacity increase, it will be possible during the life of the vehicle to increase its capacity by adding an additional intermediate car. This operation should be coordinated with a major vehicle overhaul.

In any event, addition of an intermediate car shall constitute a Variation subject to Article 14 – Variations and Adjustment of the Vehicle Subcontract.



Estimated capacity will then be the following:

SINGLE UNIT CAPACITY					
Passenger capacity	Normal load (3.33 p/m²)		AW2 (4 p/m²)		AW4 (8 p/m²)
	Seats folded up	Seats unfolded	Seats folded up	Seats unfolded	Seats folded up
Seated passengers	127	147	127	147	127
Standing passengers	243	227	294	272	586
Total passengers/ vehicle	370	374	421	419	713
Comfort rate in normal load %	34%	39%	30%	35%	18%

Main vehicle modification will include but not be limited to the following:

- Addition of a second intermediate car (IMC2) between the CC and the MC2;
- Coupler change-out for increased load;
- Crash module change-out for increased vehicle weight;
- Addition of an auxiliary power supply for the additional HVAC
- Minor wiring modification.

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Vehicle extension predisposition study

As part of the original studies the following actions will be conducted to take provision for this future vehicle extension:

- Five section vehicle feasibility study
- Vehicle performance calculation
- Pre-sizing of wiring ducts to accommodate additional wiring
- Dynamic calculation to validate dynamic sizing of articulation in five sections configuration
- Predisposition of software to accommodate additional equipment (HVAC, Doors, traction cubicles...)

The original study will not include:

- Detailed design of the additional section and of the five car vehicle,
- Industrialisation of the five section vehicle,
- Validation of five section vehicle.

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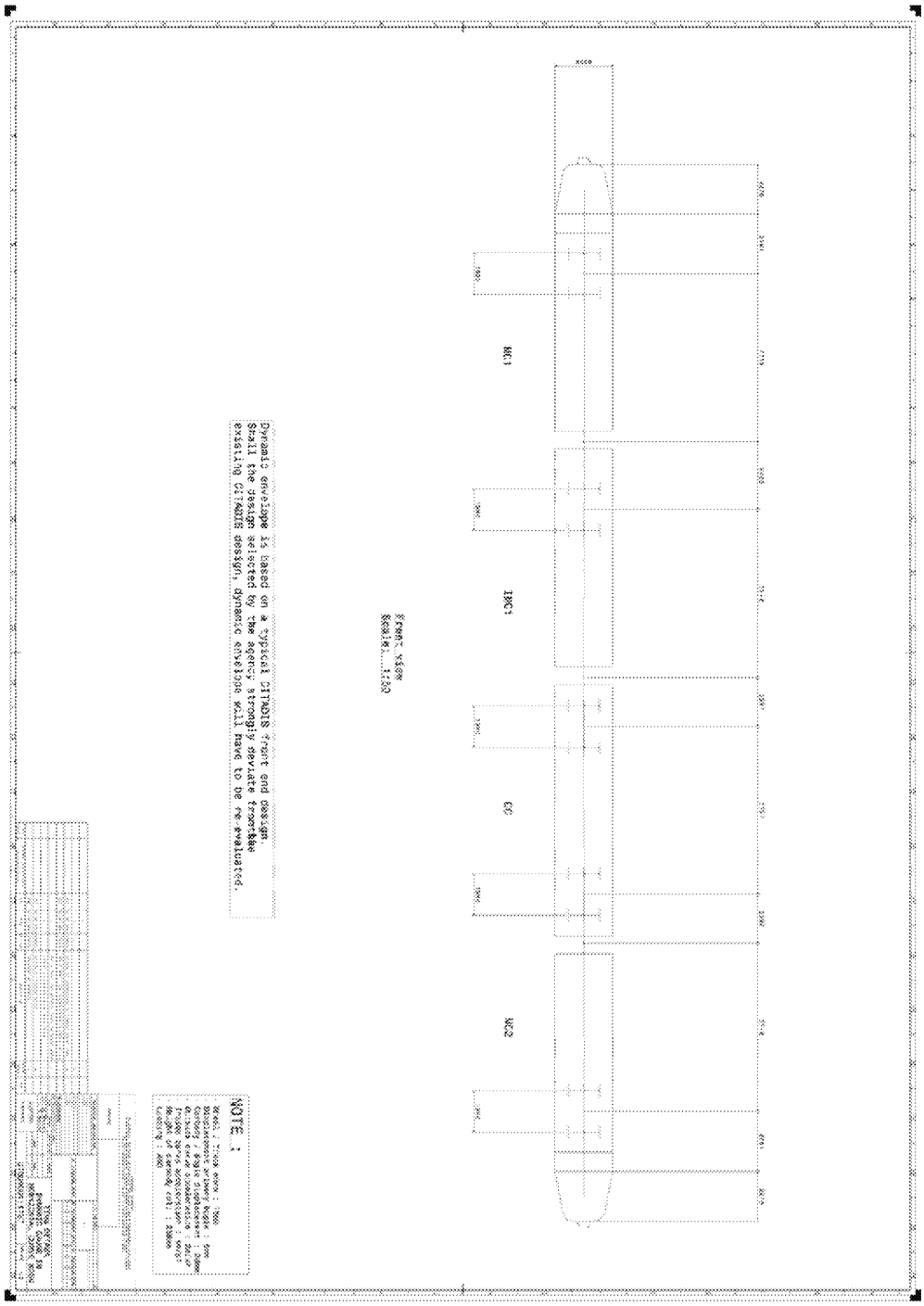
APPENDICE C – DYNAMIC GAUGE IN HORIZONTAL 35m CURVE



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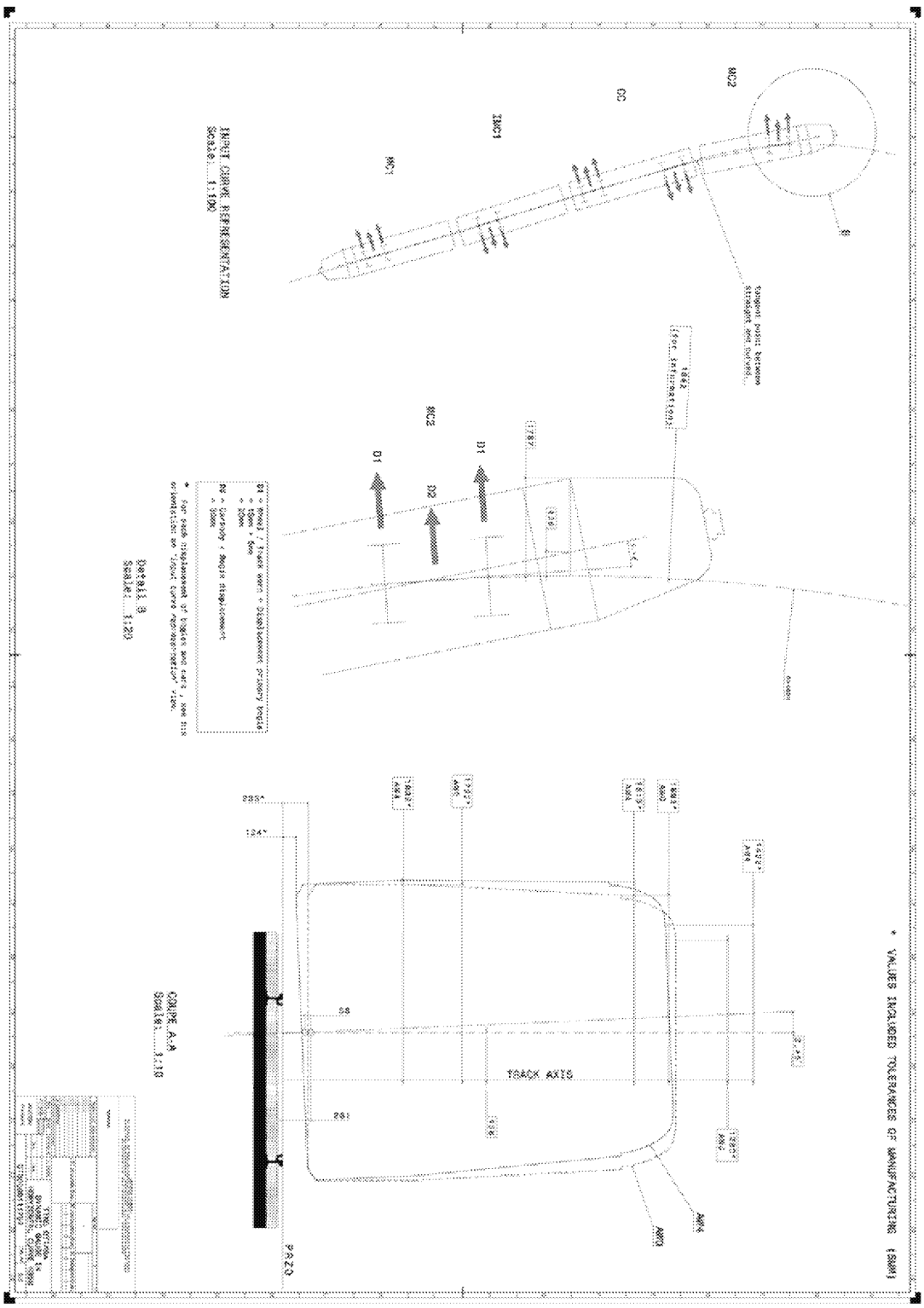

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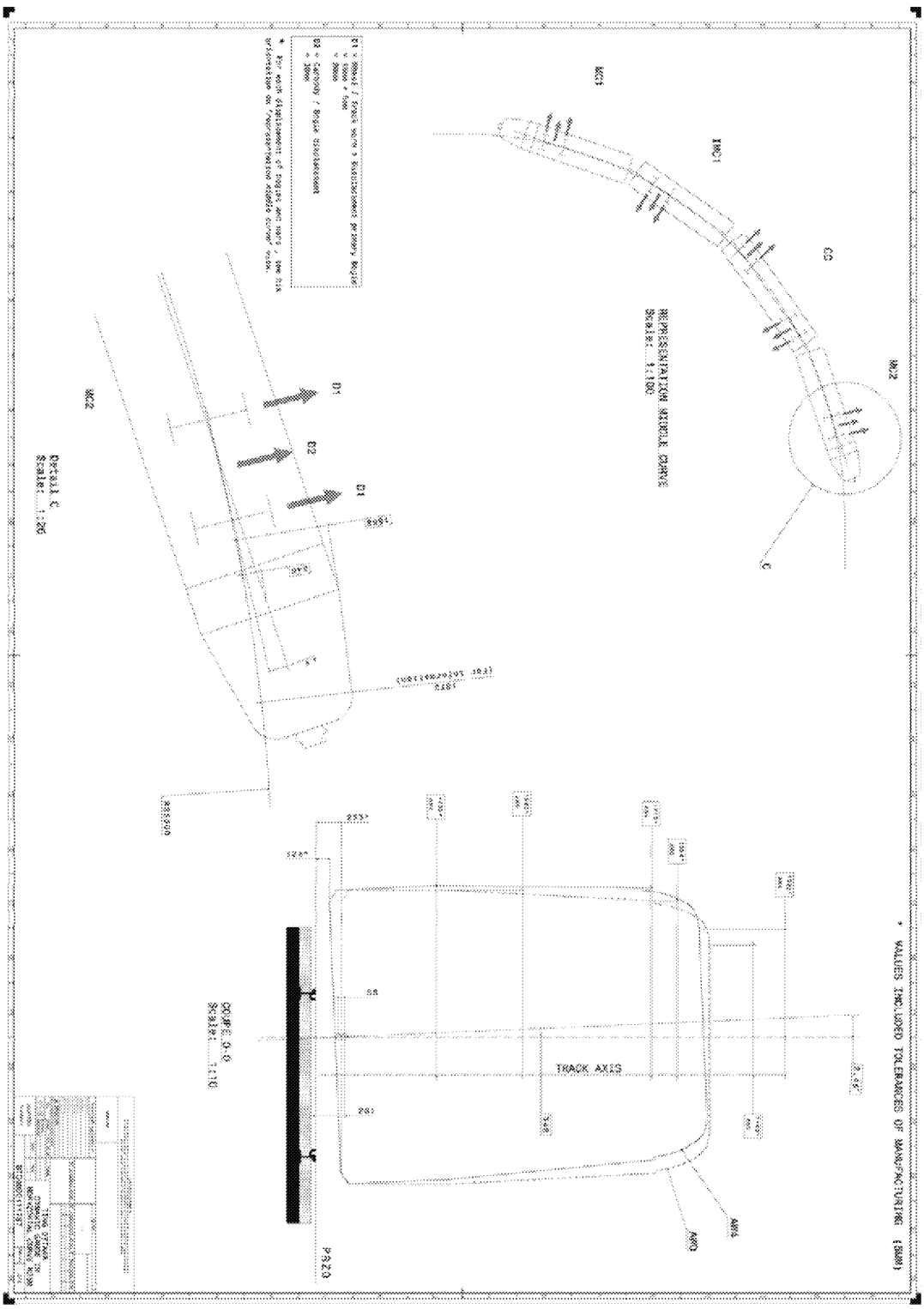

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APPENDIX A2
DOCUMENTS FROM ANNEX A TO THE LOI

APPENDIX A2
DOCUMENTS FROM ANNEX A TO THE LOI

1.0 Vehicles Specification

1.1 Please refer to Schedule 15-2 Part 4, Article 3 which contains the vehicle specification that was provided by the City of Ottawa in the RFP package.

1.2 Include in the vehicle proposal the following items:

- A branding strategy, with a narrative to describe how the City has input into the branding of the vehicle and its suitability towards the image of Ottawa as the Capital of Canada. The narrative shall include possible branding schemes and methods of changing the brand image;
- A description of the type and manufacturer of vehicle proposed, and its general arrangement and expected performance levels. Performance, reliability and safety of the proposed vehicle in similar climatic conditions;
- Service history of proposed vehicle (agencies used, years in operation, and number of cars) including experience with 4 and 5 car train consists and testing waivers expected with corresponding test results;
- Drawings including propulsion systems, carbody, truck, communications, braking system, HVAC, pantograph, auxiliary power systems, passenger interfaces, and cab layout ergonomics;
- Vehicle testing and commissioning schedule and strategy;
- Modelling and simulation results to validate system performance and applicability to Ottawa;
- A narrative of the design approach to vehicle accessibility and how the design can accommodate the AODA and ADA requirements and accompanying drawings and layouts detailing features of the vehicle;
- A narrative of the train systems and safety critical items, including descriptions of key components of the vehicle. Drawings reflecting spatial requirements and the potential impact to interior body space;
- A narrative describing spin/slide control system;
- A narrative describing vehicle delivery to site and any partial assembly required for the delivery system; and
- A narrative of key system interfaces between the vehicle and wayside subsystems.

1.3 The vehicle supplier will be responsible for installation and Post Installation Check-Out (PICO) of all onboard Train Control System equipment including, but not limited to, tachometers, transponder readers, radios and antennae. The equipment will be free-issued to the vehicle supplier. The Vehicle Supplier shall cooperate with the Train Control Supplier for all aspects of the interface between all Vehicle and Train Control equipment as listed in the *Vehicle Onboard CBTC Scope Split* matrix (attached as Appendix K1 to this Subcontract). This includes, but is not limited to, detailed design, implementation, testing and demonstration of all vehicle and Train Control equipment interfaces. As far as practicable the supplier 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. The supplier shall provide the Designer-Builder with unrestricted access to major vehicle subcontractors including, but not limited to, the propulsion and brake suppliers as may be necessary to validate the integration of the vehicle and Train Control interfaces.

1.4 The vehicle supplier shall provide as an option the supply, installation, testing and demonstration of the following onboard communications systems and equipment as required to meet the Rail Vehicles Technical Specification Requirements:

1.4.1. CCTV Equipment, including, but not limited to, cameras, network equipment, video recorders and driver's cab display.
1.4.2. Public Address system, including, but not limited to, speakers, driver's microphone, ambient noise microphone and amplifier/signal processors.
1.4.3. Train voice communications systems, including, but not limited to, passenger emergency intercom (PEI), cab-to-cab intercom, and driver's silent alarm.
1.4.4. Passenger Information Displays, including, but not limited to, destination boards and announcement boards.
1.4.5. Passenger counting system, including, but not limited to bars above each door and interface/processing box.
1.4.6. The intra-train communications network.

Radios and antennae will be free-issued to the vehicle supplier who shall be responsible for its installation (including all cabling and connectors) and Post Installation Check-Out (PICO). The vehicle supplier shall provide detailed interface specifications for all equipment, recommendations for the central equipment (to be provided by the Design-Builder) that interfaces to the onboard communications systems, and shall support the integration of these systems by the Design-Builder during the final Testing and Commissioning in Ottawa, ON.

END OF SECTION

5.4.2 COMPLIANCE WITH CANADIAN CONTENT POLICY

5.4.2.1 Canadian Content Compliance Strategy

RTG is pleased to propose a Vehicle that will achieve 27% Canadian content as detailed in the Canadian Content Certificate – Attachment B. In this section we are providing supporting information to demonstrate the compliance, this includes names of potential manufacturers, equipment type and place of manufacture and contact details of manufacturer (**Table 5.4-3**). **Table 5.4-2** indicates the breakdown of the requirements calculated in accordance with the Canadian Content Policy and in the specified categories. Of the 27% Canadian Content 16% is from Ontario.

Table 5.4-2 | Local Content calculation

Project Subdivision Items	Items / Total proposed price (%)	Part Localized in Canada (%)	Local Content (% proposal price)
Labour	8%	85%	7%
Sub-components and components inc. CBTC	64%	22.4%	14.3%
Project management	6%	25%	1%
Engineering	16%	5%	1%
Manual, Training, Simulators	0.5%	0%	0%
Special tools	0.3%	0%	0%
Test equipment	2%	70%	1%
Freight	0.2%	0%	0%
Warranty	3%	100%	3%
TOTAL	100%		27.3%

* *The price excludes any Canadian sales taxes (GST and others)*

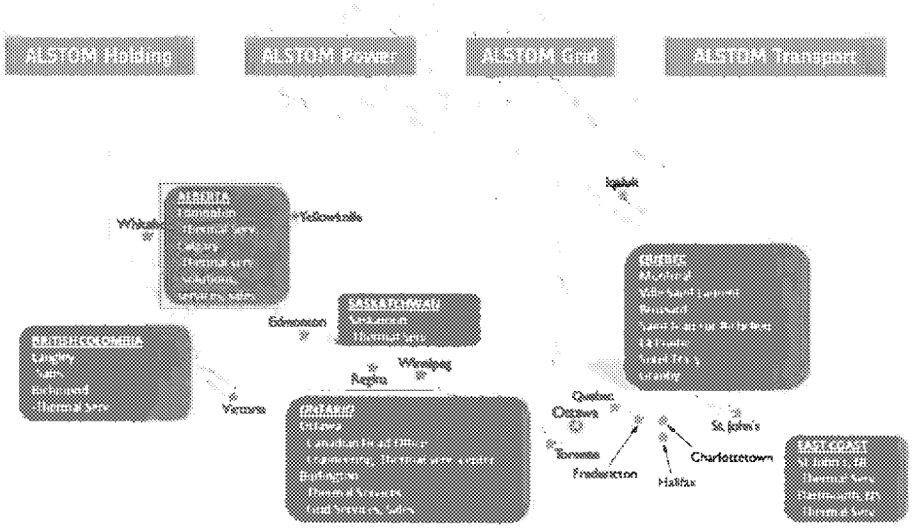
Alstom and RTG consent to the disclosure, verification and audit of the information forming the basis of their certification during the evaluation stage and any further steps taken before Commercial Close and, during and after the term of the Project Agreement. Such disclosure, verification and audit will apply to the Province of Ontario, MTO, the Auditor General of Ontario, and their designates.

70 Years of Experience in Canada

Alstom is able to exceed the required Canadian Content requirement of 25% by three means: local resources currently in place in Canada, local sourcing, and provision of final Vehicle assembly in Ottawa.

Alstom has been operating multi-specialist railway facilities in North America for more than 70 years. Alstom currently has more than 2000 employees working in Canada. Alstom Transport has available, qualified and experienced Canadian resources for the OLRT Project, including from the Center of Excellence for Passenger information, safety, communication and entertainment systems for rolling stock, station and trackside applications in Ville Saint Laurent's site in Quebec, and the Montreal railway maintenance centre (see **Figure 5.4-1**).

Figure 5.4-1 | Alstom Canadian Operations



Local Project Management

A local Project Manager will be appointed at the Project launch. Based in Ottawa, he/she will ensure that the targeted Canadian content is achieved. They will work in close cooperation with the various managers of the project who contribute to the Canadianization of the project. The team will include a Procurement Manager, Industrial Manager, Engineering Manager and Human Resources Manager for instance The Project Manager will help them to set up a localization strategy in order to satisfy and even exceed the local content. They will issue a regular internal report allowing the Authorities to check on the contractual conformity of the 25 % minimum Canadian content.

Supplier management

In order to guarantee the quality of Alstom's products, every supplier retained for the OLRT Vehicles will be qualified by Alstom's purchase quality department.

To date, Alstom already have in their qualified supplier data base a certain number of Canadian supplier such as indicated in Appendix B and **Table 5.4-3**. However Alstom will extend this Canadian supplier base and develop a specific procurement strategy for OLRT in order to deliver the objectives for sustainable procurement, including providing supply chain opportunities in the local area, especially to new and small and medium sized enterprises.

Alstom will advertise their upcoming contracts on their website, in local newspapers, procurement websites and relevant trade journals. In addition to this, they will include a list of key contacts for each current supplier contract and sub-contracted service, to encourage second and third tier potential suppliers to contact key suppliers and work in collaboration. Last but not least, Alstom will organize a Supplier Day in Ottawa to communicate the Project's main objectives and the needs in terms of purchase and schedules.

Management of the procurement process for new Canadian suppliers

A dedicated procurement team lead by the Procurement Manager will manage the procurement process, they will be supported by the various disciplines in preparation of the tender documents.

Procurement will be a key part of the design and construction progress meeting. Tender lists, procurement status, recommendations and performance against local supplier procurement targets will be discussed and monitored. If local supplier procurement targets are not being met the local Project Manager will instigate corrective actions.

Evaluation of tender submissions

A clear evaluation criteria will be established that provides a weighting in favour of local suppliers and sub-contractors.

The evaluation criteria will be a two stage process. The first stage will be a compliance check and submissions will either pass or fail. The compliance check will ensure that the suppliers/ sub-contractors have the capability to deliver the contract safely. The pass/ fail will be assessed on:

- Safety performance
- Capability (Turnover, relevant experience)

If suppliers/ sub-contractors pass the first stage then a weighted scoring criteria will be used to select a supplier/ sub-contractor. The scoring criteria will include:

- Location (Local, regional, national or international)
- Commercial competitiveness
- Programme and methodology
- Quality proposals
- Environmental control proposals
- The suppliers / sub-contractors use of local suppliers, sub-contractors, labour, plant and material
- The suppliers / sub-contractors recruitment and training opportunities for local people

The above scoring criteria with weightings will be developed at Preferred Proponent stage.

Management of suppliers/ sub-contractors

On contract award a start up meeting will be organized between RTG, Alstom and the supplier/sub-contractor. For suppliers this will be less involved, but for sub-contractors this will be an in depth meeting chaired by the relevant System or Element Project Manager. The following will be discussed and formalized:

- Management team
- Frequency and content of progress meetings
- Programme
- Quality standards and regime
- Health and safety outline (this will be followed with a Health and safety start up meeting)
- Environmental issues and control measures
- Commercial

Labour

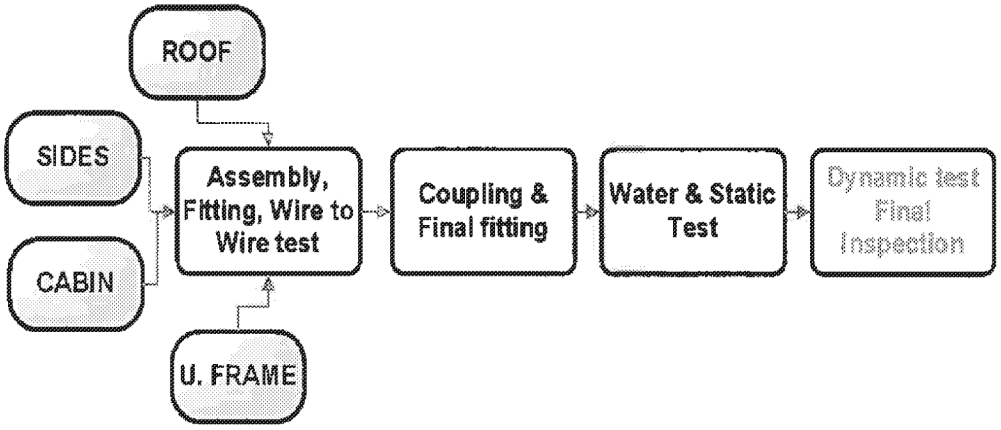
Alstom has develop a standard manufacturing process (APSYS) applicable to all rolling stock types and all manufacturing sites. This standard process will be deployed in the Ottawa MSF, where vehicles will be assembled.

A dedicated Ottawa Industrial Management Plan will be defined at the beginning of the Project. The objective of the industrialization plan is to:

- Define the manufacturing tools and process, and optimise the related investments.
- Build the Product Bill of Material (PBOM) from the Product Breakdown Structure defined by the Technical team

Final Vehicle assembly will be done using Canadian workers in the MSF in Ottawa. The modular design of Citadis Vehicles easily supports production and final assembly of the sub-assembly modules (roof, sides, cabin, and underframe) in the Canadian facility (see **Figure 5.4-2**).

Figure 5.4.2 | Modular Design Facilitates Production and Assembly



The final dynamic routine tests will take place on the OLRT System track.

Subcomponents and Components

Drawing on its supplier database, Alstom will use Canadian and Ontario suppliers for key components as shown in **Table 5.4-3**.

Subassemblies

The main subassembly frames (underframe, roof, cabin and end ring) will be produced individually including welding and painting outside the MSF building.

These frames will be delivered to the MSF where they will be pre fitted and partially tested including the cabling.

Section assembly

The pre fitted modules will be assembled to form each section based on riveting technology. After the dimensional control of the section structure, the final interior fitting and installation of roof equipment will be carried out. An assembly control (mainly electric continuity and dielectic test) is carried out before train assembly (see **Cut Sheet 5.4.1-CS-1001**).

Vehicles assembly

Each completed section is placed on bogie (s) and then coupled to the next vehicle. When the 4 cars of a train are coupled, final wiring is completed before the train is transferred to testing.

Vehicles testing

Each vehicle will be tested in static and dynamic mode according to a standard serial test program designed to test all vehicle functions.The final dynamic routine tests will take place on the OLRT System track.

Table 5.4-3 | Supplier Database Located in Canada

Supplier Name	Location	Product	Logo
Faiveley Transport Canada Inc.	1002 Rue Sherbrooke Ouest, Montréal, Québec	Brakes	Faiveley TRANSPORT
Mersen	88 Horner Ave, Etobicoke, Ontario	Electrical components	MERSEN

Supplier Name	Location	Product	Logo
Wablec	475 Seaman St. Stoney Creek, Ontario	Passengers doors	Wabtec CORPORATION
Ceit Groupe	5650 Rue Trudeau, Saint-Hyacinthe, Québec	Interior Lining	CEIT Groupe
Knorr Bremse	675 Development Drive. Kingston. Ontario	Brakes	KNORR-BREMSE
Dimension Composite	2530, 95e Rue, Saint-Georges, Québec	GRP Front End	DIMENSION Composites
I Gard	7615 Kimbel St., Unit 1, Mississauga, Ontario	Braking resistor	GARD
Alstom Canada Inc.	1010 rue Sherbrooke, Montréal, Québec	CCTV	ALSTOM
Prelco	94 Bouleverd Cartier. Rivière du Loup. Quebec	Windows & Windshield	PRELCO

Other Items

- **Project management** - Alstom's Project Core Team will be based in Ottawa. This team will be in charge of all OLRT rolling stock requirements from the start of the Project until the end of warranty
- **Engineering** - Alstom's Field Engineer will be in charge of the warranty, reliability and maintainability growth phase. Work will be performed locally by Canadian engineers.
- **Test equipment** - Serial tests on each Vehicle will be performed on OLRT System track by Canadian Engineers. NRC's climatic chamber in Ottawa may be used for specific climatic-type tests.
- **Freight** - Canadian freight companies will be used to transport vehicles and goods.
- **Warranty** - During the warranty period, Canadian engineers will ensure Vehicle reliability and availability.

Technology Transfers

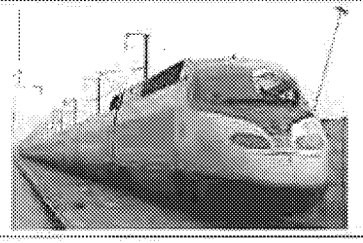
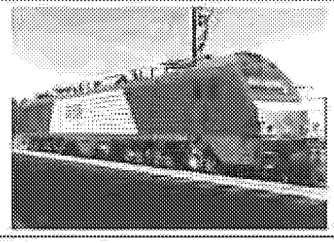
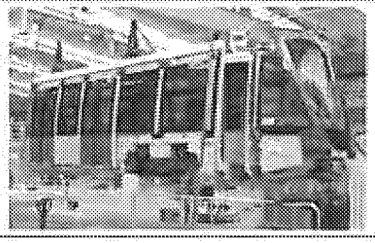
Alstom Transport has more than three decades of experience in technology transfer. In response to a diverse range of local content requirements Alstom Transport has implemented numerous partial and total technology transfers around the world. **Table 5.4-4** shows some of Alstom's main projects with a local content requirement.

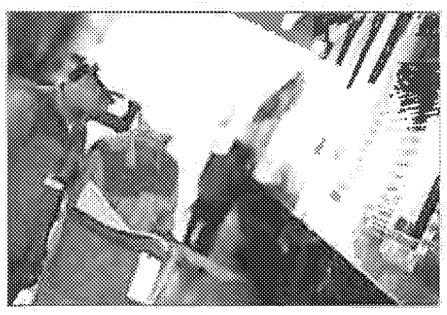
Table 5.4-4 | Examples of successful Technology Transfer

Header	Header
34 Korea - KTX (Korean High Speed Train)	Full transfer from France to Korean partners
500 China CoCo Electric locomotives	Full transfer from France to Chinese partners
Montreal Metro (Bogies)	Transfer from Alstom Le Creusot to Alstom Sorel Tracy (Quebec)
70 Madrid LRV	Transfer from La Rochelle (France) to Barcelona(Spain)
37 Istanbul LRV 20 Acela Express trains	Transfer from Valenciennes (France) to Katowice (Poland)

Header	Header
20 Acela Express trains	Traction cubicle: Transfer from Tarbes (France) to Hornell (USA) Trucks: Transfer from Le Creusot (France) to Bombardier (USA)

Figure 5.4-3 | Examples of Successful Technology Transfer

Korean High Speed Train	China Locomotives	Istanbul LRV
		



Once the two first OLRT Trains have been fully validated by Alstom's Center of Excellence in Valenciennes, France, Alstom will complete a technology transfer to Canada. This process ensures that the entire Train will be assembled in the Ottawa facility described below. Major components of the technology transfer process include the following:

- Preparing the manufacturing plant
- Installing and testing of validated tools for pre-assembly
- Preparing documentation, training and support for local staff

Manufacturing Facility at the MSF

Two main functional areas are required to produce the Citadis vehicle:

- A manufacturing building (4000 m² approx. + additional warehouse)
- A static test building to perform water tightness and functional static test – (2500 m² approx.)

The two MSF tracks designated for heavy maintenance will be used for final vehicle assembly. The MSF will be available for manufacturing equipment installation in early 2015. The vehicle wash facility area will be used to perform the water tightness test. The planned layout is shown in **Cut Sheet 5.4.1-CS-1001**.

Hiring Plan and Skills Development

Alstom intends to hire more than 100 people locally to manufacture the OLRT Vehicles. These workers can be transferred to maintenance activity on conclusion of manufacturing. The personnel breakdown will be approximately 80% workers and 20% management. In addition, the hiring plan will consider other personnel for the Project management team and local engineering team.

Alstom's recruitment strategy will be based on two search modes: active and passive.

Active Candidate Sourcing

- Posting the jobs on niche sites to reach a national audience within specific technical disciplines
- Utilization of "Banners" on the main page of niche sites to highlight Alstom jobs in comparison to competitors

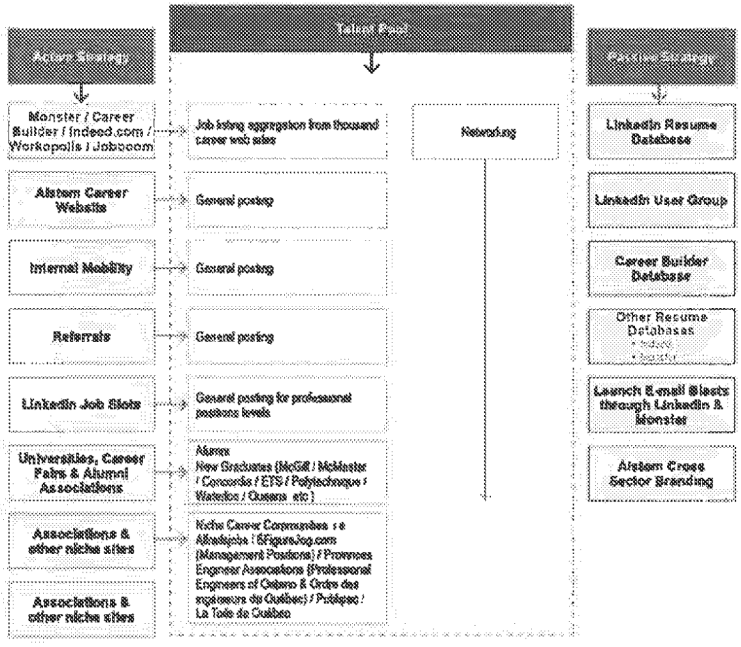
- Utilization of "e-mail blasts" to send Alstom job announcements to candidates who are registered viewers of these various niche sites

Passive Candidate Sourcing

- Using Social Media/Business networking tools
- "Mining" third party applicant databases containing résumés

These two sourcing methods are performed simultaneously and therefore have several benefits:

- Branding and visibility reinforcement
- Multiple sources of applications = multiple sources of advertisements
- Supporting the search for key technical talent: useful niche sites for technical experts
- Being able to compete with strong competitors using well advanced Social Media strategies
- Methodology is applicable to all other disciplines (Key Management positions, etc).



This strategy will be applied to all type of positions:

- Internships
- Technical Experts
- Production employees
- Senior Management
- Professionals

The standard recruitment process is as follows:

- The first selection of resumes is managed by the Human Resources Department
- The selected resumes are sent to the Managers for their review
- The relevant Manager and his/her team review the resumes and communicate the preferred selection to the Human Resources Department
- The HR Department phones the selected candidates with selected questions and send feedback to the relevant Manager
- The Manager, the HR Manager & his/her team interview the candidates face to face and make the final decision
- A background check is implemented on the final candidate. Some psychological tests could be added to the selection process

In accordance with the strategies discussed in this section, RTG is confident that the 25% Canadian Content can be achieved.

5.4.3 LIGHT RAIL VEHICLES

Passenger Vehicles are the dynamic linking element of any LRT system and contribute significantly to the customer's experience. The OLRT Vehicles must consistently address a wide range of factors including safety, comfort, availability and local conditions. For these reasons and more, the proposed OLRT vehicle is a Citadis 100% low-floor LRV. Since production of Citadis vehicles began in 1997, more than 1,500 Citadis LRVs have been sold worldwide. More than 40 cities have purchased the Citadis LRV, thereafter accumulating more than 245 million kilometres for this service-proven vehicle.

Citadis vehicles deliver a wealth of advantages in support of Passenger comfort, and system capacity, aesthetics, availability and safety. This superbly engineered vehicle is easily customizable, easily accessible and easier on the environment. Citadis is also the only 100% low-floor LRV in the world running in daily operation at 100 km/h. Key advantages of the proposed Citadis vehicle include the following:

- **Customer Comfort – Best in class**
  - Design focused on Passenger comfort and safety
  - Modular design allows multi-purpose areas
  - Large windows provide bright, attractive riding experience
  - Two-level suspension truck provides ultra-smooth trip and high comfort levels
- **System Capacity - 100% Low-floor Vehicle**
  - Vehicle interior is configured with no steps, allowing for safer, quicker and smoother Passenger flow and reduced dwell times
  - More efficient standing capacity compared to a 70% low-floor LRT
  - Improved access for Passengers with mobility restrictions
- **System Aesthetics – Visual appeal**
  - Sleek, lower profile Vehicle integrates beautifully into the urban environment
  - Iconic addition to the Ottawa landscape
- **System Availability – State-of-the-art systems; global expertise**
  - Citadis benefits from Alstom's global expertise as a Train maintainer
  - State-of–the-art on-board monitoring system for remote diagnosis and troubleshooting
  - Braking equipment, gear-box, traction motor and wheels are directly accessible for inspection and replacement from the side of the Train without truck removal
  - Exclusive rapid-mounting system replaces side window in 30 minutes
- **System Safety – Safety enhancements**
  - Designed according to the latest safety standards (EN 50126)
  - Safety is considered through the entire lifecycle of the Vehicle: from concept to O&M
  - Compliant with ASME-RT1 requirement for structure and crashworthiness
- **Easily Customizable – Modular design**
  - Designed to be easily customized to accommodate Ottawa's specific requirements
  - All Citadis Vehicles are based on the same proven-design sub-systems for improved availability
- **Increased accessibility – Mobility for all**
  - 100% low-floor allows ease of use for all Passengers
  - Leveling system ensures perfect alignment between platform and the LRV
  - Large corridors and gangway

- **Environmentally Sensitive – Reduced footprint and impacts**
  - Vehicle is recyclable at 95%
  - Reduced energy consumption
    - LRV features regenerative braking
    - Citadis is fitted with a single-stage gearbox for better efficiency
    - Interior lighting is based on low-consumption LED
  - Vehicle design reduces noise levels inside and outside the Train

5.4.3.1 Branding Strategy & Approach

Best or Leading Practices

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.

Station and urban design are critical components in developing a 'complete brand approach', but the Vehicles are the dynamic linking element and ultimately become the 'face' of the brand. Too often, Vehicle livery has been largely regarded as an extension of the agency, a "uniform" for vehicles. This ignores the potential to capture and communicate the brand promise with each passing view of, or travel experience onboard, an OLRT Vehicle.

As a member of RTG, Alstom is committed to working with the City to integrate the Vehicle brand with the overall brand of the System. We will work with the City during its System branding process to develop a full understanding of the complete identity for the OLRT. More specifically, the Vehicle brand will encompass the Vehicle front styling, interior and exterior colour schemes, window tinting and livery.

Brand Building

To develop a compelling and positive Vehicle brand, the branding strategy should incorporate the following elements.

- **A long-term vision** - An explicit definition of what the brand is to represent in the eyes of its target audience.
- **A better product** - Product quality is an ideal branding variable. Working within the budget envelope, RTG will assist the City in delivering a better product across Vehicles.
- **An analytical edge** - RTG will help the City use research and consultation for a clear understanding of transit users (current and prospective) and their needs.
- **An exercise of creativity** - Vehicle branding requires creative thinking, planning and execution through every element of the Vehicle.

RTG Approach – Fully Integrated Branding

RTG understand that branding goes beyond Vehicles and must have a 'complete design approach' to be successful. Our partnership approach with the City, our expertise, and our lessons learned will benefit the citizens of Ottawa and create a world-class LRT identity.

Alstom enjoys a long-established global reputation for expertise and innovation in transportation solutions. One reason for this is the Design & Styling (D&S) department created in 2005, and which is unique in the railway industry. The department comprises 20 top designers, each dedicated to creating designs that harmonize with the general configuration of the Vehicle - and ensure that Vehicle branding adds a compelling and exciting element to the overall System brand.





The D&S department's cross-functional organization is particularly well suited to meeting the specific needs of envisioning and incorporating key branding elements:

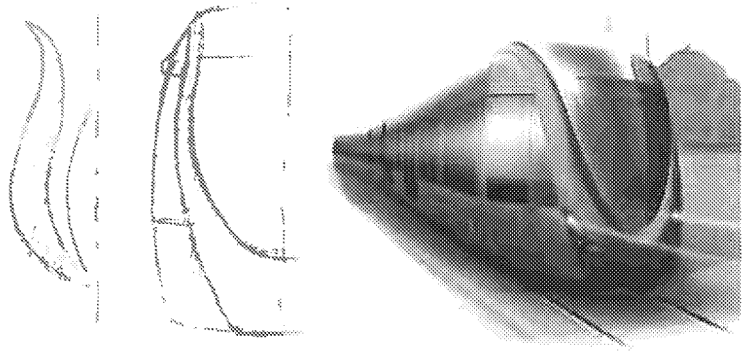
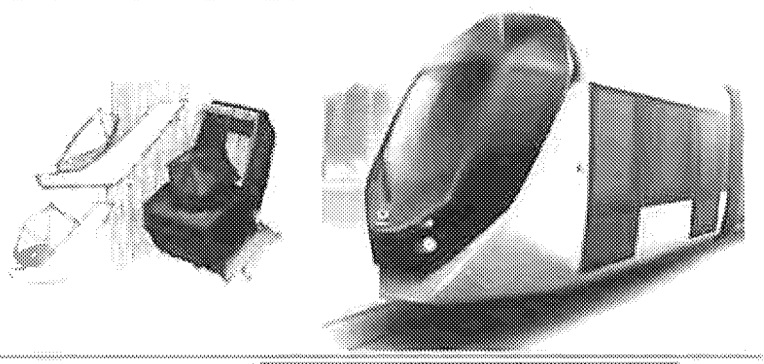
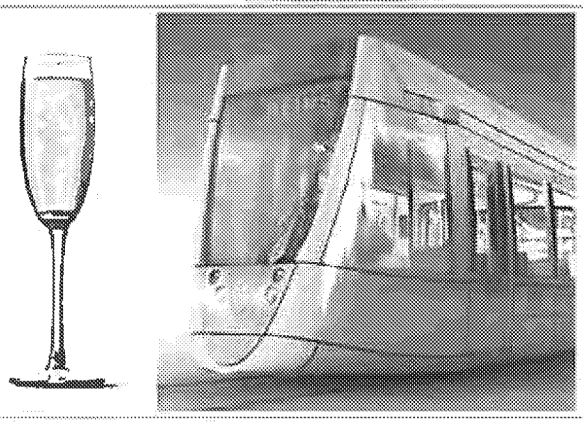
- Consolidating competencies in terms of design, digital modelling, colours, materials, and lighting
- Producing designs suited to each client's cultural context
- Stimulating creativity

For the OLRT Project, Alstom will follow its normal practice and use a highly collaborative approach to branding with active and ongoing involvement of the City and key Stakeholders. A multi-disciplinary team, including graphic designers, architects, planners, engineers, branding specialists, and Stakeholders is involved in strategy and ideation. Working with the City's branding process, the D&S department will analyze the cultural, economic, political and geographical context of the Project. This is summarized through photo reports and keywords. The objective is to define the artistic theme which will be used as a connecting thread for creation throughout the Project.

A unique competitive advantage of our modular product configuration is that the front end and interior arrangement can be customized and become a critical component of the brand. The D&S department will propose various versions of shapes for the interior and exterior, colours and trims in support of the final branding approach.

Branding is completely integrated into the industrial design process for the Vehicle. See **Section 5.4.3.7** for a complete description of the industrial design process. **Table 5.4-5** shows three examples of how Vehicle design becomes a key brand element.

Table 5.4-5 | Vehicle Design

City and Theme	Vehicle Design
LRV Istanbul – Theme: Tulip	
LRV Dubai – Theme: Diamond	
LRV Reims – Theme: Champagne Flute	

Branding by Design

The Alstom D&S department follows a multi-step iterative process that ensures Vehicle design delivers maximum branding value and quality results.

Design, Step-By-Step

The design process is divided into six steps: preliminary meeting, pre-choice meeting, choice meeting, freeze meeting, working mock-up and representative mock-up.

Round-The-Clock Dialogue

Teamwork is part of a methodology that has been proven over time. Face-to-face meetings will establish a rapport with the client that makes the choice process simple and straightforward. Once the design principles are agreed upon, they are integrated into product design. In addition, the Design & Styling department can work directly with external designers or local partners.

A Committed Team

The dialogue takes place over several months. An Alstom project manager first proposes a work schedule and this sets off a feedback loop involving designers, modellers and colours and materials experts. These in turn consult with engineers and suppliers who speak a common language.

A Proven Methodology

Listening to client needs is built into the team-based approach. It is imperative to ask the right questions to fully grasp the nature of each project. Only this kind of quality interaction gives rise to previously unexpressed needs.

Feasibility

All elements proposed during the selection process are feasible. The design team works with software that is compatible with the one used by railway engineers. Adjustments can be made at any stage of the process, from the rough sketch to the 3D model. A five-axis milling machine then renders the design into a volumetric model.

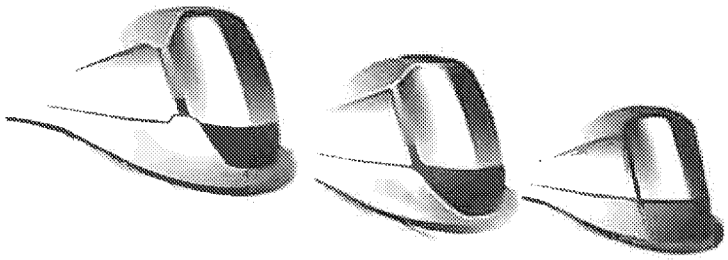
Design Manual

At the freeze meeting, customers are handed a Design Manual detailing the specifications of their proprietary train design. The Manual lists up to 80% of the shape characteristics of a Train, both interior and exterior. It also includes a graphic line, colour preferences, seating configuration, lighting options and materials. The signing of the Design Manual serves as a contractual agreement between Alstom and its clients.

OLRT Treatment Exploration – Positioning Led Design

Figure 5.4-4 shows examples of branding schemes are provided only as examples, to demonstrate how different positioning choices could inform final branding.

Figure 5.4-4 | Preliminary studies of three front end shapes proposed for OLRT



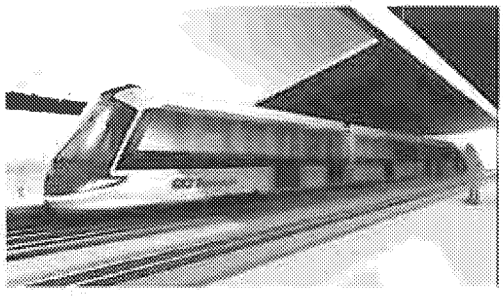
To demonstrate the scope and flexibility of our branding process the Alstom D&S department and RTG have created three preliminary design alternatives for exterior design and interior design. Following a review of what is building the City today, and what the City is building for tomorrow, these alternatives have been specifically created for Ottawa. Starting with the identification of key elements that could form the basis of a strong OLRT brand foundation, we have shown how we translate these into shapes, graphics and colours in the vehicle design.

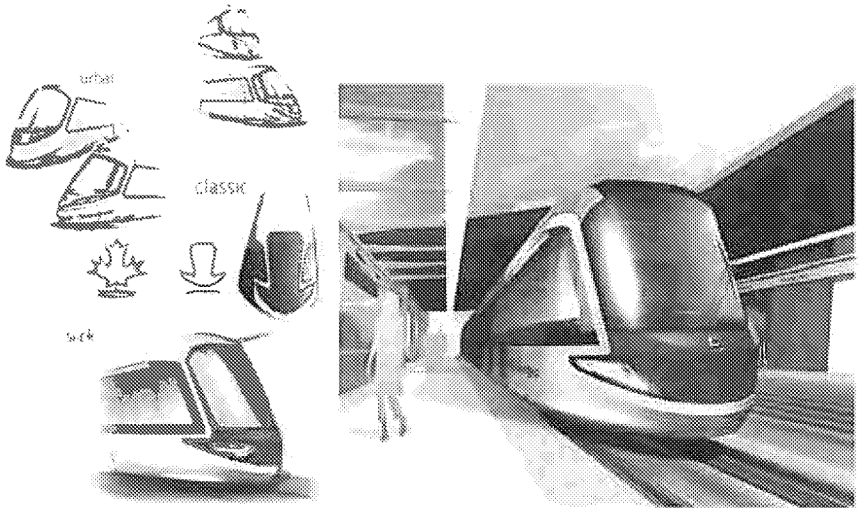
The Citadis product is a technically proven design, but the platform has been purposely designed such that it can easily be customized for each of our clients. This creates flexibility and possibility from the outset. The alternatives included here are intended to demonstrate the degree of differentiation possible – and are the starting point for a collaborative branding process with the city.

Exterior Design

Theme A: Strong and Free

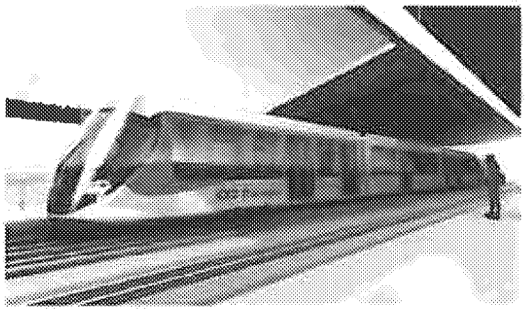
This design incorporates a strong graphic shape on the front end. It retains the essential lines of the maple leaf to create a design that recalls the national symbol without being literal and obvious. The graphic and form create a style that is contemporary today, and will become a classic in the future. It is strong, solid and present. The surface treatment is both detailed and sleek, conveying a sense of quality and pride befitting the stature of Canada's capital city.

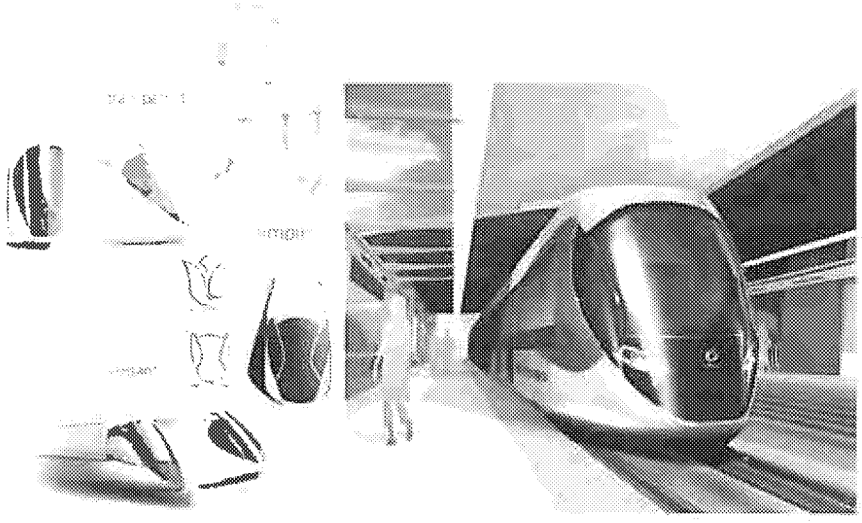




Theme B: Quiet Strength

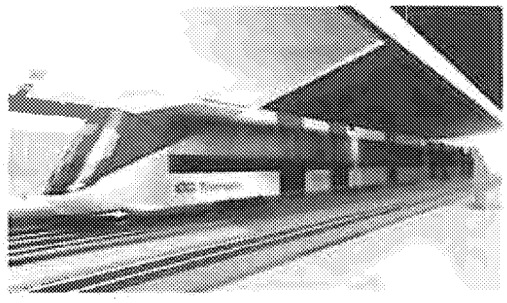
Ottawa is home to the world's largest tulip festival. This theme takes inspiration from the tulip petal and is well balanced and softly curved. The result is highly aesthetic and elegant, and conveys a sense of quiet strength. The large windscreen with integrated headlights creates a heightened sense of transparency and expansiveness. A comparison of this treatment to that of the Istanbul LRV is a strong example of how we take the essence of a city and transform it into a unique brand element. Although both cities claim the tulip as an iconic element, the OLRT expression is uniquely Canadian.

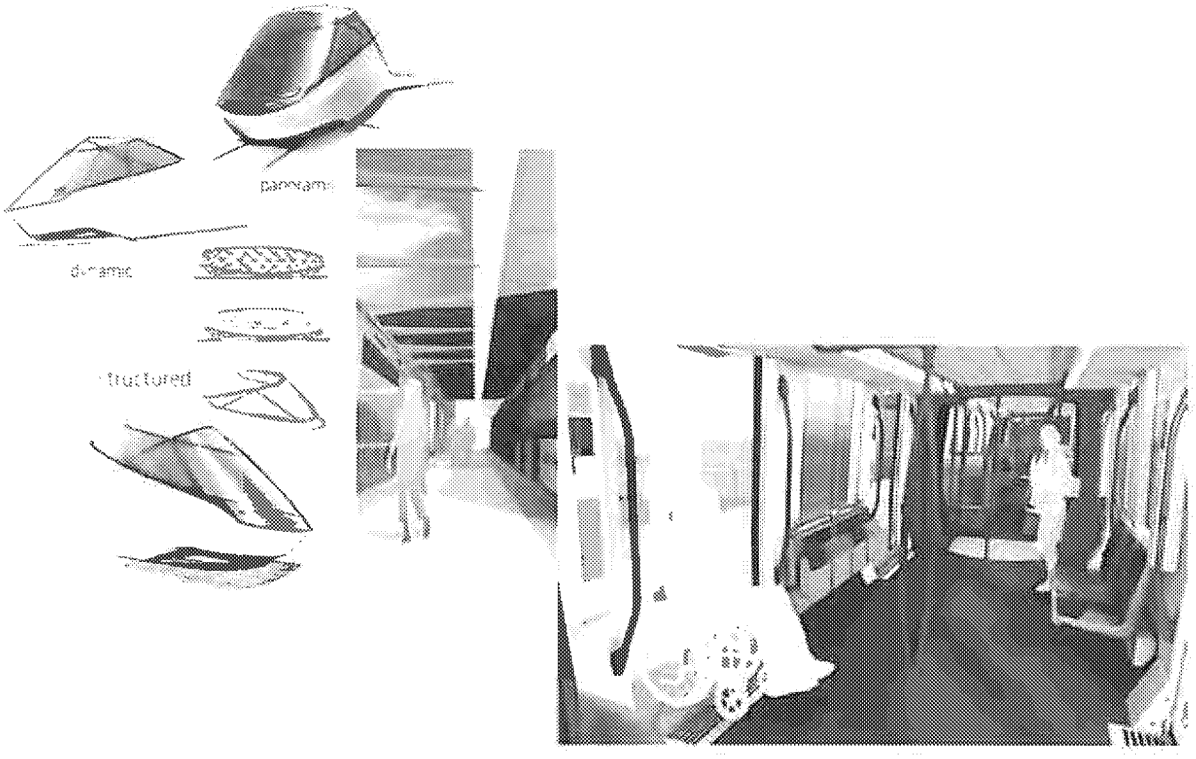




Theme C: Fast Forward

This theme takes its inspiration from some of the most advanced architectural features in the City. The design conveys a strong sense of purpose and motion; at once dynamic and panoramic. The sleek continuous front end is futuristic and powerful – with just a touch of attitude. The design makes a strong statement that the City has arrived.





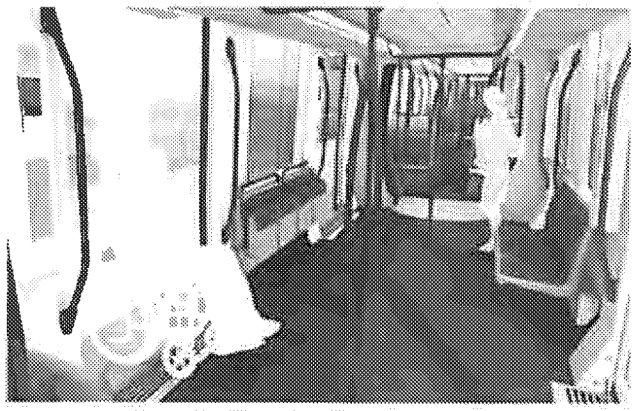
Interior Design

Theme 1: Geometry

Geometry is the basis of all strong composition. With a starting point of straight lines and geometric shapes this design theme shows how intriguing the basics can be when skillfully combined. In this simple but bold choice, a sense of animation is created by combining strong contrasting colours with neutral elements. The result is strong, contemporary and distinctive.

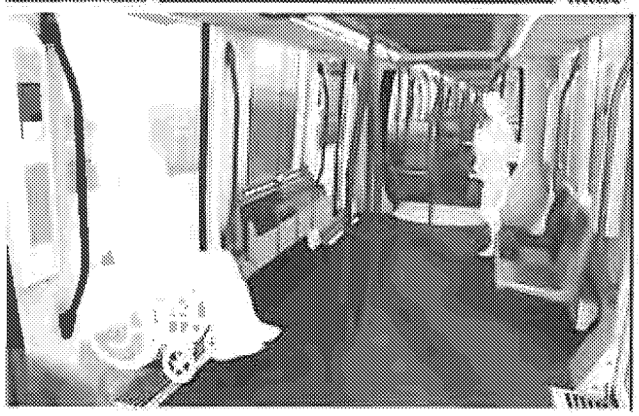
Theme 2: Facets

In this design it appears that facets of light from passing buildings are reflecting within the Passenger car. The diamond grid pattern on the ceiling gives the impression of light reflecting off the water - creating a bright, animated ambiance. The classic colour scheme produces a sense of calm and comfort. The use of red creates an additional feeling of warmth.



Theme 3: Tulip

This innovative interior design dramatically separates the ceiling from the rest of the interior. Nature images and landscapes in the ceiling panels give the impression of a contemporary photograph exhibition. These pictures are filtered using plain colours and low contrasts, creating a calm, contemplative atmosphere. The images are a subtle reminder of the simple pleasure of taking time each day to really look at our surroundings.



All of the elements shown in the three external and three internal design options are interchangeable. These design options demonstrate how character and interest can be added to the Vehicle branding process by integrating elements that reflect on local history, aspirations, culture, and unique aspects of the surrounding landscape.

5.4.3.2 Proposed Vehicle

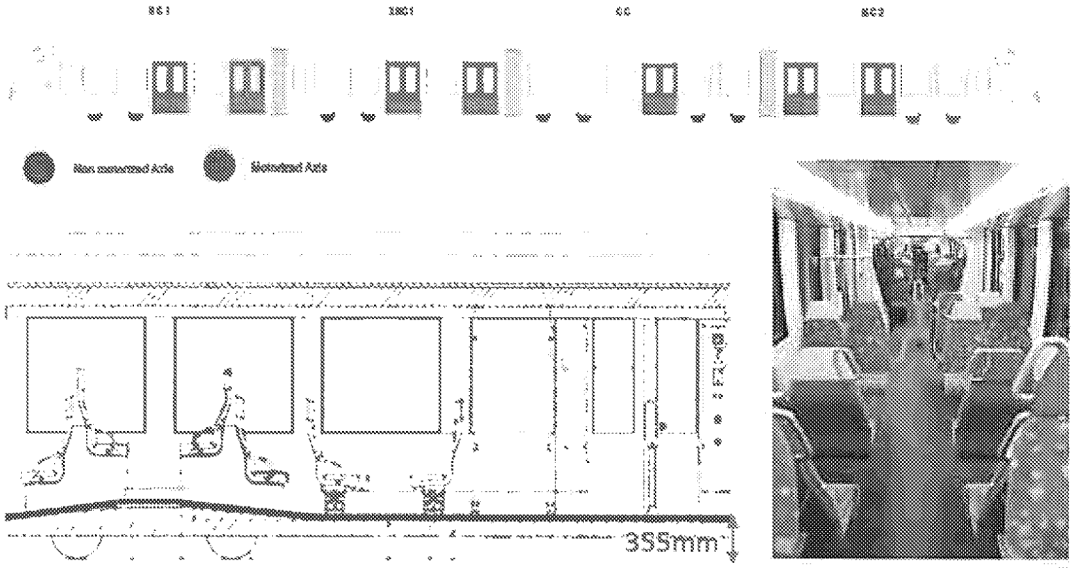
General Arrangement and Performance Level

The proposed Vehicle for the OLRT Project is part of the Citadis product range. As shown in **Figure 5.4-5**, each Vehicle is composed of the articulating sections.

- 1 extremity section with Driver's cabin and motor truck (MC1)
- 1 intermediate section with one trailer truck (IMC1)
- 1 centre car with one trailer truck and one motor truck (CC)

- 1 extremity section with Driver's cabin and motor truck (MC2)

Figure 5.4-5 | Articulating Sections and Low Floor Arrangement



The Vehicle features 100% low-floor in the Passenger area for an improved ride experience:

- **Optimized Passenger Flow** - Safer, quicker and smoother Passenger flow inside the Vehicle to reduce dwell time.
- **Improved Comfort** - The flat floor provides Passengers with an increased sense of comfort.
- **Improved Safety** - No step means no trip-hazard in the Train.
- **Improved accessibility** - All Passengers, including those with restricted mobility, strollers or luggage can move easily within the Passenger area.
- **Optimized Capacity** - In partial low-floor vehicles, standing Passengers remain in the low-floor sections; in a 100% low-floor Train, they have full access to all available space within the Vehicle.
- **Improved aesthetics and urban integration** - 100% low-floor vehicles are lower than partial low-floor Vehicles resulting in smoother vehicle profiles and reduced visual impact.

Other key Vehicle features include the following:

- Maximum operating speed of 100 km/h for high-capacity line.
- Large windows in the Passenger compartment create a feeling of spaciousness.
- Seven dual-leaf sliding-plug Passenger doors are evenly distributed throughout the Train for reduced dwell time. The Passenger-exchange length over useful Vehicle length (i.e. not including the Driver's cabin) is higher than 20 percent.
- An HVAC unit located in each car ensures optimum thermal comfort in the Passenger cars.
- The proposed width and length combination optimizes capacity while ensuring a high level of Passenger comfort.
- Major sub-systems, such as HVAC, traction cubicle or air compressor, are roof-mounted and concealed by lateral roof fairing profiles presenting a pleasing, uniform appearance when seen from road level.
- Vehicle can be operated in multiple units of two vehicles.
- Bi-plan side walls produce a more aesthetic vehicle with a large Passenger compartment while reducing the vehicle dynamic envelop.
- The Vehicle's modular design enables large use of pre-assembly, making it easy to assemble and maintain.

The Vehicle layout is shown in **Drawing 5.4.1-SW-101**. **Table 5.4-6** summarizes the other main characteristics.

Table 5.4-6 | Vehicle Characteristics

Characteristics	Dimension/Performance
Length over coupler face	49 metres
Vehicle width	2,650 mm
Vehicle tare weight	78 tonnes
Number of sections	4
Number of trucks	5
Number of motor trucks	3
Seated Passengers	104 seats + 16 flip-ups
Standing Passengers with 3.33 pass/m²	180 Passengers
Total Train capacity at 3.33 pass/m²	300 Passengers
Comfort rate with 3.33 pass/m²	40%
Wheelchair areas	4
Double doors	7

Performance Reliability and Safety of Proposed Vehicle

The proposed Vehicle is an evolution of Citadis based on Istanbul Citadis and SNCF Nantes Citadis to fulfil OLRT requirements (**Section 5.4.3.3** provides more details). The main modifications to the Citadis Nantes are the following:

- Replacement of the 25 kV/750 Volts dual-voltage traction package by a 1500 Volts traction package
- Lengthen car body to provide Passenger capacity in line with OLRT System performances
- Addition of one door on MC1, MC2 and IMC1 to manage Passenger flow and reduce dwell
- Removal of the handicapped toilet in MC1
- Replace SNCF signaling system with Thales CBTC system
- Implementation of design solutions to comply with climatic conditions in OLRT environment
- Modifications to comply with standards and regulations specific to OLRT environment and Canadian content (for example: addition of service proven pneumatic secondary suspension to comply with ADA/AODA)
- Modifications to comply with Transport Canada regulations, only to the extent that the regulations are appropriate for LRV vehicles. For example RTG does not plan to provide onboard washrooms.

Performance

Table 5.4-7 | Performance of Proposed Vehicle

Parameter	Performance
Maximum Speed	100 km/h
Acceleration: Initial maximum vehicle acceleration (OCS voltage>1500 V, AW2 Loading) up to 32 km/h	1.34 m/s² +/-5%
Full service electric brake rate at AW3 loading from 64 km/h to 5 km/h	1.34m/s²
Full service blended (electric/friction) at AW3 from 80 km/h to standstill	1.34m/s²
Maximum service blended (electric/friction) + track brake up to AW3 from 88 km/h to standstill	2m/s²

Parameter	Performance
Full service friction brake rate at AW3 loading from 80 km/h to standstill	1.34m/s² +/-10%
Emergency Brake at AW3 load from 48 km/h to standstill	≥2.24 m/s²
Friction only at loads up to AW3 load from 80 km/h to standstill	1.78 m/s² +20%/-10%
Parking brake holds an AW3 Train on a 6% grade indefinitely	Yes
Jerk rate	From 0.44 to 1.34m/s3

Reliability

As with every product developed by Alstom, the Citadis range and Ottawa's Vehicle are designed to deliver a high level of reliability and to allow for easy maintenance operations. **Table 5.4-8** shows figures applicable for the proposed OLRT Vehicle.

Table 5.4-8 | Vehicle Reliability

Parameter	Performance
Mean distance between Service-Disrupting Failures over a 12-month period (per LRV)	52000 km
Mean Time To Repair failures (MTTR)	1.5 hour
Maintenance periods	12500 km 25000 km 75000 km 100000 km 300000 km 400000 km 600000 km 900000 km 1200000 km
Failure recovery achievable within "x" minutes of two Trains converging (i.e. time to couple to an immobilized Train, reconfigure the consist, and start moving it off the line)	30 min

Safety

Safety is at the core of every Alstom product. During development of the Citadis product range, close attention was paid to all safety-related aspects and items to make Citadis one of the safest Trains on the market. For the OLRT Project, a complete safety study will be part of product development. This study will take into account the tremendous amount of in-service experience on the Citadis product range as well as all the requirements, environmental and operational, specific to the OLRT. Safety studies will be conducted in accordance with the EN 50126 standard and the Safety Assurance process outlined in **Section 5.1.5.1**. For each hazard identified in the PHA (Preliminary Hazard Analysis), Alstom will submit proof that the Ottawa Vehicle complies with the safety target.

Safety Analyses

The subsystems or equipment liable to create events identified in the PHA will undergo detailed analyses, conducted in accordance with at least one of the following methods:

- **Fault Tree Analysis taking into consideration the different events** - A deductive method starting from a single and well identified event, leading to basic events that are each independent and amenable to calculation of their probabilities (e.g. breakdowns, human mistakes, external conditions).

- **FMECA (Failure Mode Effects and Criticality Analysis)** - An inductive method whereby, starting from the exact definition of the functions of a device or assembly, one can systematically seek out the failure modes and their consequences or effects on the Citadis set.

These analyses will demonstrate that the steps taken to deal with risks are or will be set up to reduce the probabilities of occurrence related to the events in categories of gravity 3 and 4 to a negligible level. These analyses will be entered in the "rolling stock safety level justification file". The steps needed to deal with risks may consist of the following:

- Structural provisions
- Functional provisions
- Provisions related to the detection of the failures
- Provisions related to standards
- Calculations
- Tests
- Quality procedures
- Maintenance procedures
- Operating rules

Corrective action will be taken if results do not meet objectives. Examples of safety hazards considered are as follows:

- Loss of command of Emergency Brake
- Insufficient Emergency braking effort
- Propulsion fails to cease when Emergency Brake is requested
- Train moves in wrong direction
- Door opens spontaneously when not commanded
- Door opens on wrong side of car
- Excessive currents or overheated equipment cause fire hazard
- Train moving when doors are not closed and locked
- Cars in Train separate when not commanded
- Indication of uncoupled when not uncoupled

Synthesis of Safety Analyses

Safety-Critical Item List

The safety level concerns all equipment which requires safety analysis during the Project by the Alstom RAMS team. The Engineering Department is in charge of designing these assemblies and validating them by using calculations or design principles (in accordance with the normative documents). Safety analyses are performed to verify the design.

Safety levels are attributed during the design phase by the safety department for the equipment being considered. The safety level of an assembly corresponds to the consequences of the rupture of a single component of the assembly in relation to its effects on people, the equipment and the environment. The classification of safety levels used for the design, whether screwed or welded assembly, is as follows:

- **Level 1 – High:** The rupture of the assembly leads to physical injury and global failure of the assembled system. => Disastrous level
- **Level 2 – Moderate:** The rupture of the assembly affects global operation of the system or may have consequences involving physical injury. => Critical and significant level
- **Level 3 – Low:** The rupture of the assembly does not directly affect the global operation. Consequences involving physical injury are highly improbable. => Minimal level

Safety Synthesis File Justifying the Safety Level of the Rolling Stock

The file justifying the safety level of the rolling stock consists of all safety notes relating to analysis of the events included in categories of gravity 1, as follows:

- An overall description of the event and the associated subsystems
- A qualitative and/or quantitative analysis of the event grouping together the structural provisions, the quality links, the operational surveillance systems and the requirements during operation and maintenance

Requirements for Safety during Operation (Line and Maintenance)

"Requirements for safety in operation" is the outcome of the safety analyses, bringing together all the customary maintenance and operating requirements needed for preserving safety. This document takes into consideration the conditions affecting safety and requiring application of one or several logistics actions to preserve safety.

Analysis of Test Plans

The objective of this task is to check that the requirements and recommendations resulting from safety analyses concerning the tests to be performed have been taken into consideration.

Analysis of Procedure for Application of Modifications

Following an encoded modification in design, a procedure is set up for applying these modifications. The objective of safety is to check that the proposed modifications in accordance with this procedure comply with safety requirements.

Safety File

The safety file consists of all documents describing the steps taken to deal with risks and/or those demonstrating for a given subject that the risk studied has been eliminated or controlled.

Winterization Measures

Due to Ottawa's extreme climate, some winterization solutions will be implemented on the OLRT Vehicle. Adaptation will be concentrated in two main areas:

- Ensure Passenger and Driver safety and comfort
- Ensure proper operation of rolling stock

The solutions implemented on the OLRT will be based on the following:

- Alstom's extensive experience in manufacturing vehicles for environments with heavy snow and extreme cold conditions (e.g. Citadis for Grenoble, X40 Train for Sweden, Helsinki-Saint Petersburg high-speed tilting Train, Moscow tramway, EP 20 and 2ES5 locomotives for Russia, KZ8A and KZ4AT locomotives for Kazakhstan)
- The future European Norm PrEN16251 - Railway Application – Environmental conditions - design and test of rolling stock under severe conditions

The extreme cold climate related issues are the following:

- **Extreme cold temperature** - This will affect material mechanical characteristics; reliability of electronic, pneumatic and hydraulic equipment; thermal comfort, and cold surfaces in Passenger area.
- **Snow** – This will impact filtration at air intake, roof and underframe accumulation, presence on track, and visibility.
- **Ice formation** - Main issues linked to ice formation are improper operation of unprotected moving parts such as doors or pantograph; risk of impact of ice blocks on underframe equipment wiring; and slippery conditions for Passengers.

- **Ice/snow removal** - Presence of salt, glycol or other products used to deal with snow on roads, walkways or rolling stock in the environment will be taken into account in the design of the LRV (risk of corrosion or chemical attack).
- **Condensation** - Condensation will impact interior comfort conditions, visibility, increase risk of corrosion, affect proper operation of electronic component and affect equipment's life expectancy. Particular care will be taken to deal with the 58°C thermal shock.

Winterization will be addressed at the Train level. Product adaptation linked with winterization will be validated by specific tests, at Train and sub-system level, as suggested by the PrEN16251 - Railway Application – Environmental conditions - design and test of rolling stock under severe conditions.

Based on operational experience from the Edmonton and Toronto LRT systems, during periods of extreme cold temperature (below -25°C), Trains will be parked either in a heated area (MSF), outside under catenary power, or outside without catenary power. Vehicle winterization measures will support each of these operational strategies.

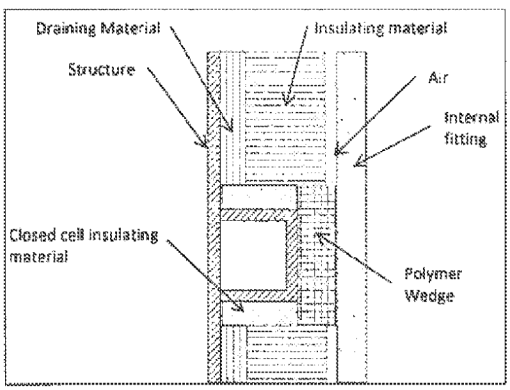
Solutions to Ensure Passenger Safety and Comfort

Thermal insulation of Passenger compartment and Driver's cab. To ensure that temperature remains comfortable and homogeneous inside the Train in the most extreme conditions (hot or cold), thermal insulation is key. It serves three main purposes:

- Ensuring homogeneous temperature through the Passenger compartment
- Preventing Passengers from contacting cold and/or wet surfaces
- Reducing the energy needed to heat-up or cool down the Vehicle

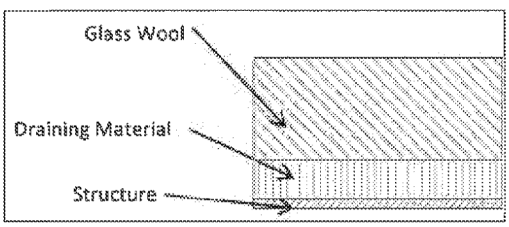
Insulating material will be used on walls, ceiling and floor of the Passenger compartment and the thermal coefficient will be increased to meet OLRT specifications for thermal comfort. The wall and roof insulation will consist of the following:

- A multilayer acetate celluloid insulating material to drain condensation water
- A layer of self-adhesive insulation material



In areas where structure could come in contact with the internal fitting wall, particular care is taken to prevent thermal bridges between the structure and the material accessible to Passengers, by using a combination of the following:

- A thermal and water vapour barrier made of a closed-cell insulating material
- Polymer wedges between steel structure and interior paneling



Floor insulation will be achieved by superposition of the following:

- A multilayer acetate celluloid insulating material to drain condensation water
- A layer of glass wool with a protective skin

Most floor insulation will be incorporated in the floor structure.

Safety of Passenger access. To reduce risk of slipping, heating will be located at floor level to prevent snow or ice accumulation. Door thresholds will be heated to prevent ice and snow accumulation in this sensitive area.

Passenger compartment heating. To provide thermal comfort performance required by the ORLT specification, heating will be provided by the roof-mounted HVAC unit, and heated air will be provided to the Passenger compartment through an air diffuser located on the ceiling and at floor level. Where required, heaters and a heating floor will provide additional heating.

Door adaptation to cold climate. Freezing rain in the Ottawa region will cause the formation of an ice layer on the Train car-body. To ensure proper operation of the doors in extreme cold conditions, the power of the motor actuators will be reinforced, thus allowing the actuator to open the door in case of ice formation around the door area on the Vehicle side. Additionally, the following door-operating mode will be proposed to the City for extreme cold conditions:

- **For an outside stop** - Door will only open when requested by a Passenger through a push button located inside or outside the door. This will prevent cold air from entering the Vehicle if no Passenger needs to get in or out of the Vehicle, thus increasing overall Passenger comfort.
- **For a stop in tunnel** - All platform side doors will open to ensure every door on the Train is open at least three times per round trip, thus preventing significant accretion of freezing rain on the door.

Door-edge elastomeric gasket will be adapted to -38°C operation.

Ensure proper braking performances of the Train. The Vehicle will be equipped with a state-of-the-art wheel slip/slide protection system as described in the braking equipment section of this section of the Response. Sanders and sand-boxes will be heated to prevent ice clogging the sand ejector circuit, thus ensuring functionality in cold weather and snowy conditions.

Solutions to Ensure Proper Vehicle Operation

Door adaptation to cold climate. The following measures will be taken to mitigate the effects of condensation on Vehicle components:

- Structural elements will be hermetically sealed or will contain drainage holes of at least 20 mm located to prevent condensation water from accumulating and freezing inside the structure. Drainage holes will be located to prevent water projection on sensitive equipment.
- External equipment will contain provisions (e.g. insulation, drainage holes) to reduce thermal shock and/or evacuate condensation water.
- A global draining frame will be located inside the Train to evacuate condensation water.
- Humidity resistance of electrical and electronic apparatus will be reinforced (e.g. use of specific varnish on electronic boards).

Material selection. All material used on the Train (including oil, grease, rubbers, plastics) will be selected and tested to ensure performance in Ottawa's extreme cold conditions. Particular care will be taken for subsystems located outside the car body such as the flange lubrication system, lubrication of truck components (bearings, gear-box), and rubber mounts.

Particular care will also be taken during design in locations when different materials will be used (for example steel/aluminium interface). In these areas, differential contraction values will be taken into consideration during the design process. Properties of all materials used in the Vehicle design will be validated by test at -38°C, including glues and joints. For all external components, material will be selected to ensure mechanical and chemical resistance to de-icing method used by the operator (glycol, steam). The salt used on regular roadways will also be taken into account as necessary.

Solutions to deal with snow accumulation. External panels and components will be designed to reduce snow accumulation on the roof. Particular care will be taken to prevent snow accumulation and/or to allow proper snow evacuation around the pantograph. The design will allow for evacuation of water coming from melted snow or ice. Air

outlets will be designed to reduce the risk of "melting then freezing" around sensitive devices (pantograph). The full low-floor architecture does not allow sufficient room for significant snow accumulation in the truck area.

Protection against ice impacts. When necessary, screens and covers will be used to protect under-frame equipment, wiring and connectors from ice impacts. Components will be located to minimize exposure. In areas where protection screens cannot be installed (area around truck), the frame will be protected against impact by a protective coating.

Removal of snow on track. A snow plough will be mounted under the cabin and designed according to the operating principle used on the ORLT network (removal of major snow accumulation by use of dedicated vehicle or by revenue service vehicles).

Optimization of air inlet and outlet. The air inlet will be positioned and sized so that snow accumulation in any part of the Vehicle cannot obstruct an air intake. As much as possible, the air intake will be located as high as practically feasible in regards of the surface where snow can accumulate, and its shape will be designed to minimize the risk of complete obstruction (i.e. air inlet will be shaped to favour height over width).

Adapt pantograph to deal with snow accumulation on catenary. Pantograph raising and lowering will be done electrically. To ensure a good electrical contact between the pantograph and the catenary, the proposed pantograph will be fitted with an ice scraper that will remove ice from the catenary.

Adapt coupler to presence of snow and ice. Heated coupler faces will be used to prevent accumulation of ice and snow. When folded, the coupler will be protected from external pollution such as snow, ice, dust and salt.

Validation

All the proposed solutions, whether they are at the component or Train level, will be revalidated in the OLRT context. At sub-system level:

- Validation will be run at component level with our internal and external suppliers
- When required, specific mock-up will be built to reflect the actual OLRT environment

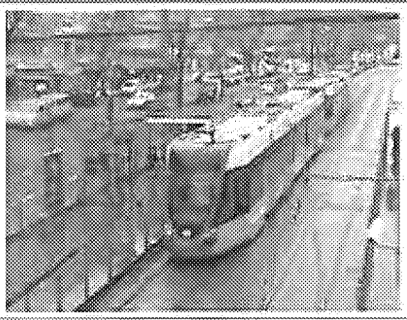
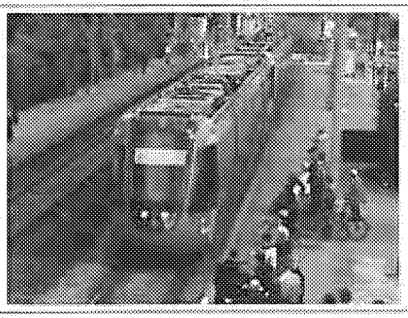
At the Vehicle level:

- Design adaptations linked with Vehicle winterization will be validated on the Train. When applicable, test procedures will be based on the recommendations of the PrEN16251.
- Train-level performance will be validated under the severe conditions described in the OLRT specification. Depending on the test, it can be run in one of the following climatic chambers:
  - In North America: in the Alstom facility in Hornell, NY or in the NRC facility in Ottawa
  - In Europe: in the Alstom facility in La Rochelle (France) and Vienna (Austria)

5.4.3.3 Service History of Proposed Vehicle

As described in **Table 5.4-9**, the existing Vehicles are substantially compliant with the four parts of the PA Schedule 15-1 definition of a *Service Proven Vehicle*.

Table 5.4-9 | Service History

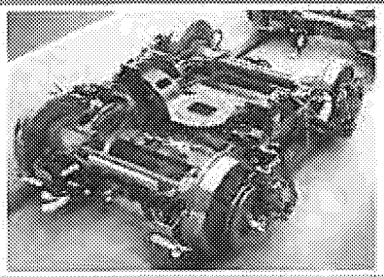
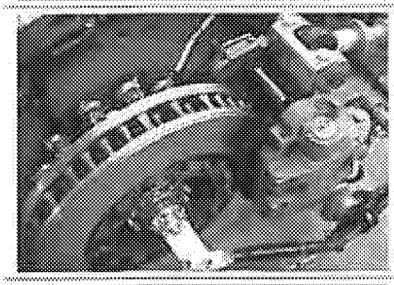
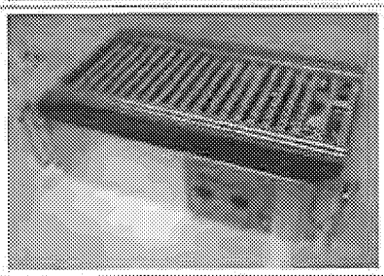
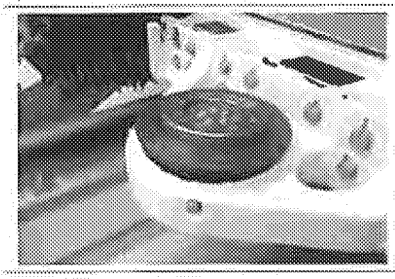
Vehicle	Service History
	**Istanbul Citadis** ■ 37 vehicles in service ■ System opened December 2010 ■ Operating Speed: 70 km/h ■ Operation in multiple unit of two vehicles ■ 120s minimum headway ■ 19.5 km line ■ 14,000 PPHPD at peak hour
	**SNCF Nantes Citadis** ■ 7 vehicles with 12 months of service ■ Operating Speed: 100 km/h ■ Operation in single and multiple units of up to three vehicles ■ Operated as a suburban Train ■ 26.5 km line ■ Only Full low-floor LRT running at 100km/h

As summarized in **Table 5.4-9**, all OLRT Vehicle subsystems are service-proven on both Istanbul and SNCF Citadis.

The Citadis vehicle has been operating worldwide since 1997 with more than 1500 LRVs in service. Alstom's experience in cold climates has been described in **Section 5.4.3.2**. Many of the Vehicles, including Istanbul, are operating in hot climates. The in-service MDBF of the Istanbul is as follows, with failures being defined as malfunctions causing Revenue Service delays of 4 minutes or more:

- Target MDBTD on Istanbul = 130,000 km
- Achieved MDBTD after 14 month = 575,000 km
- Target MDBTD on Ottawa LRT = 50,000 km

Table 5.4-10 / Vehicle Subsystems

Vehicle Component	Service History
	**IXEGE Truck** ■ Most recent Citadis truck generation specially designed for high comfort, 100% low-floor and 100 kph operation ■ This truck is pivoting and fitted with solid axle ■ Truck layout drawing is provided in Cut Sheet 5.4.1-CS-208
	**Hydraulic braking system** ■ Alstom has developed two alternative and interchangeable solutions for the Citadis family: - Faiveley system is mounted on Istanbul - Knorr system is mounted on SNCF Nantes ■ Drawings for Nantes brake system are provided in Cut Sheets 5.4.1-CS-201 to 5.4.1-CS-207
	**ONIX Propulsion system** ■ Alstom ONIX IGTB technology + Alstom AGATE control unit is the standard Alstom traction system ■ Equip all Citadis LRV
	**Articulation joint** ■ Standard and proven-design Citadis solution is installed on both Istanbul and SNCF Citadis

5.4.3.4 Experience with Consist Arrangements

Citadis is a modular product. The Citadis range is based on service-proven modules and subsystems assembled together to meet the client need precisely. Alstom has experience with coupling long consists and will design the OLRT Vehicles to account for the requirements for structural strength, pushing and towing, coupler structural strength, resistance losses for instance, as further described in Section 5.4.3.21.

Figure 5.4-6 | Vehicle Consist Modularity

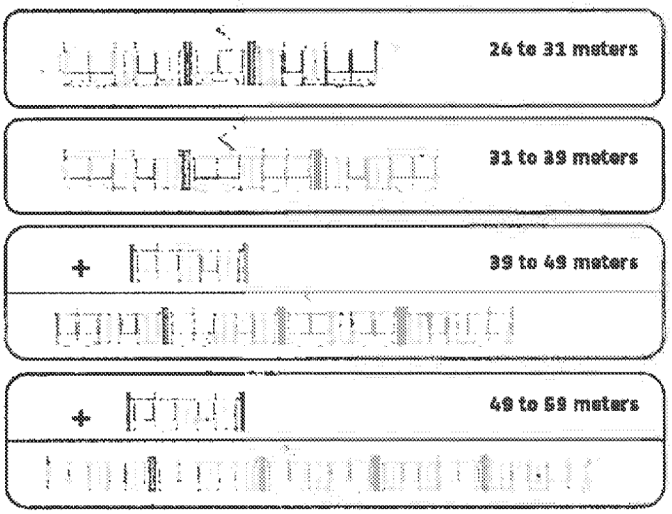
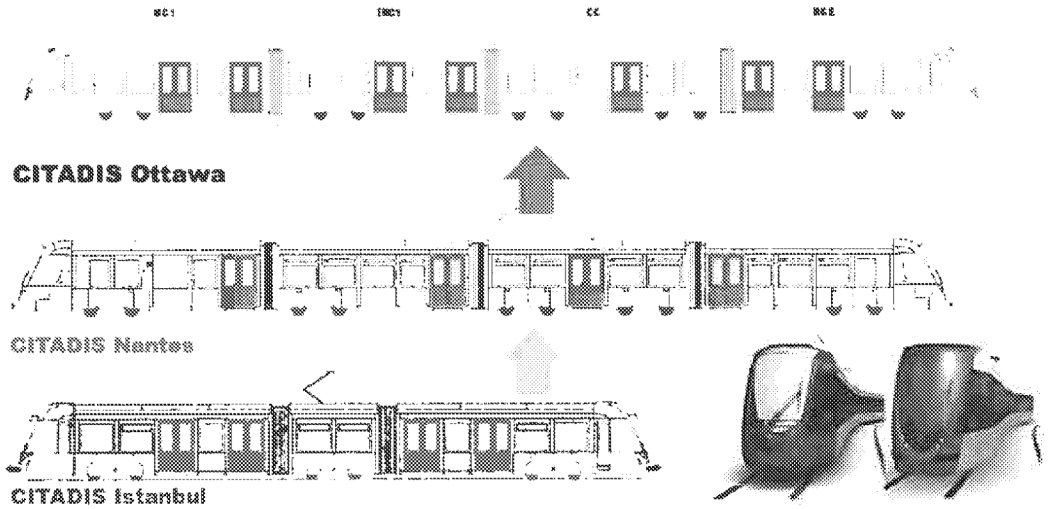


Figure 5.4-6 illustrates the Vehicle consist modularity principle of the Citadis range fitted with pivoting trucks. Ottawa's Vehicle will be an evolution of SNCF Nantes Citadis and specific design modifications are, therefore, not required.

Train consist and architecture is similar but the carbody shells are slightly extended for Ottawa, to comply with ridership and door arrangement expectations. Particular attention has been paid to comply with truck axle weight limitation and minimum radius curves.

The Citadis Nantes is operated daily in multiple units of 2 or 3 Vehicles for a maximum Train length of 126m. As shown in **Figure 5.4-7**, the typical proposed OLRT Train will be a multiple unit of two 49 m Vehicles for a maximum Train length of 98 m. Based on our experience with long Train consists, the maximum Train length in normal operation (2-Vehicle Train) as well as during rescue missions (one 2-Vehicle Train towing another) is taken into account in the design of the Train (e.g. structural strength car-body and coupler, Train line design for losses due to Train length and coupler passage).

Figure 5.4-7 | Train Consists



5.4.3.5 Testing

List of Tests

Serial Tests

The serial tests are tests performed on each Vehicle to confirm, by simplified tests, that the main performance levels checked by the type test are effectively reproduced. The serial tests, performed on the series sub-assemblies and parts of the Vehicles, are aimed at verifying the main characteristics of the concerned sub-assemblies and parts; these can be systematic or statistical.

Static Serial Tests

All tests necessary to prove proper functionality of the Vehicle will be performed:

- Current return circuits and protection circuits tests
- Dielectric strength and insulation of all 1500 V and low voltage circuits
- LV functional tests (e.g. exterior signaling and lighting circuits, Driver's cab)
- HV static tests including auxiliary supply
- Door functional tests
- Ventilation and heating tests
- Traction – braking static tests
- Brake system and hydraulic circuits tests
- Passenger information and CCTV tests
- Interface with Train control system tests.

Dynamic Serial Tests

For each Vehicle, the dynamic performance will be tested to prove that the City's requirements are fulfilled:

- Geometric checks
- Weighing of Vehicles
- Water tightness check of complete Vehicle
- Wheel flange lubrication and sanding system tests
- Safety devices tests
- Door functional tests
- Traction functional check
- Braking functional and performance tests

Type Tests

To ensure the City's complete satisfaction, Alstom will set up a Validation Type Test plan, to demonstrate compliance with the technical specification as well as the legal requirements.

The validation strategy will cover the full range of activities from component validation, through Vehicle integration testing, functional static and dynamic type tests, as well as dynamic performance type tests to Vehicle integration testing in Ottawa. Type tests are performed on new items, or new sub-systems. A type test proves that the specified contractual performance and functional requirement has been achieved. Validation activities will be structured in the following sequences:

- Design Phase
- Component Validation
- Integration Testing
- Functional and Performance static Validation
- Dynamic Performance Validation
- On-site Integration tests

Alstom has incorporated in its quality system the requirements set forth in the EN 17025 "General Requirements for the Competence of Testing and Calibration Laboratories. For the main system integration, accredited test laboratories will be used.

Design Phase

During the design phase the Validation team will prepare the Validation Plan, identifying the main verification and test activities of the Vehicle and the Train, and draft the test procedures. The main input for the validation plan will be the IEC 61133 "Railway applications – Rolling stock - Testing of Rolling stock on completion of construction and before entry into service" and the technical specification requirements that need a test to demonstrate Vehicle and Train compliance.

On the basis of a gap analyses with the reference solution, a FMECA-based critical risk analysis will define the depth of the validation activity – need for specific design reviews, simulations, mock ups or test. The Validation Plan will be refined throughout the design reviews of the specific subsystems.

Component Validation

During the testing phase the Validation team will work with the different subsystem suppliers and internal subsystem experts, to prepare component type tests, and participate in testing critical systems, i.e. doors, traction, brake, bogies, and Train Control and Monitoring System (TCMS).

A significant component validation test will be the static car-shell structure test, performed at Alstom's Valenciennes site. During this test, the car body will be outfitted with strain gauges and all the main structural tests, as defined in EN 12663, will be performed.

Integration Testing

Integration of the different equipment and subsystems will be tested with their suppliers during the initial integration of the first Vehicle. To prepare this phase, a functional integration test bench will be used to validate the functional design including vehicle low voltage, TCMS logic and subsystem control logics. The functional integration test bench will incorporate at least one electronic unit of each type under test while the others, as well as their environment, may be simulated. The test bench will be used for functional validation in single mode Vehicle use as well as multiple-unit Train.

Functional and Performance Static Validation

Complementary to the functional integration test bench, static functional test will be performed in Vehicle (single unit) and Train (multiple unit) configuration. Static performances such as battery autonomy, lighting levels, and acoustic levels will be measured. ODA compliance will also be tested at this stage.

To demonstrate Vehicle performance under winter conditions, tests will be performed under extreme temperatures, and under winter conditions, in a climate chamber. During this test the important systems such as the brake system, air supply, and door system will be tested.

Dynamic Performance Validation

Dynamic traction and braking performances will be tuned and tested on a test track in France, prior to testing on-site in Ottawa. The program will focus on the different braking modes in nominal and degraded mode in several load cases as well as testing with degraded adhesion. The dynamic performances will be performed in Vehicle (single unit) mode. The Train (multiple unit) configuration testing will demonstrate a smooth operation without performing braking performance tests. During this phase, the ability to rescue a Train with another Train will also be tested.

On-Site Integration Tests

The on-site integration test will focus on tests requiring either the final interfaces or localizations. This testing will include: dynamic gauge, bogie stability and comfort, EMC, dynamic noise, the correct localization of Passenger announcements, radio and Vehicle/ground communication.

Test Results from Equivalent Vehicles

Even though most components are service proven, most type tests at Train level will need to be performed for the specific Ottawa Train configuration and operation interfaces. However, the component type tests performed for existing Citadis will be used as a reference and will be supplied.

Available applicable Test Result reports from Nantes Citadis (**Reports 5.4.1.A-TR-101 to 5.4.1.A-TR-119**) are listed in **Table 5.4-11A** below. Please see applicable test reports.

**Please Note: Due to the length of test results, the following reports have been submitted in electronic format only.*

Table 5.4-11A | Available Test Reports

Reference Number	Type	Report Name	Entitled Report Title
5.4.1.A-TR-101	Testing	TEST REPORT TRAM-TRAIN NEW GENERATION WINDSHIELD	RAPPORT D'ESSAIS Tram-Train Nouvelle Génération ▪ Pare Brise
5.4.1.A-TR-102	Testing	TYPE TEST REPORT CDRL 7-08 AUXILIARY CONVERTER FOR CITADIS OPTIONS 7, 9, 11, 12, 13, AND 16	
5.4.1.A-TR-103	Testing	TEST REPORT TRAM-TRAIN NEW GENERATION ALSTOM BRAKING PERFORMANCE ON FRENCH NATIONAL RAILWAYS	RAPPORT D'ESSAI TRAM-TRAIN NOUVELLE GENERATION ALSTOM PERFORMANCES DE FREINAGE SUR RFN
5.4.1.A-TR-104	Testing	TYPE TEST PROJECT TTNG SWIVELLING AND SLIDING DOOR WITH 2 PANELS AND STEP	Essai de type – projet TTNG Porte louvoyante coulissante à 2 vantaux & marche
5.4.1.A-TR-105	Testing	TEST REPORT ACOUSTIC SPECIFICATIONS	EXIGENCES ACOUSTIQUES AU CAHIER DES CHARGES
5.4.1.A-TR-106	Testing	CITADIS 35 kW TTNG PROJECT QULIFICATION TESTS	
5.4.1.A-TR-107	Testing	TYPE TEST REPORT MEASURES OF ILLUMINATION/LIGHTING	Measures de l'éclairement
5.4.1.A-TR-108	Testing	▪ TYPE TEST REPORT ▪ SANDING	▪ Sablage
5.4.1.A-TR-109	Testing	▪ TYPE TEST REPORT ▪ NVR, CAMERA AND EMB	

Reference Number	Type	Report Name	Entitled Report Title
5.4.1.A-TR-110	Testing	▪ TYPE TEST REPORT ▪ VEHICLE MEDIA CONTROLLER – 4T	
5.4.1.A-TR-111	Testing	▪ TYPE TEST REPORT ▪ INTERNAL LED DISPLAY	
5.4.1.A-TR-112	Testing	▪ TYPE TEST REPORT ▪ INTERNET ONBOARD SYSTEM	Système Internet on bord Rapport d'essais de type
5.4.1.A-TR-113	Testing	▪ TYPE TEST REPORT ▪ 6U PA PACK	
5.4.1.A-TR-114	Testing	▪ TYPE TEST REPORT ▪ SURVEILLANCE CAMERA (IP)	Caméra IP Rapport d'essais de type
5.4.1.A-TR-115	Testing	▪ TYPE TEST REPORT ▪ RACK CCTV ▪ NVR/EBM/WIFI	Rack CCTV - NVR / EBM / WIFI Rapport d'essais de type
5.4.1.A-TR-116	Testing	▪ TYPE TEST REPORT ▪ BREAKER	▪ Disjoncteur Arc 1520 M
5.4.1.A-TR-117	Testing	▪ TYPE TEST REPORT ▪ BRAKING RESISTANCE ▪ AIR COOLED	▪ Rapport d'essais de type ▪ Résistance de freinage à ventilation naturelle ▪ TTNG
5.4.1.A-TR-118	Testing	▪ IMPACT SIMULATION FOR ALSTOM ▪ PROJECT TTNG/FRANCE ▪ AUTOMATIC COUPLER ▪ TYPE SD330	
5.4.1.A-TR-119	Testing	▪ STATIC TESTS ▪ EXTRACT FROM STANDARD NF F 31-119 ▪ RAILWAY ROLLING STOCK ▪ BEHAVIOUR OF ROLLING STOCK'S SEATS AT STATICS STRESS, ▪ FATIGUE STRESS, VIBRATIONS STRESS AND SHOCKS STRESS	▪ Extrait de la norme NF F 31-119
5.4.1.A-TR-201	Car Body	▪ STATIC RESISTANCE TEST OF ▪ CAR BODY STRUCTURE ▪ TTNG	▪ Essais Statiques De Resistance De Structure ▪ Sur Chaudrons De Caisses TTNG De Fabrication ▪ Alstom

Reference Number	Type	Report Name	Entitled Report Title
5.4.1.A-TR-202	Car Body	▪ DESIGN NOTES ▪ CAR BODY STATIC AND FATIGUE DESIGN ▪ CALCULATIONS ▪ CEx WITH 2 DOORS PER SIDE	▪ CALCULS EN STATIQUE DE LA ▪ STRUCTURE DE CAISSE CEx ▪ AVEC 2 PORTES PAR FACE
5.4.1.A-TR-203	Car Body	▪ DESIGN NOTES ▪ CAR BODY STATIC AND FATIGUE DESIGN ▪ CALCULATIONS – CX	▪ CALCULS EN STATIQUE ET EN ▪ FATIGUE DE LA STRUCTURE DE ▪ CAISSE Cx
5.4.1.A-TR-204	Car Body	▪ DESIGN NOTES ▪ CAR BODY STATIC AND FATIGUE DESIGN ▪ CALCULATIONS – C2B	▪ CALCULS EN STATIQUE ET EN ▪ FATIGUE DE LA STRUCTURE DE ▪ CAISSE C2B
5.4.1.A-TR-301	Crash	▪ DESIGN NOTES ▪ CRASH TESTS REFERENCE SIMULATIONS	▪ Simulations des collisions de référence
5.4.1.A-TR-302	Crash	▪ REGISTRATION OF CRASH TEST	▪ Recalage de l'essai collision cabine
5.4.1.A-TR-303	Crash	▪ TEST REPORT ▪ CRASH TEST LEVEL 1 ON CABIN	▪ Essais de collision échelle 1 ▪ sur la cabine TTNG ▪ RAPPORT ▪ D'ESSAI
5.4.1.A-TR-401	Thermal Load	▪ CITADIS OTTAWA ▪ HVAC THERMAL LOAD CALCULATION	

Table 5.4-11B lists component-type tests and Train-type tests.

Table 5.4-11B | Component Type Tests and Train Type Tests

Validation Activity	Test on Equivalent Vehicle	Test on Proposed Vehicle
Component Type Test		
Windscreen Performances	●	
Bogie System	●	●
Winterization/Climatic Adaptation	●	●
Aux: Auxiliary Supply	●	
Brakes	●	
Doors	●	
Horn	●	

Validation Activity	Test on Equivalent Vehicle	Test on Proposed Vehicle
HVAC	●	
Internal Lighting	●	
Sanding	●	
PA/PIS	●	
Signaling Interface		●
TCMS	●	
Main Circuit Breaker	●	
Traction Converter		●
Braking Resistor	●	
Motor		●
Carbody Shell	●	●
Automatic Coupler	●	
Seats	●	
Interiors		●
Smoke Detector		●
Train Type Test		
Resistance to Motion		●
Dimensional and Gauge		●
EMC: Electromagnetic Compatibility		●
Acoustics/Noise		●
Railway Dynamics		●
Weight Management and Allocations		●
Winterization/Climatic Adaptation		●
Aux: Auxiliary Supply		●
Break		●
Doors		●
Horn and End Lights		●
HVAC		●
Internal Lighting		●
Sanding		●
PA/PIS		●
Signaling Interface		●

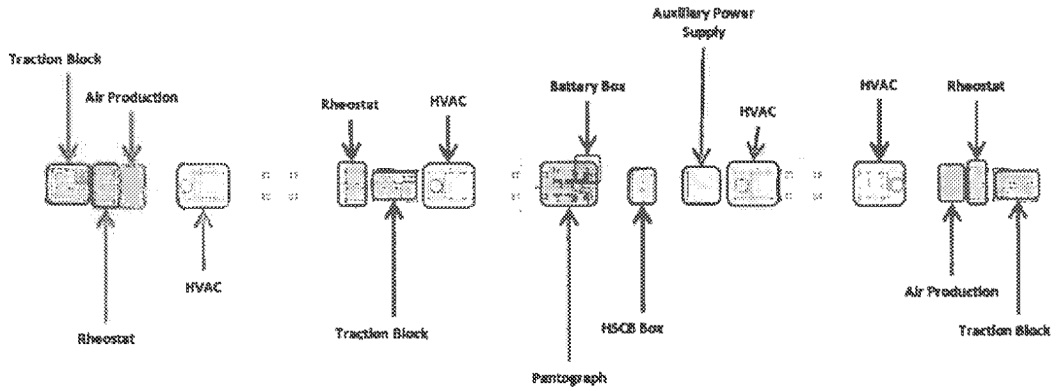
Validation Activity	Test on Equivalent Vehicle	Test on Proposed Vehicle
TCMS		●
Traction		●
Safety Earthing (grounding)		●
Fire Protection System		●
Train: Journey Time		●

5.4.3.6 Preliminary Drawings & Electrical Subsystem Schematics

Roof Equipment

Figure 5.4-8 shows our proposed distribution of roof equipment on the proposed OLRT Vehicle.

Figure 5.4-8 | Roof Equipment



The Vehicle's high-voltage architecture is shown in the Traction Block Diagram (**Cut Sheet 5.4.1-CS-901**):

- The power supply (see 1 on the diagram) collected by the bi-directional pantograph
- The lightning arrester (2), protecting the high-voltage equipment against over-voltages
- The circuit-breaker box containing:
  - The ultra-fast circuit-breaker (3) protecting and isolating the traction chain
  - The HV presence indicator
  - The auxiliary protection fuse

All equipment listed above is located on the CC car (see **Figure 5.4-8**).

The power is then distributed to the various power blocks located on the MC1, IMC1 and MC2 cars and the Auxiliary power supply located on the CC car.

Traction Block Control Unit

The traction block contains the following apparatus (see **Cut Sheet 5.4.1-CS-901**):

- Pre-charge circuit (6 and 7)
- Line inductor (8)
- Rheostatic chopper (12)
- Filter capacitor (11)
- A traction inverter (14) driving the two associated three-phase induction motors (18.1 and 18.2) located on the motor truck
- Associated current sensors (17)
- The rheostatic grids (13) are located on the roof next to the traction box

Return Current

The return current scheme has been designed to provide redundant paths to return current safely to the rail in a manner that protects bearings while reducing interference to wayside equipment. Resilient wheels are provided with four shunt straps between the wheel hub and the rim.

Auxiliary Power

The redundant auxiliary converters (see architecture and layout drawing in **Cut Sheets 5.4.1-CS-401 to 5.4.1-CS-405**) deliver different types of power output to operate the various on-board systems and devices:

- 28.5 Volts dc that supplies all LV equipment (on-board CBTC, Train lights, rear facing cameras, Passenger saloons' normal and emergency lighting, Train Control and Monitoring System, track brakes, door motors, windscreen wiper, battery charger)
- 480 V 60 Hz, three-phase, fixed frequency that supplies the Driver's cabin heater, saloon heaters and air compressors
- 480 V 60 Hz three-phase with variable frequency from 45 Hz to 60 Hz (U/f constant) that supplies the compartment HVAC units

Alstom's auxiliary power design complies with the redundancy requirements of the PA. In the case of failure of one auxiliary converters all loads and limited battery charging shall be maintained. Upon complete failure of auxiliary converters or loss of the OHL voltage, the two 28.5 Vdc batteries provide back-up power supply to critical loads for up to 90 minutes. In normal operation the battery chargers charge the batteries to ensure that they are kept at full load all the time.

All auxiliary loads (ac and dc) are circuit breaker protected. All circuit breakers are available from the cab compartment.

Batteries

The nickel-cadmium batteries, charged by the static converters deliver the following:

- Energy for low-voltage circuits (e.g. track brakes)
- Emergency loads
- Various devices (e.g. pantograph motor, windshield wiper motor)

The battery capacity was calculated taking the following design criteria into account:

- Restart the LRV after 48 hours in the stabling yard with the parking lights turned on
- Supply essential loads in operation following a loss of power for 90 minutes
- Supply energy in stabling for at least 3 hours

Depot Supply Sockets

When the batteries are discharged, they can be recharged by an external source through dedicated sockets. These sockets are located on the low-voltage control box on the MC2 section roof near the battery box.

This operation must be carried out when the Train is in sleep mode and the battery isolated from the 28.5 V Train network. The battery is isolated from the Train by means of the battery isolation switch and is then connected directly to the socket. Connection of this socket to an external charger then enables the battery to be recharged. Note that it is not possible to power Train equipment via this charging socket.

5.4.3.7 Industrial Design Representations

Alstom has long established a global reputation for know-how in transportation solutions. Unique for the railway industry, the Design & Styling department was created in 2005 to meet the needs of today's railway customers and guarantees quality results.



With a dual role in the engineering and manufacturing of rail vehicles and infrastructure, Alstom has established its own dedicated Design & Styling (D&S) department, comprising 20 designers dedicated to the full spectrum of railway products, from streetcars to very high-speed Trains. This multi-disciplinary approach allows us to create innovative designs that meet clients' aesthetic and performance expectations, while respecting the general configuration of the vehicle under development.

The department's cross-functional organization is adapted to meet the specific needs of rail transport markets:

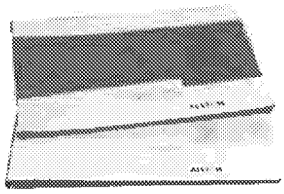
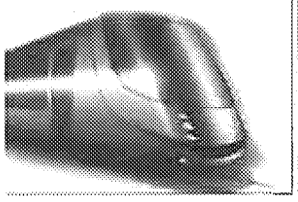
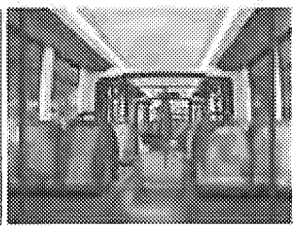
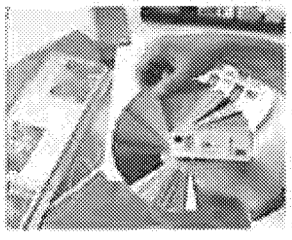
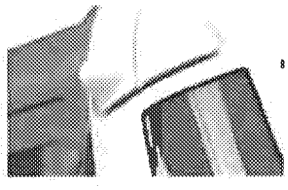
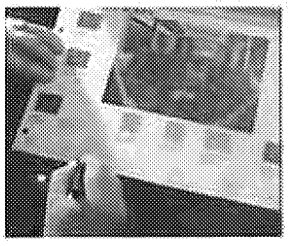
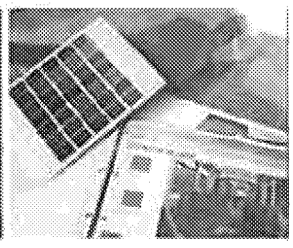
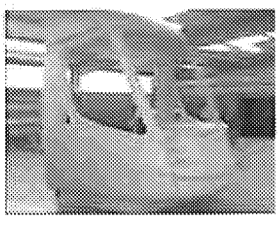
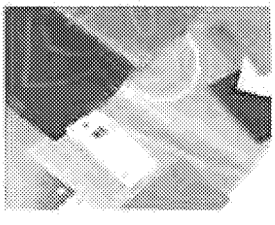
- Consolidating competencies in design, digital modelling, colours, materials, and lighting
- Benefiting from the knowledge of a network of industrial design experts in different regions
- Stimulating the creative process and producing designs suited to each client's cultural context
- Meeting design expectations for the entire range of Alstom Passenger Trains, from urban to main line Trains

With more than 100 successful projects completed, the process encourages customer input, creates a common vision and identifies and integrates the efforts of potential project partners. In the past, D&S has worked with civil contractors including Systra, Impresa Pizzarotti, Isolux Corsan; and international architects including Dubus Richez, BillingsJacksonDesign, RKD architects, Cepezed.

Our highly collaborative approach to design actively involves the client and key stakeholders. Working with each city's branding process, the D&S department analyzes the cultural, economic, political and geographical context of the project. This is summarized through photo reports and keywords. The objective is to define the artistic theme which will be used as a connecting thread for creation throughout the project.

A unique competitive advantage of our modular product configuration is that the front end and interior arrangement can be customized and become a critical component of the brand. The D&S department will propose various versions of shapes for the interior and exterior, colours and trims in support of the final branding approach.

Alstom has laid out a collaborative design process that guarantees quality results. The objective of this process is to develop a product that fully satisfies all stakeholders and results in production of a full scale mock-up. As soon as the mock-up is accepted by the City, it will be sent to Ottawa and made available for community and Stakeholder programs.

Preliminary Meeting

After the notice to proceed, Alstom meets with city representatives to gather input regarding requirements.

Pre-Choice Meeting

New proposals based on information collected through preliminary meeting are presented. Selection of these proposals serves as a departure point for shape definition, colour schemes, graphic lines and materials.

Choice meeting

The shape, colour and graphic line of a Train car is further determined with 3D software. Virtual images allow customers to get a feel of the object from different angles. It is also a way to confirm the details and options agreed upon previously.

Freeze of options

Customers sign off to 80% of their preferences. This marks the beginning of the manufacturing phase for products related to styling and design. The shapes, colours and materials chosen are specified at this stage. Alstom then submits a life-size impression of the graphic line for approval by the client.

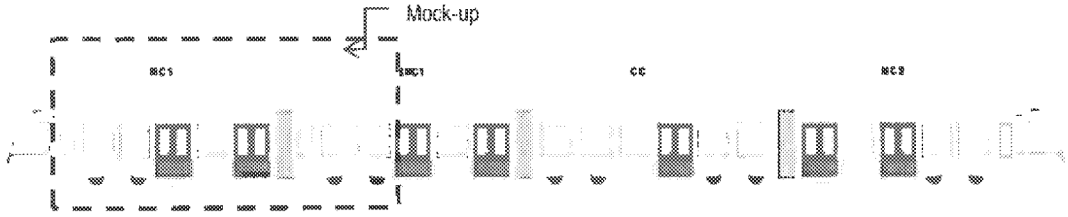
Working mock-up

Customers can see working mock-ups of components such as the front-end cab or seating, among others. The mock-ups represent 90% of the design choices made. This step is optional, but highly recommended. Clients see factory samples to check for colours, patterns and trims.

Representative Mock-up

The representative mock-up is an accurate model of the future Vehicle unit. All specifications may be reflected in the mock-up, from front-end cab design to the colours and trimmings inside. The mock-up proposed for OLRT will consist of a section as shown in **Figure 5.4-9**.

Figure 5.4-9 | OLRT Vehicle Mock-Up



Constructions, surfaces and finishes will be as close as practicably possible to the final product specification. Volume and location of interior components will be representative to the serial product to ensure representative spacing between components. The mock-up will not be functional and will not be equipped with trucks but will be fitted with lighting and Passenger Information Display Systems (PIDS). It will be connected to the 110 V, 60 Hz network to provide energy to the functional equipment. **Figure 5.4-10** illustrates the concept, showing the exterior and interior of the Reims LRV mock-up.

Figure 5.4-10 | Reims Vehicle Mock-Up



5.4.3.8 Vehicle Dynamic Modelling and Simulation results

Traction Performance

Except where otherwise specified, the traction system performances and curves are defined with the following parameters:

- Maximal load 4 pass/m²
- Power supply voltage: 1500 V
- Inverter filter voltage: 1800 V in braking modes
- Half worn wheels
- Jerk limitation to 1.3 m/s³

The values specified in the curves and text below, are to be assigned with a tolerance of ±5%. The specified values take into account of the following:

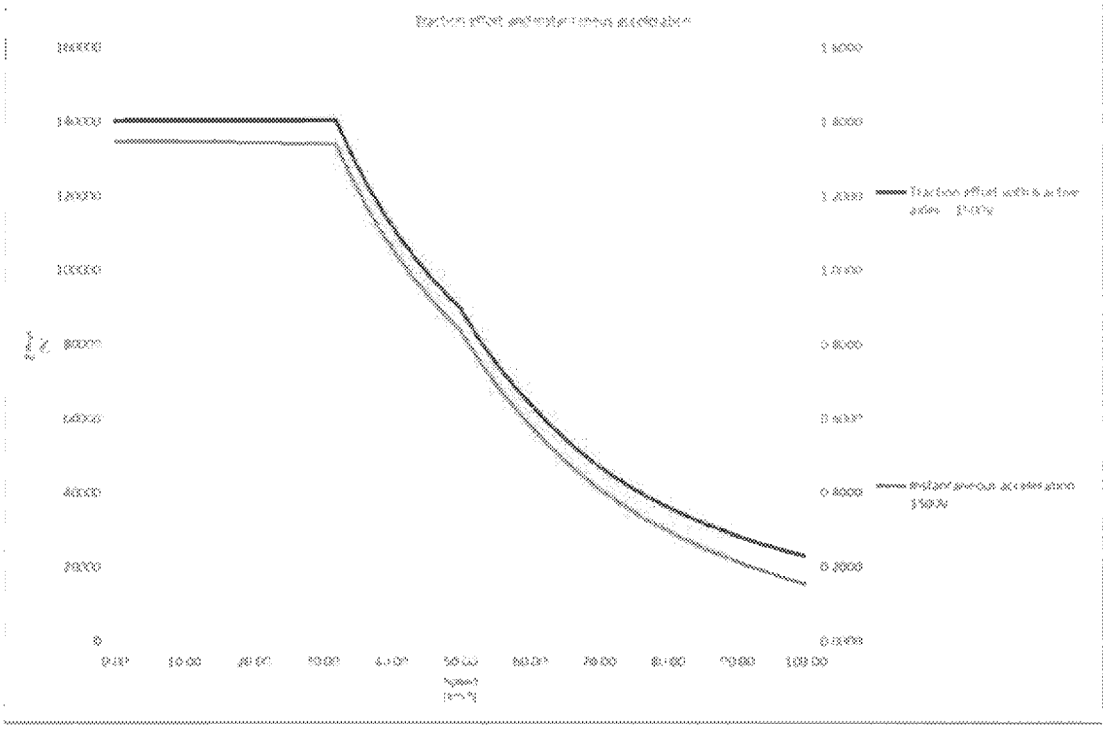
- Acceleration of flywheel masses

- Resistance to forward motion calculated with Davies formula (R)
- Starting resistance
- Resistance due to slopes (where specified)

Traction Characteristics on Flat Track

Figure 5.4-11 presents the traction Train level curves of the Citadis in single unit. The propulsion system will provide initial maximum vehicle acceleration of 1.34 m/s² +/-5% (OCS voltage>1500 V, AW2 Loading) up to 32 km/h as required by the PA.

Figure 5.4-11 | Single Unit Nominal Traction Characteristic



Train Simulation Results

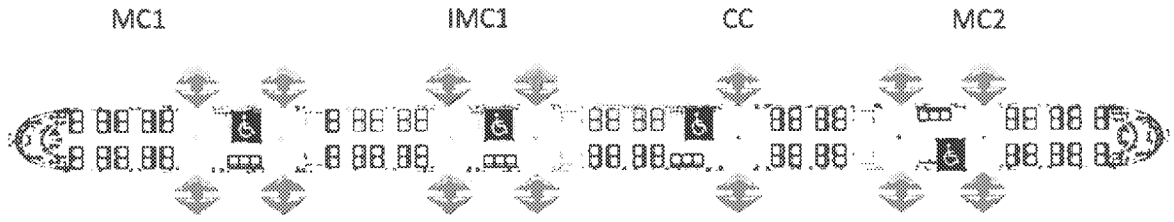
The Vehicle dynamic modelling and simulation results are presented in Section 10.0 and summarized in Section 5.4.5.

5.4.3.9 Accessibility

Approach to Vehicle Accessibility

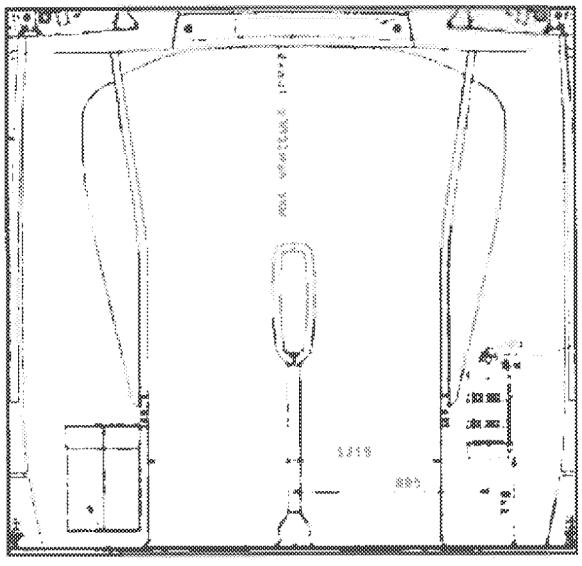
The Vehicle interior is designed with full low-floor Passenger area and seat arrangement (longitudinal and transversal) to provide full accessibility in compliance with AODA/ADA requirements. Transport Canada requirements will be complied with only to the extent that they are applicable to LRVs. The Vehicle is equipped with seven dual leaf Passenger access doors per side to optimize Passenger accessibility and reduce exchange time at stations (see Figure 5.4-12).

Figure 5.4-12 | Door Placement



In addition:

Figure 5.4-13 | Vehicle Cross-section



- The Ottawa Vehicle, part of the service-proven Citadis product range, guarantees a continuous unobstructed path connecting all accessible elements and spaces of the Vehicle with a low-floor which includes slopes (less than 8 percent in accordance with TSI Requirements)
- The accessible space between seats, handrails matches with the ADA requirement (600 mm)
- Proposed Vehicle accommodates the needs of individuals with or without restricted mobility
- All thresholds are equipped with a colour band running along the full width which contrasts with the step tread and is adjacent to the floor
- Vehicle access points are located to facilitate entry and to maximize passenger flow. The proposed Vehicle doors provide a width of 1300 mm when opened, facilitating access for people with restricted mobility.
- For boarding, the proposed Vehicles are equipped with a leveling system (air suspension) which ensures a gap of plus or minus 15.8 mm between the height of the Vehicle floor and the platform. The maximum horizontal gap between the Vehicle at rest and the platform is 76 mm.
- The gangway walkway links two sections and includes a floating tread plate. The width in the gangway is 1215 mm.



Accommodation of AODA and ADA Requirements

The proposed Vehicles comply with subparts A and D (Light Rail Vehicles and Systems) of the Americans with Disabilities Act (ADA) reference 49 CFR 38 for Transportation Vehicles. During design, manufacturing construction, and revision of Trains, Alstom covers the ADA requirement by taking inic account anthropometric dimensions.





Wheelchair Access

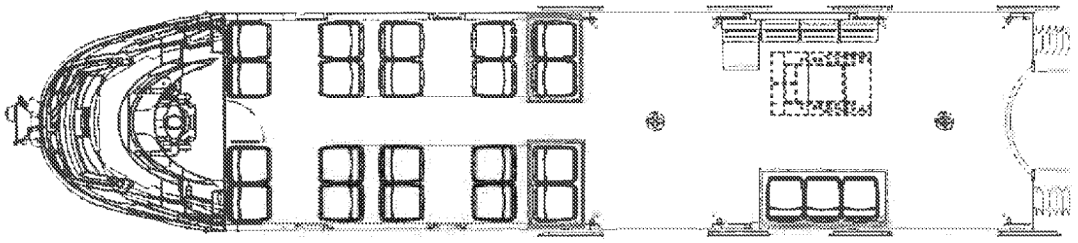
At each entrance, the dual-leaf doors providing an access width of 1300 mm, to allow passage of one wheelchair or mobility aid users. A 1220 mm by 760 mm wheelchair spot is conveniently located next to each door area and allows smooth Passenger flow around the area. Priority seats are located next to the wheelchair area.

Information Displays

Signage

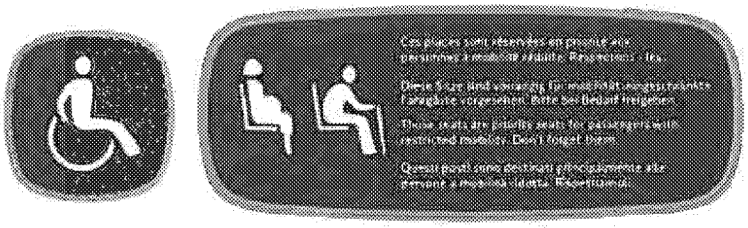
All signs are bonded on the Train with International Symbol of Accessibility and are displayed on the exterior of each operating Vehicle. The doors use auditory and visual warning signals to alert Passengers when doors are closing. Each Vehicle contains signs which indicate that certain seats are priority seats for persons with disabilities (see **Figure 5.4-14**; seats in front of display and close to the doors-as outlined in red).

Figure 5.4-14 | Signage



OLRT Vehicles will accommodate persons using wheelchairs or other mobility aids. In these areas, signs indicate the location and advise other Passengers of the need to permit wheelchair and mobility aid users to occupy them (see **Figure 5.4-15**). Signage dimensions will meet ADA/AODA requirements.

Figure 5.4-15 | Example of Accessibility Signs



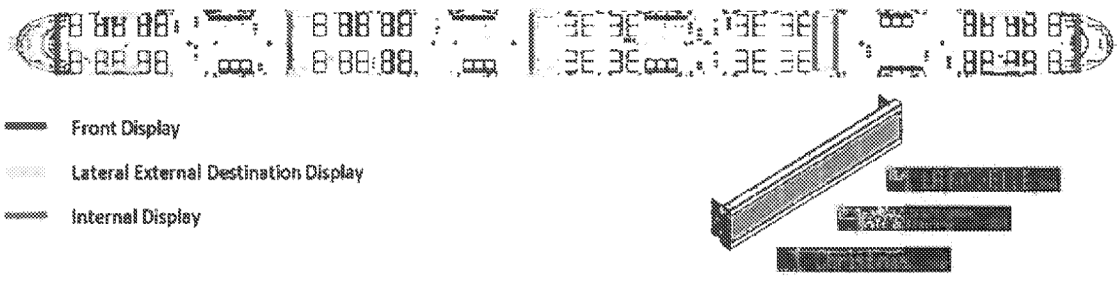
Passenger Information Displays

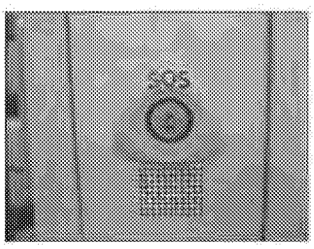
Proposed Vehicles are equipped with displays which inform Passengers of the route (see **Figure 5.4-16**). The system is designed to provide synchronized audio and visual Passenger information announcements including destination, station stops, time, and emergency announcements according to Train route. The displays will meet these standards:

- Visible from the platform
- Located on the face to be visible (two per face of the Vehicle)
- Integrated behind the window and have a glare-free surface, and a consistent shape. Text letters are yellow, contrasted with the black serigraphy of the window which permits a clear view.

The Ottawa LRT information system is also equipped with an interior public address system operated by OLRT personnel, or digitized human speech messages to announce Stations and provide other Passenger information.

Figure 5.4-16 | PIDs

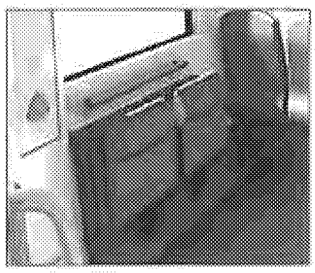




Pushbuttons

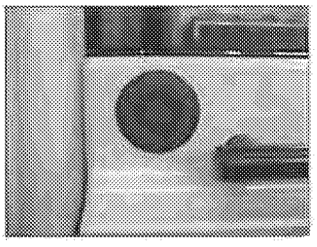
All Passengers have access to push buttons for access-door opening request or to communicate with the Driver in an emergency. Provisions are made to integrate these push buttons according to ADA/AODA requirements:

- Located to be accessible by Passenger in wheelchairs
- Contrast with internal fitting on which they are mounted



In wheelchair areas, a push button allows Passengers to request the automatic opening of the adjacent Passenger door at the next Station. This allows Passengers in wheelchairs to request door opening before arriving at a Station, allowing time to go out of the Train comfortably.

Interior – Handrail and Stanchions



The handrails in Ottawa's Vehicle are sufficient to permit safe boarding, onboard circulation, seating and standing assistance, and alighting by persons with disabilities. The proposed Vehicle also fulfills the TSI requirements so it is possible to grab the handrails everywhere in the Train. The OLRT Vehicle is equipped with grab bars, handholds, handrails or stanchions located as follows:

- In appropriate locations
- By each priority seating area intended for use by persons with disabilities
- At each side of any entrance or exit used by persons with disabilities

- In location at any entrance or exit used by a person with a disability. The bars are accessible from ground level and are mounted inside the Vehicle when the doors are closed.
- At appropriate locations throughout the Vehicle to support independent and safe boarding, on-board circulation, seating and standing assistance and de-boarding for persons with disabilities.





The grab bars, handholds, handrails or stanchions do not interfere with the turning and manoeuvring space required for mobility aids to reach the allocated space from the entrance. They are contrasted (K>3 as TSI requirement) with their background to assist with visual recognition. Every grab bar, handhold, handrail or stanchion will have these characteristics:

- Rounded and free of any sharp or abrasive element
- With an exterior diameter of 35 mm that permits easy grasping by the full range of Passengers and sufficient clearance from the surface to which it is attached
- Designed to prevent catching or snagging of clothes or personal items
- Equipped with a slip resistant surface

Grab bars, handholds, handrails and floor-to-ceiling stanchions have a smooth curve. Their precise shape will be finalized during the design phase.

5.4.3.10 Train Systems & Safety Critical Items

During development of the Citadis product range, safety analyses have defined critical items and assemblies. Safety-critical equipment is equipment whose failure might induce a safety hazard; for example, structural elements, braking system, traction systems, doors and signaling equipment. A preliminary list, provided in **Cut Sheet 5.4.1.B-7**, is based on Alstom's experience and will be updated for OLRT in the design phase. A brief description of the main sub-systems is provided in this Section, with a summary of the associated safety approach where relevant.

Doors

The Vehicle is equipped with seven dual-leaf sliding plug doors on each side of the Train. Doors are largely glazed. The electric type actuator (one per dual leaf door) is in the upper part of the door. The door leaves are made up of an exterior glazing of the laminated glass type, bonded onto the structure and covering the door-leaf surface area. The panes include black silkscreen printing all around the edges, to round off their aesthetic appearance and protect bonded areas from UV radiation. The door leaves' leading edges are fitted with elastomeric joints to ensure safety when closing, and tightness. Tightness all around the door edges is ensured by an elastomeric sealing joint on the door leaf itself and the frame, concealed for aesthetic reasons and mechanical strength. The doors are equipped with a fixed threshold to reduce the gap between Train and platform. Doors' main characteristics are provided in **Cut Sheet 5.4.1.B-2**.

Our approach to access safety has the following elements:

- **Train-speed criteria** - The doors (except emergency working) can only be opened if a zero-speed threshold information signal is present. The door's closed-and-locked status is interlocked with propulsion.
- **Closing control** - Doors are fitted with special safety devices that allow each door to be locked after its closure and which authorize Train start-up once all doors are closed and locked.
- **Obstacle detection on door closure** - An obstacle-detection device inhibits the closure of the relevant door as long as a Passenger is detected between the door posts.

Truck

The proposed truck is a truck from the IXEGE family used on Citadis LRTs. For the OLRT, this truck will be fitted with a pneumatic secondary suspension to meet the levelling requirement specific to the OLRT Project. This truck benefits from all validation tests completed for the IXEGE truck. The main truck characteristics (see **Cut Sheet 5.4.1.B-5**) include:

- Achieves simultaneously the goals of having a pivoting motor truck for a low floor with a conventional truck configuration with primary suspension, secondary suspension and axle drive.
- Allows negotiation of tight curves, even without transition, while reducing wheel /rail contact forces and the resulting wear, due to pivoting trucks in the lead Vehicle position.
- Provides optimum accessibility for wheels, brakes and traction equipment. Wheels can be removed without separating the truck from the Vehicle, or removing the axle from the truck.

Braking System

Detailed information about the braking system is given in **Cut Sheet 5.4.1.B-1**. The safety approach related to the braking function is as follows:

- **Safety Brake** - Safety brake command is reversed logic, which means safety brake is applied when the safety braking trainline is not energized. This safety braking trainline is galvanically insulated to ensure that a single-point failure cannot lead to the non-application of the safety brake. Magnetic track brakes are applied independently.
- **Mechanical Brake** - Brake actuators are also reversed logic, so if no voltage is applied on the line, sufficient braking is applied to stop the Train and hold it still.

Traction System

The traction system is described in **Section 5.4.3.6**.

Safety Approach

Driving direction is distributed to traction equipment through two independent trainlines. These trainlines are powered by a stable multiple-position commutator. If a driving selection occurs when the Train is running, it will not be taken into consideration. Traction power application depends on activation of the dead-man system by the Driver. Traction is inhibited by trainlines when brakes are applied and the main circuit breaker is open upon safety braking.

Traction motor

The 4 LCA 1651 traction motor is a closed, self-ventilated, three-phase induction motor. Its nominal power is 150 kW. Additional information is given in the traction motor **Cut Sheet 5.4.1.B-4**.

Train Control/Monitoring System

The Train Control/Monitoring System (TCMS) is based on the latest generation of Alstom computerized processing software. The basic architecture for the Citadis is designed for operation in both single and multiple units without requiring reconfiguration.

The philosophy for the Citadis is to enable the TCMS to process a maximum of functions, both vital and non-vital ones. This is accomplished largely by using data-processing techniques (digital computers, software and communication by local information networks) with the aim of decreasing the number/lengths of hard-wired circuits needed, while increasing the service level, focusing on providing assistance in driving and maintenance.

Control Electronics are dedicated to performing a given Train function (e.g. the door function) that is linked with the TCMS. The TCMS inputs/outputs and the data network are used to exchange information between all electronics units of the Train. In all cases, the MPU performs the main control/command and monitoring functions, with other equipment performing its own local functions. Following this principle, data sent by the MPU to one or several electronic equipment is called "commands"; data sent by electronic equipment to the MPU or others devices is called "controls" or "monitoring".

The software programs concerned are not designed to accomplish safety-critical functions. Vital functions will be achieved by hardware logic. The software has been developed in compliance with the EN50128 software development standard.

Architecture of the Train Control/Monitoring System (TCMS)

The main architecture deployed is based on the following:

- Trainlines to perform Train safety command functions (e.g. traction/braking, doors opening/closing authorization) and controls (e.g. all doors closed status), at Train and unit level
- A redundant MVB network allowing communication between all electronic equipment inside the same unit (e.g. Traction Unit, Brake Control Unit)
- A WTB network linked (via the unit coupling cable) with the MVB network of each unit via a Gateway WTB/MVB, and allowing communication between Train units (when in multiple unit mode)
- An Ethernet network interfaced with major sub-systems for collection of maintenance and diagnosis data, at Train unit level (when in multiple unit mode)

Cut Sheet 5.4.1-CS-903 provides the preliminary TCMS architecture for the OLRT Vehicle. This architecture is given for information and may be subject to change during the design stage. It indicates the various types of equipment connected to the networks but does not represent an exhaustive quantitative list.

5.4.3.11 Spin/Slide Control system

Each truck type is equipped with an anti-slide device. Slide is detected axle per axle on the motor trucks and wheel per wheel on the trailer truck. Brake release during vehicle slide is performed truck per truck (both on the motor truck and trailer truck). The anti-slide module automatically activates the release of sand.

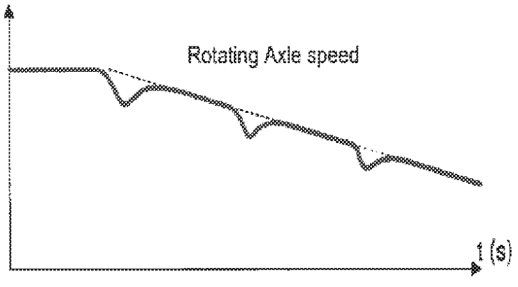


Figure 5.4-17 / Rotating axle speed regulation on a sliding wheel (trailer truck)/axle (motor truck) during service brake

In the event of a slide, in service brake, the control system quickly reduces the effort (Kill the slide) on the truck that has slid. The effort setting is reduced to adapt the effort to the adhesion available. The effort correction is calculated to match the wheel (trailer truck)/axle (motor truck) deceleration and the difference between the speeds of the wheel (trailer truck)/axle (motor truck) and the reference speed as shown in **Figure 5.4-17**. This type of regulation (Kill the slide) allows for quick and stable slide deletion.

In a slide during emergency brake, the control system reduces the effort on the truck that has slid to maintain a certain controlled level of slide (15-20%) to stay as close as possible to the maximum effort request (Keep the slide). This type of regulation (Keep the slide) allows for high efficiency in high-adhesion level braking (**Figure 5.4-18**).

In a skid, the effort rapidly regresses. The gradient and amplitude of this regression depends on the acceleration of the axle (motor truck) and the difference in the axle (motor truck) speed compared to the reference speed. When there is no more spin, the traction effort is gradually applied again (**Figure 5.4-19**).

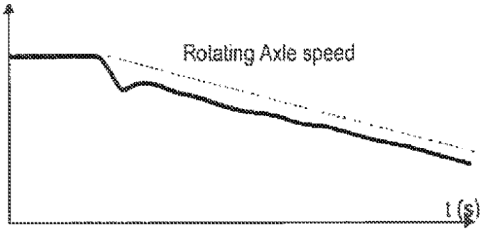


Figure 5.4-18 | Rotating axle speed regulation on a sliding wheel or axle during emergency brake

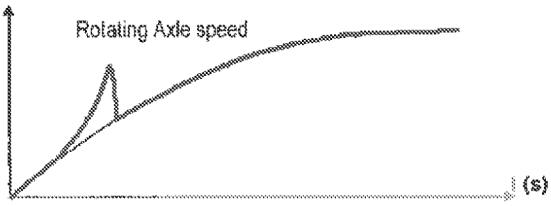


Figure 5.4-19 | Rotating axle speed regulation on a skidding axle (motor truck) during traction phase

5.4.3.12 Vehicle Delivery & Partial Assembly

The Vehicle will be shipped separately in two sections from France to the MSF in Ottawa.



5.4.3.13 Vehicle & Wayside Subsystems

Communication between Vehicle and wayside is managed by the Train Control/Monitoring System (TCMS). The proposed TCMS for the OLRT Vehicle is part of the service-proven standard Citadis product range.

Communication Based Train Control

The on-board and wayside portions of the CBTC system are described in **Section 5.4.4**.

On Board Communications Network

All Train-wide voice communications, control of destination signs and Passenger information signs and transmission of video within the Train will take place over a dedicated Ethernet network (see **Cut Sheet 5.4.1-CS-903**).

The vehicle will communicate with the wayside via a Wi-Fi system with transceivers at Stations and the MSF. This link will be used for non-vital information such as video, Automatic Passenger Counting (APC)

Radio

On-board Train Radio will be specified as defined in PA Schedule 15-2 Part 4 to fulfil related interface requirements with the planned City Radio System.

Closed Circuit Television

Exterior Surveillance

In each Station, video cameras will monitor boarding platforms. Video will be streamed to the TCMS via Wi-Fi communication and displayed to the Driver. Cameras will also be installed aboard the Trains, enabling the Driver to monitor the sides of the Train when not in a Station.

Interior Surveillance

The video-surveillance system is based on a complete digital technology system. The CCTV function is integrated with the Ethernet backbone. Electronics cards which ensure "supply, network communication and recordings" functionalities needed by this system are located in the same shelf (called Universal Mobile Controller) as Public Address.

This CCTV system consists of the following elements:

- Cameras to monitor the Passenger compartment
- Cameras to monitor the view out of the cab front and rear window
- One recorder with a hard disk(s) integrated in the UMC racks

Automatic Passenger Counting (APC)

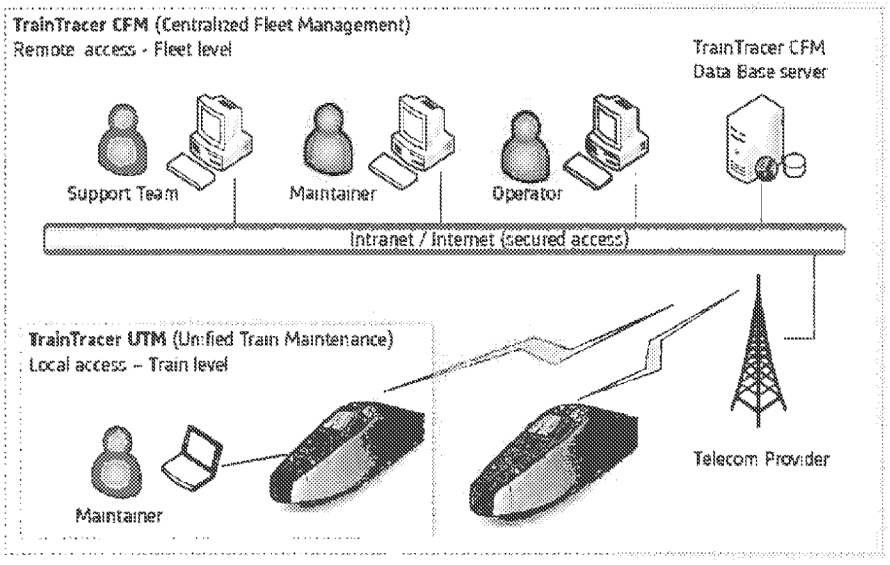
The APC system will provide an accurate count of passenger traffic and report the data to the Performance Monitoring System in real time.

Remote Diagnosis - Train Tracer

TrainTracer is the Alstom solution to facilitate Train diagnostics, interfacing Train on-board equipment with the M&R Team. Besides the usual access to Train data using a laptop PC directly connected to the Train, TrainTracer offers remote access to full fleet data through intranet and internet. Health data is automatically monitored on board each Train in operation and moves to back-office Web server through cost-effective wireless communications (see **Figure 5.4-20**).

Using a web-based server enables technicians to access Train data anytime and from anywhere there is intranet or internet access. Data will be available to the M&R Team, as well as for a remote support team or maintenance manager. As an option, access to TrainTracer could be made available to the Operator. This approach provides unprecedented visibility into the real-time operation and health of each Train. It expedites corrective maintenance, supports the Train crew and prevents some failures. TrainTracer reduces maintenance cost and simultaneously improves Train availability. This section describes the technical aspects of TrainTracer solution proposed by Alstom Transport as the maintenance assistance system for rolling stock.

Figure 5.4-20 | TrainTracer



TrainTracer Application Overview

To assist the Train maintainers, two TrainTracer applications will be available:

- **TrainTracer CFM (Centralized Fleet Management)** - A centralized application, managing data at fleet level, accessible using a thin client through a secured intranet or internet access
- **TrainTracer UTM (Unified Train Maintenance)** - A local application, managing data at Train level through a laptop PC. The connection to the Train is direct.

Main faults generated by the Trains are automatically sent to TrainTracer CFM server and recorded:

- Alarms related to failures affecting current commercial service
- Faults to be fixed at depot

Other faults and detailed information are accessible through a laptop in the MSF using TrainTracer UTM and other servers using open protocols. They are used for deeper investigation of faulty equipment.

These two applications may collaborate since CFM imports maintenance data that has been recovered by UTM. This solution enables us to manage the case where a remote connection is unavailable and a direct local maintenance operation has been necessary.

Catenary System

Interface with catenary system is described in **Section 5.4.3.14**.

Wheel Rail Interface

Information on wheel rail interface is given in the truck **Cut Sheet 5.4.1.B-5**.

5.4.3.14 Power System

The OLRT Vehicle complies with the EN50163 standard, concerning the supply voltages for traction systems. **Table 5.4-12** summarizes the lowest, highest and nominal voltages.

Table 5.4-12 | Voltages

Lowest non-permanent voltage	Lowest permanent voltage	Nominal voltage	Highest permanent voltage	Highest non-permanent voltage
U_{min2} [V]	U_{min1} [V]	U_n [V]	U_{max1} [V]	U_{max2} [V]
1000	1000	1500	1800	1950

Table 5.4-13 shows the estimated power balance on the catenary power supplied for nominal catenary voltage.

Table 5.4-13 | Estimated Power Balance

Parameter	Performance
Maximum Power for auxiliaries	325 kW (including 4*75 kW for heating)
Maximum Power for low voltage network and equipment	16 kW
Maximum Power for Traction	1050 kW
Maximum Power required on Catenary Power Supply	< 1400 kW (estimation)

5.4.3.15 Carbody Strength

To ensure maximum safety for Passengers, the carbody will exceed requirements of ASME-RT1. Cars are composed of the following equipped modules:

- Underframe (version depending on Vehicle)
- Driver's cabins (in head Vehicle only)
- Roof
- Sidewalls (symmetrical left and right)

Final assembly between the sub-assemblies will be performed either by welding, riveting or fastening, as required by structural, manufacturability and maintenance requirements. Several lifting and jacking points are present in each Vehicle, designed and calculated to ensure correct performance for re-railing and maintenance operations. The exact position and design of the support surfaces shall be developed to ensure compatibility with existing and service-proven elements.

See Test Reports **5.4.1.A-TR-201** to **5.4.1.A-TR-204** for the car-body strength calculation results of the Citadis Nantes.

5.4.3.16 Vehicle Weights and Axle Loads

Table 5.4-14 shows Vehicle weights and axle loads under different configurations.



Table 5.4-14 | Vehicle Axle Loads

Tonnes	MC1		IMC1		CC				MC2		
Condition	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5	Axle 6	Axle 7	Axle 8	Axle 9	Axle10	Total
Tare Load	**8,341**	**8,341**	**6,945**	**6,945**	**7,271**	**7,271**	**7,998**	**7,998**	**8,276**	**8,276**	**77.6T**
3.33p/m²	10,229	10,229	10,267	10,267	9,227	9,227	10,731	10,731	10,164	10,164	101.2T
4 p/m²	**10,797**	**10,797**	**11,589**	**11,589**	**9,933**	**9,933**	**11,851**	**11,851**	**10,732**	**10,732**	**109.8T**
8 p/m²	11,365	11,365	12,910	12,910	10,369	10,369	12,970	12,970	11,301	11,301	118.4T

5.4.3.17 Crashworthiness

The end cabins provide appropriate protection to both Driver and Passengers. The design integrates ASME RT-1 required elements. It includes crash-energy absorption devices designed to deform in a preprogrammed fashion and located as shown in **Figure 5.4-21**.

Using a modular concept allows for a quick re-entry into revenue service of any Train involved in one of the considered crash scenarios. In the event of low speed crashes, impacted elements (central absorber and/or coupler assembly) are designed to be easily replaced. In the event of a higher-speed collision, end cabins are bolted on the end of the frame and can be easily and quickly replaced.

From the structural point of view, the Driver's cabin can be divided into two main elements:

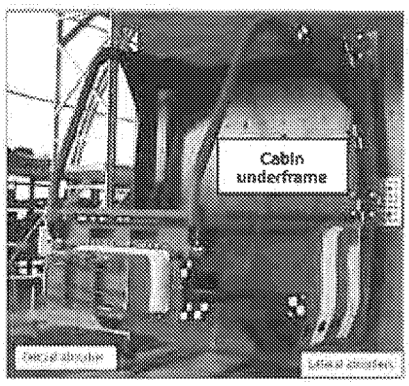
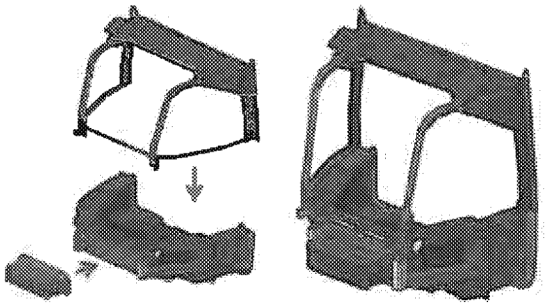


Figure 5.4-21 | Crash-Energy Absorption Devices

- A top frame composed of corner posts and a top structural shelf as specified in ASME RT-1
- An underframe integrating the crash absorption elements, the driver's survival cell, full-width anti-climber, collision posts and the interfaces with the top frame and all required equipment supports to comply with ASME RT-1



Detailed design will be finalized in conformance with the client's aesthetical design requirements. See **Test Reports 5.4.1.A-TR-301 to 5.4.1.A-TR-303** for the preliminary crash calculations.

5.4.3.18 Development, Production, Testing and Commissioning Schedule

See **Section 5.4.1.E** for the preliminary schedule. **Section 5.4.3.5** details the Testing and Commissioning Strategy.

5.4.3.19 Compliance Matrix

See **Section 5.4.1.F** for the compliance matrix.

5.4.3.20 Heating and Cooling

The Passenger compartment air conditioning is ensured by a roof-mounted fully unitized air conditioning unit on each car. All units can be maintained from the roof.

Equipment Description

The HVAC unit is a fully unitized roof-mounted unit developed to achieve heating and cooling performances while minimizing noise. The cooling circuit is hermetically sealed and uses homologated refrigerant liquid (R407C) in accordance with current European Standards and the Montreal protocol, and complies with Canadian laws and regulations. Drawings of the proposed HVAC are provided in **Cut Sheets 5.4.1-CS-501 and 5.4.1-CS-502**, with further details of the HVAC unit in **Cut Sheet 5.4.1.B-3**.

The HVAC unit has been designed to provide 8 m^3/hr of fresh air per Passenger in AW2 loading conditions. The fresh air damper can be closed by the Driver for faster warm-up and cool down of the Passenger compartment. If over temperature is detected, thermostatic and electrical protection is provided. An emergency shutdown switch is also provided in the Driver's cabin.

System Capacity

HVAC capacity has been designed for optimal comfort. The proposed unit offers 35 kW of cooling power and 30 kW of heating power. To ensure system capacity in terms of temperature stratification, treated air will be distributed to Passenger compartment by air outlets located on the ceiling and at floor level. Thermal load calculations used to define the heating and cooling capacity required are provided in **Test Report 5.4.1.A-TR-401**.

Controller

The controller regulates temperature in the Vehicle through multiple operating modes. These operating modes are determined by system configuration, analogue input values, digital input states, and the system set point. The following functions are provided by the controller:

- Safety and shutdown protection
- Diagnostics
- Fault monitoring and annunciation to MPU
- Self-health check

- Sequential starting of motors
- Includes a +/-2°C set point adjustment for all switching points

Cabin Equipment

The ventilation, heating and cooling functions for the Driver are ensured as follows:

- An overhead air diffuser with volume and directional adjustability fed from the main HVAC unit
- Two thermostatically controlled cab heaters
- Side window defrost
- Electrically heated windshield

5.4.3.21 Approach to Pushing/Towing, Fire Safety and Ride Quality

Pushing/Towing

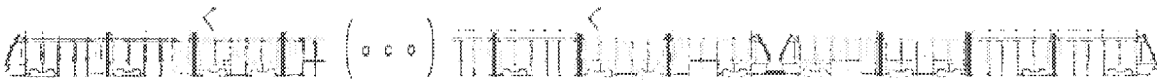
Alstom Citadis products are service-proven on diverse railway networks and are designed to rescue and to be rescued. The proposed OLRT Vehicle is designed for the following towing/pushing operations:

- A single Vehicle rescues another single one



Rescuing single Vehicle *Rescued single Vehicle*

- A multiple Vehicle rescues a single unit



Rescuing multiple Vehicle *Rescued single Vehicle*

- A multiple unit rescues another identical multiple unit



Rescuing multiple Vehicle *Rescued multiple Vehicle*

In rescue operation, the allowed operating speed is limited to 30km/h.

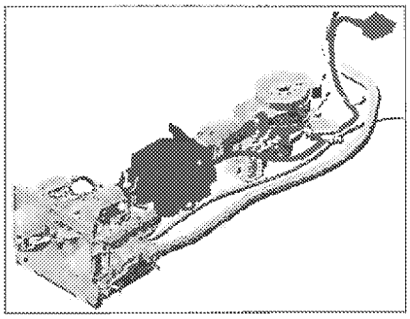


Figure 5.4-22 | Automatic Coupler

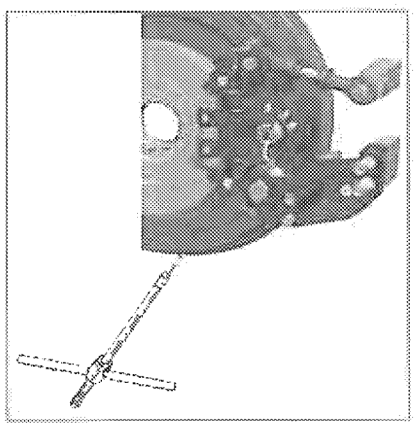


Figure 5.4-23 | Brake Release

Coupling

In normal rescued condition, the automatic coupler is used (see **Figure 5.4-21**), which contains all necessary trainlines for rescue mode. It can be manually deployed in cases of low battery or motor breakdown.

Rescue Mode Description

The rescuing Train provides low-voltage energy for all necessary functions. Mechanical brakes are released with the auxiliary hydraulic pump thanks to shared low-voltage energy.

In an emergency stop button or an unwanted uncoupling, all rescued mechanical brakes are actuating to stop the Vehicle, preventing all cases of unbraked Trains.

In the exceptional case of non-brake release through auxiliary hydraulic pump, the Driver can release the brake mechanically (**Figure 5.4-23**). Brake application will be possible only when hydraulic pumps are activated again.

In addition, the following functions are available in the rescued Vehicle (the rescuing one is fully operational):

- Emergency stop buttons (in both cabins)
- Windshield wiper
- Exterior lighting
- Cabin lighting
- Train radio

Fire Safety

All non-metallic components used on the Vehicle are smoke-, flame- and toxicity-tested to NFPA 130, 49 CFR part 238 and BSS 7239. Equipment will meet NFPA 130 requirements. All materials used on the Vehicle, as well as their weight, location and their fire/smoke/toxicity test report will be recorded in a database and maintained through the Vehicle lifecycle. **Table 5.4-15** summarizes the fire loading values.

The underframe and roof are made of steel to ensure sufficient fire resistance. Design will be validated by performing tests in accordance with ASTM E119, NFPA 130 and 49 CFR part 238. Smoke detectors are located in fresh air intake sections of each car. If smoke is detected, fresh air intake will be automatically closed to prevent external smoke from entering the Vehicle. Two additional smoke detectors will be installed in the vehicle's interior to alert both the driver and the Control Operators in the TSCC of a possible onboard fire. To ensure proper Vehicle evacuation in case of fire, all doors are equipped with an external and an internal manual door release. Two fire extinguishers will be located in each Driver cab.

Table 5.4-15 | Fire Loading

Item	Value
Estimated fire loading for MC section (MC1 & MC2)	43 GJoules
Estimated fire loading for IMC section	36 GJoules
Estimated fire loading for CC section	39 GJoules

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.

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/m² in Scenarios 1 and 2, and 336 Passengers at 4.0 m² in Scenario 3 during peak service. In off-peak service the average standee density of 0.8 standees/m² 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

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/m²)	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%

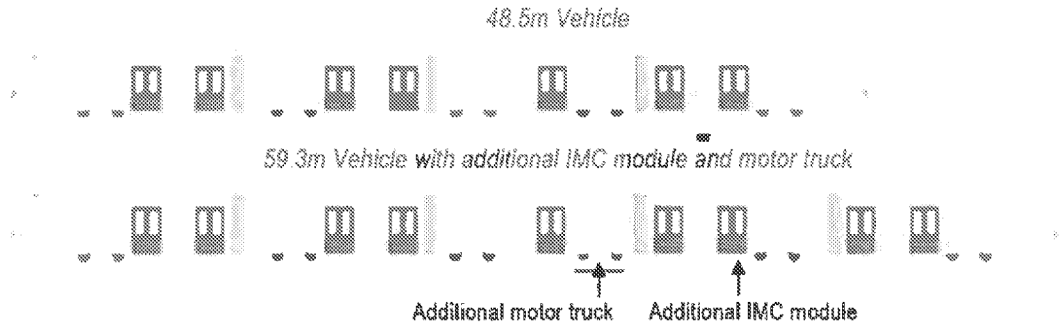
6 Average capacity of a mixed fleet of 48.5 and 59.3m long Vehicles (see below)

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/m² to 4.3 Passengers/m² 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

RIDEAU TRANSIT GROUP

Light Rail Vehicle Appenix Summary Document

This Attachment contains a list of the drawings and test reports submitted in Alstom's August 20, 2012 response to RFP 507528-P001. All drawings are subject to revision during design development to incorporate localization constraints consistent with Canadian Content requirements, Regulatory Standards to be developed per Project Agreement Schedule 15-4, and further design development in conformance with the requirements of Schedule 15-2, Part 4 and constraints due to environmental, interface or similar factors that may arise during design development.

Appendix	Documents	Comments
Appendix A - Layout	DTD0000099943_A1	Vehicle Layout
	DTD0000109035_A0	Vehicle Cross Sections
Appendix B – Brake System	Air Production	Air Production Block Drawing
	C124796	Magnetic Track Brake
	C126889	Hydraulic Unit
	C129704	Brake Caliper
	C132723	Hydraulic Unit
	C68359	Hydraulic Accumulator
Appendix C - Truck	IPONAM EN VUE ISO	Motor Truck Isometric View
Appendix D - Pantograph	01-0020-Drawing 04-18-12_Panto_Schunk	Pantograph Layout Drawing
Appendix E – Auxiliary Power Supply	UF-1620_0601_APS	Auxiliary Power Supply Global View
	UF-1620-040101	Principle Schematic
Appendix F – Testing	SL-VP-07-051R_A_Rapport_essai_PB_TTNG	Front window type test
	40300_7-08_TypeTestReport_R20_071218	Auxiliary power supply type

		test
	Rapport frein en 1500 V sur RFN DOC025418-00	Brake type test
	VB080711_00 Issue 05 Typetest TTNG_Test with results_FR	Door type test
	VPFN992212	Averter type test
	ZZ-854-08_indice C	HVAC type test
	VPFN892025	Interior lighting type test
	VPFN192005	Sanding type test
	MES-PRODU-TTR-001-A-EN	NVR, Camera and EBM type test report
	MES-PRODU-TTR-006-A-EN	Vehicle Media Controller type test report
	MES-PRODU-TTR-020-B-EN	Internal LED display type test report
	MES-PRODU-TTR-021-B-EN	On-Board Internet type test report
	MES-PRODU-TTR-022-A-EN	6U Passenger Announcement Rack type test report
	MES-PRODU-TTR-044-A-EN	IP video camera type test report
	MES-PRODU-TTR-046-A-EN	CCTV/NVR/EBM/WIFI rack type test report
	Essais de type DISJONCTEUR.ARC1520M	MCB Type test
	10-5278 043 - TR_F_M518RFTTNG Rev1	Rheostat type test
	2009-008_TTNG Simulation Rev_1	Automatic Coupler validation note
	static tests_KIEL_3.1_corrigé	Seat type test
Appendix G – Safety Critical Item List	-	Safety Critical Item List
Appendix H – Car-Body	DOC018144	Compression test result
	VPFN_291027	Extremity car fatigue

2

		calculation
	VPFN_291020	Intermediate car fatigue calculation
	VPFN_291021	Center car fatigue calculation
Appendix I - Crash	VPFN291023	Crash Calculation
	VPFN291018	Crash Calculation update after test
	054_2008-07-15_REI-TTNG_rev1_Rapport	Crash test report
Appendix J - HVAC	IE54656_B_HVAC_TTNG	HVAC Top Assembly
Appendix K – Automatic Coupler	R0000252028001D	Automatic Coupler Assembly Drawing
Appendix L – Electrical Cabinet	AK00001070290	Electrical Cubicle Assembly
Appendix M – Driving Cab	CABINE TTNG NANTES AVEC VITRE VUE ISO	Driver Cab Assembly view
	CABINE TTNG NANTES AVEC VITRE VUE ISO	Driver Cab Assembly view
	VPFR262001	Cab underframe
	VPFR262002	Cab Mounting
	VPFR262004	Cab Lateral Absorber
	VPFR262007	Cab Central Cross Beam
	VPFR262008	Shield
	VPFR281002	Absorber
	VPFR361006	Cabin Upper Assembly
	Driving desk top view	Driving desk top view
Appendix N – Block Diagram	OLRT Traction block diagram	-
	ArchitectureTCMS_MVB_Ottawa_1_VerE	-
	AN00001046476C	Traction block layout drawing
Appendix O – HVAC Thermal Load Calculation	Appendix N OLRT_HVAC_load_calculation_revA	

Appendix P – Cutomer Feedback	Istanbul_recommendation_letter	
	Nantes_recommendation_letter	
Appendix Q - Datasheets	Door datasheet	
	HVAC datasheet	
	Traction motor datasheet	
	Truck datasheet	
	Braking System narrative	

APPENDIX A3
CANADIAN CONTENT CERTIFICATE

APPENDIX A3
CANADIAN CONTENT CERTIFICATE

APPENDIX B

CANADIAN CONTENT CERTIFICATE

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
Vehicle Subcomponents and Component Cost Estimate	Propulsion system	Traction inverters		7%	5%	0.4%
		Traction control unit (motor and gearbox)				
		High Speed Circuit Breakers				
		Transmission				
		Pantograph	FAIVELEY TRANSPORT, 1002 Rue Sherbrooke Ouest, Montreal, Quebec			
		Ice Scraper				
		Wiring				
	Carshell	Stainless steel and aluminum body		14%	22%	3.08%
		Under frame/ chassis				
		Insulation Material				
		Corrosion prevention (paints and decals)				
		Windshield (includes wiper)	PRELCO INC., 94 Boulevard Cartier, Riviere-Du-Loup, Quebec, Canada			
		Cabinet Assembly				
		Air horn	FAIVELEY TRANSPORT, 1002 Rue Sherbrooke Ouest, Montreal, Quebec			
		Panels (exterior)	DIMENSION COMPOSITE INC., 2530, 95E Rue, Saint-Georges, Quebec			
		Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road,			

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
			Unit 3, Toronto, Ontario M6B3Y1			
		Fibre Reinforced Plastics	DIMENSION COMPOSITE INC., 2530, 95E Rue, Saint-Georges, Quebec			
	Trucks & Suspension	Bearings		13%	3%	0.39%
		Coil spring				
		Traction rod				
		Cabling				
		Terminations				
		Suspension control unit				
		Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road, Unit 3, Toronto, Ontario M6B3Y1			
		Pipe work				
		Wiring				
		Hydraulic levelling system				
	Interior	Panels	DIMENSION COMPOSITE INC., 2530, 95E Rue, Saint-Georges, Quebec	3%	70%	2.1%
		Material/ fabric				
		Carpet/ flooring				
		Glass partitions	PRELCO INC., 94 Boulevard Cartier, Riviere-Du-Loup, Quebec, Canada			
		Advertising panels	DIMENSION COMPOSITE INC., 2530, 95E Rue, Saint-Georges, Quebec			
	Low voltage Power supply	Auxiliary supply converters		6%	25%	1.5%
		Circuit breakers				

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
		Wiring	ALSTOM POWER & TRANSPORT CANADA INC., 1010 Rue Sherbrooke Ouest, Montreal, Quebec			
		Batteries				
	Brake Equipment	Brake Control Unit (BCU)	FAIVELEY TRANSPORT, 1002 Rue Sherbrooke Ouest, Montreal, Quebec	9%	13%	1.17%
		Brake Resistor	I-GARD CORPORATION, 7615 Kimbel St., Unit 1, Mississagua, Ontario			
		Friction brake (track brakes and sanding system)	FAIVELEY TRANSPORT, 1002 Rue Sherbrooke Ouest, Montreal, Quebec			
		Hydraulic Accumulators	FAIVELEY TRANSPORT, 1002 Rue Sherbrooke Ouest, Montreal, Quebec			
		Piping				
		Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road, Unit 3, Toronto, Ontario M6B3Y1			
		Electrically actuated bi-parting sliding-plug door assembly	VAPOR RAIL, 10655 Henri-Bourassa West St. Laurent QC H4S1A1			
		Automatic passenger counter				
		Photocell obstruction detection system				
		Passenger push buttons				

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
	HVAC	Cab heater	FAIVELEY TRANSPORT, 1002 Rue Sherbrooke Ouest, Montreal, Quebec	2%	13%	0.26%
		Floor heater				
		Underseat heater				
		Booster fans				
		Smoke alarm system				
		Wiring				
		Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road, Unit 3, Toronto, Ontario M6B3Y1			
		Piping and ducts				
	Misc. Equipment	Emergency window	PRELCO INC., 94 Boulevard Cartier, Riviere-Du-Loup, Quebec, Canada	1%	90%	0.9%
		Passenger intercom	ALSTOM POWER & TRANSPORT CANADA INC., 1010 Rue Sherbrooke Ouest, Montreal, Quebec			
		Barriers and guard rails				
		Push button panel				
		First aid box				
		Bicycle racks				
		Hand lamp and emergency hammer				
		Fire extinguisher				
	Cab Compartment	Train computer system & diagnostic system	ALSTOM POWER & TRANSPORT CANADA INC., 1010 Rue Sherbrooke Ouest, Montreal, Quebec	2%	10%	0.2%
		Desk	DIMENSION COMPOSITE INC., 2530, 95E Rue, Saint-Georges, Quebec			
		Panels				
		Seat (spare instructor				

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
		seat if required)				
		Desk controls				
		Deadman's Switch				
		Wiring				
		Pipe work				
		Screens (Includes video display screens from CCTV)				
		Radio Handset				
		Control handle				
	Articulation Assemblies	Insulated articulation bellows		1%	5%	0.5%
		Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road, Unit 3, Toronto, Ontario M6B3Y1			
	Couplers and Draft Gear	Wiring		2%	50%	1.0%
		Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road, Unit 3, Toronto, Ontario M6B3Y1			
		Anti-climber				
		Pipe work				
		Interior lighting	CEIT, 5650 Rue Trudeau, Saint-Hyacinthe, Quebec			
		Emergency interior lighting	CEIT, 5650 Rue Trudeau, Saint-Hyacinthe, Quebec			
		Hazard and indicator lights				
		Front and rear lighting (including headlamps)				
	Seating	Fixings and Fastenings	PROCESS PRODUCTS LIMITED, 920 Caledonia Road, Unit 3, Toronto, Ontario M6B3Y1	1%	5%	0.05%
		Interior passenger seats				

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
	Vehicle Train Control System	Vital onboard computer				
		Axle speed detectors				
		Wiring and connectors				
		Vehicle location system				
		Fixings and Fastenings				
		Antenna				
		Doppler shift modules				
	Communication Equipment	Public address system (including loudspeakers)	ALSTOM POWER & TRANSPORT CANADA INC., 1010 Rue Sherbrooke Ouest, Montreal, Quebec	1%	90%	0.9%
		Passenger Emergency Intercom (PEI)				
		Integrated Diagnostics and Fault Reporting System				
		Electronic Displays (PIS/ PID)				
		CCTV system				
		Event recorder	BACH-SIMPSON, a Division of WABTEC Canada Inc., 109 Meg Drive, PO Box 5484, London Ontario Canada N6A4L6			
		Hi-speed data radio and antenna	ALSTOM POWER & TRANSPORT CANADA INC., 1010 Rue Sherbrooke Ouest, Montreal, Quebec			
		Train computer				
		Radio and radio antenna				
		Wayside communication system				
	Glazing	Vandal-resistant sacrificial film	PRELCO INC., 94 Boulevard Cartier, Riviere-Du-Loup, Quebec, Canada	1%	65%	0.65%
		Laminated glass panes				
		Rubber trim/ sealant				
Soft Costs	Labour		MSF, Ottawa, Ontario	9%	85%	7.7%
	Project Management			6%	20%	1.2%
	Engineering			16%	5%	0.8%
	Manuals, Training, Simulators			0.5%	0%	0.0%
	Special Tools			0.3%	0%	0.0%
	Test Equipment			2%	70%	1.4%
	Freight			0.2%	100%	0.2%

	Sub-Systems	Typical Components (but not limited to these)	Manufacturer's name and address	% of Vehicle Contract Total Value	% of Canadian Content	% of Vehicle Supply Costs from Canadian Sources
	Warranty		MSF, Ottawa, Ontario	3.3%	100%	3.3%
	Totals			**100%**		**27.1%**

The individual ratios indicated in this table are indicative and are not contractual. Local content for specific items may change during the process of design development and development of specifics of each supplier's scope of supply. The total Canadian Content of the Vehicles shall comply with the Canadian Content policy, and specifically shall be at least 25%.

APPENDIX A4
VEHICLE COMPLIANCE MATRIX

ALSTOM CLAUSE BY CLAUSE TO SPECIFICATION : OLRT - PA - Schedule 15-2 Part 4 rev 4.1

updated on 24/01/2013 - comment on clause 3.23.h.iii deleted

Chap	Description V4.1	Compliance	Comments / Proof
3	**REVENUE VEHICLES**		
3.1	**Introduction**		
3.1.a	The LRV shall be a minimum 70% low floor LRV, 2.65m to 3m wide, no less than 28m long with low floor heights of 356mm to 550mm above top of rail (see Section 3.6 Vehicle Dimensions) and shall be in accordance with the following criteria:	Compliant	100 % low floor
3.1.a.i	The LRV (and resulting train consist) is fully compliant with the ridership and capacity requirements outlined in Schedule 15-2, Part 1 Article 2 – Operational Performance Requirements;	Compliant	
3.1.a.ii	The vehicle characteristics (weight, width, length and floor height), its dynamic envelope and the required station platform widths shall fit within the limitations of the right of way;	Compliant	
3.1.a.iii	The vehicle characteristics (weight, width, length and floor height), shall be consistent with the City's decision for the OLRT Project to protect for a future unified low-floor rail network;	Compliant	
3.1.a.iv	An existing Service Proven Vehicle design suitable for the OLRT Project; and	Compliant	
3.1.a.v	Project Co shall be responsible for coordinating Platform width and height with LRV dimensions. to meet the ridership requirements and comply with all applicable building and safety codes,	Compliant	
3.1.a.vi	Project Co shall ensure that vehicle weight, axle loads and resonant frequency are compatible with new and existing infrastructure,	Compliant	
3.1.b	30 metre Vehicles shall be fitted with a cab in one or both ends of the Vehicle. The non-cab end shall include a hostler panel for limited operation, including yard moves. If vehicles longer than 40 metres are proposed, cabs shall be provided on both ends.	Compliant	
3.1.c	Foldable or retractable couplers shall allow the use of coupler covers at the extreme ends of the consists while still affording quick coupling and uncoupling. The coupler cover movement and coupler extension shall be manually operated. Coupling (mechanical and electrical) shall be automatic.	Compliant	
3.1.d	The Vehicles shall utilize CBTC for ATO with ATP. Drivers shall be able to manually control the opening and closing of the doors. The Driver may pull back on the master controller at any time to decelerate the Train. Emergency braking shall also be available through the emergency brake pushbutton on the drivers control panel and from the TSCC.	Compliant	
3.1.e	Future expansions of the System could involve operation in a partially segregated right-of-way with level crossings. Manually controlled ATP operation shall be utilized in these sections of the Alignment and the Vehicles shall be capable of operating in such conditions.	Compliant	
3.2	**Vehicle Capacity**		
3.2.a	The design of the vehicle in conjunction with other system elements shall support the requirements outlined in Article 2 Operational Performance Requirements.	Compliant	
3.2.b	Doorways shall be located such that all doors of the consist align with the Platform at all times without undue tolerance restrictions on consist position at any Station.	Compliant	
3.2.c	Vehicles shall be designed with features to limit dwell time and maximize Passenger capacity. Wide double leaf doors and seats arranged for maximum aisle width shall accelerate boarding and alighting times.	Compliant	
3.3	**Operating Environment**		
3.3.a	The Vehicle shall be compatible with and designed to operate safely and reliably over the OLRT Alignment. Project Co shall ensure that the requirements and interfaces of the System are adhered to with specific emphasis on the following articles:	Compliant	
3.3.a.i	Part 2 – Guideway	Compliant	
3.3.a.ii	Part 3 – Tunnels	Compliant	
3.3.a.iii	Part 4 Article 2 – Traction Power	Compliant	
3.3.a.iv	Part 4 Article 5 – Train Control	Compliant	
3.3.a.v	Part 4 Article 6 – Communications	Compliant	
3.3.a.vi	Part 4 Article 8 – Overhead Catenary System	Compliant	
3.3.a.vii	Part 5 – Stations and	Compliant	
3.3.a.viii	Part 6 – Maintenance and Storage Facility	Compliant	
3.3.b	Any conflicts between these documents shall be brought to the attention of the City for resolution.	Compliant	
3.4	**Environmental Conditions**		
3.4.a	The Vehicle shall be capable of operation at the performance levels stated in this Article under the following environmental conditions and the requirements of Schedule 15-2 Part I Article 4 :	Compliant	
3.4.a.i	Thermal shock temperature change : 58°C;	Compliant	
3.4.a.ii	Humidity : 10 to 100%;	Compliant	
3.4.a.iii	Continuous rain fall rate : 60mm/hr;	Compliant	
3.4.a.iv	Continuous snowfall rate : 55mm/hr;	Compliant	
3.4.a.v	Freezing rain accretion : 5mm/hr;	Compliant	
3.4.a.vi	Maximum daily freezing rain accretion : 30mm;	Compliant	
3.4.a.vii	*Fording*	Compliant	
3.4.a.vii.A	Water : 75mm above top of rail; and	Compliant	
3.4.a.vii.B	Snow : 40cm above top of rail.	Compliant	A snow plough is proposed to invrease the avaibility of the vehicle in such extreme conditons. Speed restricitons may be proposed in project phase according to density, height of the snow.
3.4.b	The Vehicle shall be resistant to water intrusion under any combination of wind, rain or snow and any Vehicle speed. This shall include passage of the Vehicle through the car wash facility.	Compliant	
3.5	**Vehicle Design Requirements**		
3.5.a	Vehicles shall be equipped with automatic couplers on each end. To couple Vehicles together, the Driver shall manually raise the front bumper of the Vehicle to expose the coupler. Once the cover is raised, manual unfolding of the coupler may be followed by automatic coupling. The raised position of the front bumper/coupler cover shall not obstruct the driver's vision to accomplish safe coupling or foul the body during turns on super elevated Track. In the closed position, the coupler cover shall blend seamlessly with the cab side skirts.	Compliant	
3.5.a i	If Project Co elects to operate pairs, or triplets, as coupled consists, at all times during Revenue Service, coupled ends of Vehicles may be fitted with standard automatic couplers and the requirement for a coupler cover may be omitted. Exposed ends of the consist shall always be fitted with a folded coupler and coupler cover.	Compliant	
3.5.b	Vehicles shall include intra-car barriers between coupled ends to prevent inadvertent access between cars. Alternatively, platforms may be arranged with barriers located at all intra-car locations of all consist arrangements for Revenue Service.	Compliant at Global system level	Platforms will be arranged with barriers located at all intra-car locations
3.5.c	LRVs shall be arranged in articulating body sections supported by independent trucks. Brake discs shall be provided on all axles. The vehicles shall be fitted with Track brakes.	Compliant	
3.5.d	In order to meet the Operational Performance Requirements, the seating shall be arranged with longitudinal seating throughout the length of the low floor section of the LRV, to the maximum extent possible.	Compliant	
3.5.e	Flip seats shall be adjacent to all vestibules to provide clear floor space to accommodate wheelchairs, baby carriages, bicycles and the other passenger requirements. Flip seats shall be arranged to revert to the stowed position with less than 20N of force. Lowering the flip seats into position shall require not more than 40N.	Compliant	
3.5.f	Hand holds, grab bars and stanchions shall be arranged to provide comfort for standees.	Compliant	
3.5.g	The door design shall be supported by passenger flow calculations, schedule and dwell times. A minimum of eight dual leaf, electrically operated sliding plug doors shall be provided for every 30 metres of Vehicle length.	Compliant	
3.5.h	Each LRV shall include load levelling. Project Co shall ensure the height and Platform gap are within the limits of the ADA, as referenced in the AODA. Project Co shall provide a method to adjust Vehicle height for wheel and rail wear. The height adjustment device shall provide clear indication of the level of adjustment provided on both sides of the truck.	Compliant	
3.5.i	Each LRV shall be powered from an OCS by a pantograph.	Compliant	
3.5.j	The LRV shall be designed for maximum availability, be capable of operating reliably for a minimum of 100,000km per year and provide a minimum service life of 30 years.	Compliant	
3.6	**Vehicle Dimensions**		
3.6.a	Vehicle dimensions shall be in accordance with the requirements of Table 4-3.1.	Compliant	
3.6.a.i	Table 4-3.1		
3.6.a.ii	Description OLRT LRV		
3.6.a.iii	Width at threshold : 2,650mm to 3,000mm	Compliant	

3.6.a.iv	Vehicle maximum width (not including side mounted lights, cameras, etc) : 3,000mm	Compliant	
3.6.a.v	Height over roof shrouds, maximum. ATOR : 3,600mm	Compliant	
3.6.a.vi	Height over roof Equipment, maximum. ATOR : 3,800mm	Compliant	
3.6.a.vii	Height to top of low floor (with new wheels) ATOR : 356mm to 550mm	Compliant	
3.6.a.viii	Minimum Aisle width at articulation joints : 1,200mm	Compliant	
3.6.a.ix	Minimum Aisle width 600mm	Compliant	
3.6.a.x	Aisle width at accessible areas, minimum (AODA/ADA requirement) : 813mm	Compliant	
3.6.a.xi	Side door width with doors open, minimum : 1,220mm	Compliant	
3.6.a.xii	Height – floor to top of door opening, minimum : 2m	Compliant	
3.6.a.xiii	Height floor to ceiling, low floor, minimum : 2,200mm	Compliant	
3.6.a.xiv	Height floor to ceiling, high floor, minimum : 2,000mm	Compliant	
3.6.a.xv	Door protrusion from Vehicle when open, maximum : 75mm	Compliant	
3.6.a.xvi	Maximum Truck wheel base : 2,000mm	Compliant	
3.6.a.xvii	Wheel Diameter new : 600mm to 700mm	Compliant	
3.6.a.xviii	Wheel wear allowable, minimum diameter reduction : 50mm	Compliant	
3.6.a.xix	*Note : The Vehicle dimensions (length, width and floor height), its dynamic envelope and platform widths required by code shall fit within the limitations of the right of way.*	Compliant	
3.7	**Clearance Requirements**		
3.7.a	Clearance dimensions shall be in accordance with the requirements of Table 4-3.2.	Compliant	
3.7.a.i	Table 4-3.2		
3.7.a.ii	Description OLRT LRV		
3.7.a.iii	Underfloor Equipment, minimum : 120mm	Compliant	
3.7.a.iv	Truck clearance, minimum (except sand nozzles) : 50mm	Compliant	
3.7.a.iv	Truck to carbody clearance, minimum : 15mm	Compliant	
3.7.a.vi	Coupler cover in the closed position : No greater than 250mm TOR	Compliant	
3.8	**Vehicle Weight Definition**		
3.8.a	*Project Co shall consider options for weight reduction during the Design phase to maximize the energy efficiency of the LRT System and shall determine the Vehicle weight for the Vehicle in accordance with the definitions outlined in Table 4-3.3.*	Compliant	
3.8.a.i	Table 4-3.3		
3.8.a.ii	Description (1) - Definition		
3.8.a.iii	AW0 – LRV empty weight (Tare) + dry sand	Compliant	
3.8.a.iv	AW1 – Fully seated Passenger load and one Driver + AW0	Compliant	
3.8.a.v	AW2 – Standees at 4 Passengers/m2 of suitable standing space + AW1	Compliant	
3.8.a.vi	AW3 – Standees at 6 Passengers/m2 of suitable standing space + AW1	Compliant	
3.8.a.vii	AW4 – Standees at 8 Passengers/m2 of suitable standing space + AW1 (Structural design load, not expected for Revenue Service)	Compliant	
3.8.a	*(1) Note: 70 kg/passenger shall be utilized in all weight calculations.*	Compliant	
3.8.b	The Vehicles shall be designed to balance weight per powered axle.	Compliant	
3.8.c	The maximum allowed lateral imbalance shall be 2700Nm:	Compliant	
3.8.c.i	The maximum allowed weight deviation supported by each truck shall be 910kg.	Compliant	the maximum deviation between a single truck load and the average truck load in normal operating conditions (3.33 pass/m²). This requirement appears to be in contradiction with requirement (ii). Non compliant on other configuration
3.8.c.ii	For 30 metre Vehicles, the center truck shall support a minimum of ¼ of the total empty Vehicle weight. For longer vehicles, each truck shall support no less than 12,000 kg of empty Vehicle weight.	Compliant	our proposal is not a 30 m length
3.8.c.ii.A	Centre Truck(s) loading requirements shall be maintained under all conditions of accelleration and deceleration ;	Compliant	
3.9	**Noise, Shock and Vibration Requirements**		
3.9.a	Noise internal to the Vehicle shall be less than:		
3.9.a.i	68dBA with the Vehicle stationary and all Equipment running in Revenue Service conditions;	Compliant	
3.9.a.ii	78dBA at Vehicle speeds up to 100km/hr; and	Compliant	with track roughness compliant with ISO3095
3.9.a.iii	80dBA in the Tunnel sections of the right of way, at Vehicle speeds up to 65km/hr.	Compliant	
3.9.b	All measurements of exterior noise levels shall be made with the Train on or operating on level, tangent track in a free-field environment, such as outdoors, away from any reflecting surfaces. Noise external to the Vehicle, shall not exceed:	Compliant	
3.9.b.i	70dBA, when measured 20m from a stationary LRV; and	Compliant	
3.9.b.ii	80dBA, when measured 20m from a Train traveling at 100km/hr, and braking.	Compliant	with track roughness compliant with ISO3095
3.9.c	Vibration shall not exceed:		
3.9.c.i	Levels required to successfully pass the Ride Quality Test conducted per ISO2631 in Vehicles traveling at speeds from 0km/hr to 100km/hr. Testing shall take into account Track conditions when determining ride quality.	Compliant	
3.9.d	Carbody mounted Equipment shall resist shock loads of:		
3.9.d.i	2g lateral, 3g vertical, and 5g longitudinal.	Compliant	
3.10	**System Voltage**		
3.10.a	OAll Equipment shall function at the nominal OCS voltage as per IEC 60850 and subsystems shall function throughout voltage ranges allowed by EN 50155.	Compliant	Our propulsion and auxiliary power supply system work correctly following OCS voltage as defined inside EN50163. The nominal voltage takes into account is 1500V at OCS level
3.11	**Electrical Equipment Environmental Conditions**		
3.11.a	All Vehicle electronic Equipment shall function reliably under power quality conditions detailed in EN 50155, unless otherwise specified. Where environmental conditions listed in this section are more severe, those conditions shall take precedence over EN 50155.	Compliant	
3.12	Performance Requirements		
3.12.a	Performance shall be in accordance with the requirements of Table 4-3.4.	Compliant	
3.12.a.i	Table 4-3.4		
3.12.a.ii	Parameter(1)		
3.12.a.iii	Maximum speed : ≥100km/hr	Compliant	
3.12.a.iv	Acceleration		
3.12.a.v	Initial Maximum Vehicle Acceleration, OCS voltage ≥ nominal OCS voltage, AW2 loading : ≥1.34m/s2 ± 5%	Compliant	
3.12.a.vi	Speed for Initial Tractive Effort for OCS voltage ≥ nominal OCS voltage ≥32km/hr(2)	Compliant	as for 3.12.a.v
3.12.a.vii	Electric Braking		
3.12.a.viii	Electric brake type : Regenerative/rheostatic with line voltage control	Compliant	
3.12.a.ix	Full service electric brake rate at AW3 loading : 1.34m/s2 from 64km/hr to 5km/hr with electric brake fade below 5km/hr and taper above 64km/hr	Compliant	as for 3.12.a.v
3.12.a.x	Blended Braking		
3.12.a.xi	*Full service blended electric + friction brake rate at AW3 loading : 1.34m/s2 from 80km/hr to standstill*	Compliant	
3.12.a.xii	*Maximum service brake rate (electric/friction blended + Track brakes) at loads up to AW3 : ≥2m/s2 from 88km/hr to standstill*	Compliant	
3.12.a.xiii	Friction Brakes		
3.12.a.xiv	Friction brake type : Hydraulic Apply Disc Brakes with spring apply Parking Brake	Compliant	
3.12.a.xv	Full service brake rate (friction only) at loads up to AW3 : 1.34m/s2 +/- 10% from 80km/hr to standstill	Compliant	
3.12.a.xvi	Emergency Brakes		
3.12.a.xvii	Friction only at loads up to AW3 (with sanding as required) : 1.78m/s2 +20%/-10% starting from 80km/hr to standstill	Compliant	
3.12.a.xviii	Emergency Brake from irretrievable emergency brake switch		
3.12.a.xix	Initiated by emergency pushbutton (friction + Track brakes) at loads up to AW3 : ≥2.5m/s2 – 0.006m/s2 per km/h, starting above 48 km/hr and > 2.24m/s2 starting from less than 48 km/hr (standing to no motion)	Compliant	
3.12.a.xx	Parking Brake		
3.12.a.xxi	Parking brake capacity : Shall hold an AW3 Vehicle on a 6% grade, indefinitely.	Compliant	
3.12.a.xxii	Jerk Rates and Transition Dead Time Limits		

3.12.a.xxiii	*Jerk rate limit : Adjustable 0.44m/s3 to 1.34m/s3*	Compliant	Our equipments allows jerk rate configuration within the range of 0.44m.s-3 to 1.34m.s-3. Nominal performances have been calculated with a jerk rate within the range of 0.8m.s-3 to 1.2m.s-3. The most suitable jerk rate value will be adjusted during testing phase. There is no jerk management in Emergency Brake.
3.12.a.xxiv	*(1) Note : Acceleration and braking rates assume that adhesion is not the limiting factor.*	Compliant	However following our know-how on LRV market we applied our internal adhesion limit values. Be carefull with adhesion limit in Emergency Brake. The adhesion limit values to reach the EB performances are above AT experiences in LRV market
3.12.a.xxv	*(2) Note : Alternative knee points may be considered if an analysis of operational performance indicates that the proposed reduction in acceleration rate will have an insignificant impact on trip time.*	Compliant	
3.12.b	Propulsion Thermal Normal Duty Cycle Requirements		
3.12.b.i	With an AW3 loading, maximum ambient temperature, maximum variation in wheel diameters and a line voltage between nominal OCS voltage and nominal OCS voltage less 16.7%, an LRV Train shall be able to operate continuously over the entire length of the OLRT. The Train shall accelerate at the maximum rate up to maximum CBTC controlled speeds and decelerate at 0.89m/s2 for Station stops. No part of the propulsion system shall exceed the manufacturer's recommended temperature limits for a 30 year life.	Compliant	
3.12.c	Propulsion Thermal Degraded Continuous Duty Requirements		
3.12.c.i	With an AW2 average loading, maximum ambient temperature, maximum allowed variation in truck wheel diameters and a line voltage between nominal OCS voltage and nominal OCS voltage less 16.7%, an LRV Train shall be able to operate continuously over the entire length of the OLRT line with 25% of the propulsion systems cut-out. The Train shall accelerate with the maximum remaining tractive effort and decelerate at 0.89m/s2 for Station stops. No part of the propulsion system shall exceed the manufacturer's recommended temperature limits for a 30 year life.	Compliant	
3.12.d	Towing Duty Requirements		
3.12.d.i	At AW3, maximum ambient temperature, maximum allowed variation in truck wheel diameters and a line voltage between nominal OCS voltage and nominal OCS voltage less 16.7 %, any LRV Train shall be able to tow an equal length, equal weight dead LRV Train between any two Stations. No over temperature shut down shall occur and no part of the propulsion system shall exceed the manufacturer's limits for a 30 year life.	Compliant	
3.12.d.ii	At AW0, maximum ambient temperature, maximum allowed variation in truck wheel diameters and a line voltage between nominal OCS voltage and nominal OCS voltage less 16.7%, any LRV Train shall be able to tow an equal length dead LRV Train the entire length of the line. The speed through Stations shall be limited to 16km/h. No over temperature shut down shall occur and no part of the propulsion system shall exceed the manufacturer's limits for a 30 year life.	Compliant	
3.13	**Maintenance Based Requirements**		
3.13.a	Project Co shall provide, at a minimum, LRVs with the following:		
3.13.a.i	*All major Vehicle systems shall be provided with diagnostic and fault logging capability with central fault data storage in each Vehicle. Faults shall be reported to a central maintenance computer. Fault and maintenance records shall be available to the City for inspection and review, at the City's request.*	Compliant	
3.14	**3.14 Safety**		
3.14.a	FMECA		
3.14.a.i	Project Co shall perform a FMECA to identify weaknesses in system-wide hardware and software Design, and to analyze the modes and effects of failures whenever these details are not established by historical records of Equipment operation. The FMECA shall provide input to system Designs and to the Safety analyses for theoretical circuit behaviour, random component failures, electrical interference, systematic component failures, and software errors in software-based logic. The FMECA shall be updated throughout the system design development and throughout the operational life of the OLRT system	Compliant	
3.14.b	**Hazard Analysis**		
3.14.b.i	A PHL, a SSHL and a SHL shall be prepared and submitted as part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	
3.14.b.ii	Project Co shall identify failure-induced and normal operating (non-failure condition) hazards falling into severity Categories I, II and III (as defined in MIL-STD-882) Hazards shall be compiled into a PHL, SSHL, and SHL. The following hazards shall be included in the listings and shall be considered hazards of Category I or II severity:	Compliant	
3.14.b.ii.A	Emergency brakes fail to apply when requested;	Compliant	
3.14.b.ii.B	Service brakes fail to apply when requested;	Compliant	
3.14.b.ii.C	Propulsion fails to cease when requested;	Compliant	
3.14.b.ii.D	Propulsion fails to cease when Emergency Brake is requested.	Compliant	
3.14.b.ii.E	No-motion detection system indicates no-motion when Train is moving;	Compliant	
3.14.b.ii.F	Door opens spontaneously when not commanded;	Compliant	
3.14.b.ii.G	Door opens on wrong side of car;	Compliant	
3.14.b.ii.H	Door closes on person's object and indicates door closed and locked to the control system;	Compliant	
3.14.b.ii.I	Door interlocks erroneously indicate door is closed and locked;	Compliant	
3.14.b.ii.J	Excessive currents or overheated equipment cause fire hazard;	Compliant	
3.14.b.ii.K	Indication of uncoupled when not uncoupled;	Compliant	
3.14.b.ii.L	Train moves in wrong direction;	Compliant	
3.14.b.ii.M	Slide control does not reapply brakes after slide correction;	Compliant	
3.14.b.ii.N	Cars in Train separate when not commanded; and	Compliant	
3.14.b.ii.O	Train regenerates into dead section of catenary.	Compliant	
3.14.c	Project Co shall perform a hazard analysis on all hazards identified above, in accordance with the requirements of Part 1 Article 10 – Safety and Security Certification.	Compliant	
3.15	**Electromagnetic Compatibility**		
3.15.a	All LRVs and related equipment shall comply with the EMC management plan described in Part 4 Article 9 – EMI/EMC.	Compliant	For harmonic emission requirements, not yet specified, AT will have to evaluate the impacts on actual input filter.
3.15.b	An analysis shall be provided showing that no Safety or signal Equipment shall be affected by Vehicle emissions.	Compliant	
3.16	**Fire Safety**		
3.16.a	Fire Safety shall be achieved through adherence to the following requirements or equivalent specifications:	Compliant	
3.16.a.i	All non-metallic components used on the Vehicle shall be smoke, flame and toxicity tested to NFPA 130, 49 CFR part 238 and BSS 7239. Maximum smoke developed, flame spread indices and toxicity limits are outlined in Section 3.31 of this Article;	Compliant	
3.16.a.ii	Project Co shall retain a list of materials (flammability matrix) used in the Vehicles showing location of material, weight (density and total weight), heat value per kg and per Vehicle, flame spread, flashpoint, smoke generation, and toxicity. Project Co shall retain and manage test results for each component for the operating life of the Vehicle.	Compliant	
3.16.a.iii	All heat sources on the Vehicle shall be protected with redundant levels of protection so that circuits are open before unsafe temperatures exist;	Compliant	
3.16.a.iv	Smoke detectors shall be located in fresh air intake section of each unit;	Compliant	
3.16.a.v	Automatic dampers shall prevent the introduction of external smoke from entering the Vehicle;	Compliant	
3.16.a.vi	Protection from smoke and fire originating under the Vehicle floor or through the roof shall be proven through test reports documenting successful completion of a 30 minute roof and floor fire test in accordance with ASTM E119, NFPA 130, and 49 CFR part 238;	Compliant	
3.16.a.vii	Two fire extinguishers shall be located in each cab;	Compliant	
3.16.a.viii	An interior manual door release shall be provided for each side door; and	Compliant	
3.16.a.ix	An exterior manual door release shall be provided for each side door.	Compliant	
3.17	**Carbody**		
3.17.a	Carbody General Requirements		
3.17.a.i	The front and rear ends of the Vehicle shall meet the structural and crashworthiness requirements of all the related standard and requirements outlined in this Article.	Compliant	
3.17.a.ii	The car shall be constructed of the following materials:		
3.17.a.ii.A	Stainless steel utilizing AISI type 301LN or approved equivalent (non-corrugated);	Compliant	
3.17.a.ii.B	HSLA per ASTM A588 or approved equivalent;	Compliant	
3.17.a.ii.C	Stainless steel, HSLA or FRP sidewalls; and	Compliant	

3.17.a.ii.D	Aluminum, in the following alloys: 6061-T6, 5083-H111, 6082, 6005A, 6008, 6106 T6, 5454 H24 and 5754 H26. 2000 and 7000 series alloys shall not be used. Vehicles which offer aluminum carbodies shall include a full analysis of the effects of salt. Analyses shall prove compliance with the required life expectancy below.	Compliant	
3.17.a.iii	The carbody shall have a 40 year expected life.	Compliant	
3.17.b	Carshell Design features		
3.17.b.i	Equipment arranged for ease of service.	Compliant	
3.17.b.ii	Roof fairings that provide aesthetically pleasing body lines.	Compliant	
3.17.b.iii	Roof drainage through interior drain tubes terminating under the car.	Compliant	
3.17.b.iii.A	The Design shall include features that prevent water from draining over the sides or ends of the Vehicle.	Compliant	
3.17.b.iii.B	The structure shall be designed to eliminate all water traps.	Compliant	
3.17.b.iv	An exterior that is smooth and free of corrugations and that will allow effective vinyl wrapping.	Compliant	
3.17.b.iv.A	The body sides of Vehicle shall be flat or include a designed curve. Deviations shall not exceed 2.5mm over 1m.	Compliant	
3.17.b.v	A carshell finish that is graffiti resistant, and does not promote snow and ice adhesion.	Compliant	
3.17.c	Thermal and Acoustical Insulation		
3.17.c.i	Thermal insulation shall be installed throughout the Vehicle, such that all exterior walls, floor and ceiling to meet energy objectives.	Compliant	
3.17.c.ii	Sweating shall not occur on any interior or exterior surface under any temperature or humidity level.	Compliant	
3.17.c.iii	Acoustical insulation shall be utilized as required to meet the noise requirements outlined in this article.	Compliant	
3.17.d	Articulation Section		
3.17.d.i	All aspects of the articulation shall be service proven.	Compliant	
3.17.d.ii	Articulation sections shall be proven per ASME RT-1, or equivalent, by static compression test. Collision requirements of ASME RT-1 shall be proven by calculation.	Compliant	
3.17.d.iii	Articulations shall include interior and exterior flexible bellows that provide a water-tight seal and prevent Passenger exposure to pinch points. Bellows shall be compliant to the smoke, flammability and toxicity limits of this article. Exterior bellows shall be flush with the exterior surface of the side walls.	Compliant	
3.17.d.iv	Articulation sections shall be designed to allow a free flow of Passengers between body sections. Minimum aisle width through the articulation shall be 1.2m. Hand holds shall be provided throughout the articulation section.	Compliant	
3.17.d.v	The floor panels shall be arranged to allow relative motion between body sections and allow easy access to the articulation joint. The Design shall not present a trip hazard under any conditions of movement, including rotation about the longitudinal axis (body roll).	Compliant	
3.17.e	Carshell structural features shall include:	Compliant	
3.17.e.i	A full width anticlimber on each end of the Vehicle;	Compliant	
3.17.e.ii	A coupling speed up to 8km/hr with no resulting damage to coupler or anchorage. Replaceable energy absorption components of the coupler are excluded from this requirement;	Compliant	
3.17.e.iii	Provisions for Vehicle towing;	Compliant	under speed restriction according to train configuration
3.17.e.iv	The structural integrity shall be to ASME RT-1 or equivalent and protect the driver and passengers;	Compliant	
3.17.e.v	Sufficient jacking pads to allow Vehicle jacking during maintenance and in the case of derailment. Jacking pad locations shall be coordinated with the requirements of Part 6 – MSF and rerailing equipment. The position of the jacking pads shall be identified on the carshell ;	Compliant	
3.17.e.vi	Pilot beams, skirting and an energy absorbing front bumpers to prevent structural damage or entrapment of struck objects;	Compliant	
3.17.f	Carshell Strength Requirements		
3.17.f.i	Strength requirements shall be in accordance with ASME RT-1 or equivalent.	Compliant	
3.17.f.ii	If EN 12663 is proposed as an alternate specification for carshell strength, the Vehicle shall meet the requirements of category P-III.	Compliant	
3.17.g	Carshell Collision Resistance Requirements		
3.17.g.i	Collision resistance requirements shall be in accordance with the requirements of ASME RT-1 or equivalent.	Compliant	
3.17.g.ii	If EN 15227 is proposed as an alternate specification for collision resistance, crushable elements shall be tested in accordance with the requirements contained therein. The Vehicle shall meet the requirements of category C-III.	Compliant	
3.17.h	Carshell Qualification Testing		
3.17.h.i	The first carshell shall be evaluated and certified to comply with the strength requirements and collision crashworthiness of ASME RT-1 or equivalent.	Compliant	
3.18	**Coupler and Draft Gear**		
3.18.a	General		
3.18.a.i	The couplers shall be fully optimized for the Vehicle Design, for both initial and future operation. Full Train consists shall be fully functional, including capability to pull or push another full Train consist.	Compliant	
3.18.a.ii	The coupler shall be equipped with an energy absorption device and a shear off device that contains the coupler while allowing front end deformation under crash conditions.	Compliant	
3.18.b	The coupler shall:	Compliant	
3.18.b.i	Be foldable or retractable to allow concealment by front bumper/coupler cover;	Compliant	
3.18.b.ii	The coupler cover shall be easily removable for cars that are configured to operate as a pair. The cover may be omitted from the design and a standard non-foldable coupler may be utilized for Vehicles that be permanently coupled (a married pair) during Revenue Service, as long as exposed ends of the consist are fitted with a folded coupler and coupler cover;	Compliant	
3.18.b.iii	Lock in the folded and unfolded position. Easily accessible handles shall lock/unlock the coupler;	Compliant	
3.18.b.iv	Be a service proven Design;	Compliant	
3.18.b.v	Use an automatic centering device that is negatable for coupling on curve;	Compliant	
3.18.b.vi	Contain (10%) spare pins on electrical heads;	Compliant	
3.18.b.vii	Be able to transmit VMS data signals and communications network signals across the coupled interface;	Compliant	
3.18.b.viii	Be equipped with a weather protective device to protect couplers from rain, ice and snow;	Compliant	
3.18.b.ix	Include manual coupling/uncoupling lever(s);	Compliant	
3.18.b.x	Be equipped with heaters for coupler faces. Additional heaters shall be provided if they are required to ensure reliable operation in Ottawa climatic conditions; and	Compliant	
3.18.b.xi	The Vehicle shall be provided with redundant LVPS units or coupler pins for B+ and B- suitable for providing low voltage power to all low voltage loads of the adjacent Vehicle (not including battery charging).	Compliant	
3.18.c	Safety		
3.18.c.i	Coupler control shall be interlocked with the no motion relay.	Compliant	
3.18.c.ii	Couplers shall be provided with shear bolts or equivalent to allow anti-climbers to engage in the event of an accident.	Compliant	
3.18.c.iii	Couplers shall be capable of retreating rearward in a crash to allow complete collapse of all 3 crash energy management zones, as required in ASME RT-1-2009 or equivalent.	Compliant	
3.18.d	Coupler Type Tests		
3.18.d.i	The first coupler shall be evaluated or certified to meet the requirements of operation within the OLRT System. Manual force requirements shall not exceed the limits for 5th percentile females as detailed in MIL-STD-1472, latest edition:	Compliant	
3.18.d.i.A	Static design load test (a maximum length consist pushing or towing an equal length consist);	Compliant	
3.18.d.i.B	Shear pin/crushable Element test (shall not deform under test A or during compression tests);	Compliant	
3.18.d.i.C	C. Gathering range test (shall be sufficient to couple under all possible scenarios foreseeable in revenue or non revenue service on the mainline or in the MSF);	Compliant	
3.18.d.i.D	Lateral force test;	Compliant	
3.18.d.i.E	Manual lever force test;	Compliant	
3.18.d.i.F	Maximum coupler Swing (shall be sufficient to negotiate all mainline and yard track);	Compliant	
3.18.d.i.G	Centering device test;	Compliant	
3.18.d.i.H	Electric coupler Water test (car wash); and	Compliant	
3.18.d.i.I	Electric coupler ice and snow test (exposed in snow or ice storm).	Compliant	
3.18.e	Coupler Routine Tests	Compliant	
3.18.e.i	Each unit shall pass a routine test before shipment from the supplier factory.	Compliant	
3.19	**Cab Equipment and Controls**		

3.19.a	The cab shall be a spacious, ergonomic, Driver friendly environment. It shall be full width, separated from the Passenger area by a full partition and a lockable cab door. The cab shall provide the Vehicle with an aesthetically pleasing, modern look. Large windows on all four sides of the cab shall not only add to the style but shall also provide excellent visibility to the Driver, which shall contribute to the Safety of the System.	Compliant	
3.19.b	All controls necessary to operate the Vehicle, including circuit breakers, cut-out and bypass switches, shall be located in the cab. The arrangement and location of the controls and seat, visibility and overall comfort provided to the Driver shall be reviewed and approved during the mock up review.	Compliant	
3.19.c	Cab shall be as follows:	Compliant	
3.19.c.i	A full width contoured front windshield	Compliant	
3.19.c.i.A	Designed to minimize glare and interior reflection.	Compliant	
3.19.c.i.B	Laminated Safety glass, FRA Type 1, clear.	Compliant	
3.19.c.i.C	Electrically heated.	Compliant	
3.19.c.ii	Cab side windows;	Compliant	
3.19.c.ii.A	Horizontal sliding panel on both sides of cab.	Compliant	
3.19.c.ii.B	Latch easily operated by Driver.	Compliant	
3.19.c.ii.C	Glazing to be laminated Safety glass.	Compliant	
3.19.c.iii	Side windows; and	Compliant	
3.19.c.iii.A	Fixed horizontal panels on both sides.	Compliant	
3.19.c.iii.B	Maximized in size to contribute to the modern feel of the vehicle.	Compliant	
3.19.c.iii.C	Glazing to be laminated Safety glass.	Compliant	
3.19.c.iv	Partition Wall Windows.	Compliant	
3.19.c.iv.A	Large windows on door and both sides of partition, if practical.	Compliant	Only one side due to electrical cabinet
3.19.c.iv.B	Glazing to be laminated Safety glass.	Compliant	
3.19.d	Driver's Console		
3.19.d.i	A full width, modern, wrap-around style console shall be located at the center line of the Vehicle. The console shall be sealed to IP55 or NEMA equivalent. The console shall include the following:	Compliant	
3.19.d.i.A	All device controls, switches and pushbuttons;	Compliant	
3.19.d.i.A.i	Controls shall be labelled with recessed, durable, contrasting coloured pictograms to avoid cluttering the appearance of the console.	Compliant	
3.19.d.i.B	Warning and status indicators (LED);	Compliant	
3.19.d.i.C	All speakers, buzzers or other audible warning devices;	Compliant	
3.19.d.i.D	Coupler controls;	Compliant	
3.19.d.i.E	Sanding pushbutton;	Compliant	
3.19.d.i.F	Silent alarm pushbutton;	Compliant	
3.19.d.i.G	A Master Controller, including:	Compliant	
3.19.d.i.G.i	*A transfer switch which uses a dedicated cab control key*	Compliant	
3.19.d.i.G.ii	*A spring loaded handle to activate the dead man circuit or alternative alertness system that reduces ergonomic impact on the driver; and*	Compliant	
3.19.d.i.G.iii	*A direction switch*	Compliant	
3.19.d.i.H	Alternative approaches to the Master Controller arrangement may be considered during the cab mock-up presentation.	Compliant	
3.19.d.i.I	A VMU and a VMU display screen	Compliant	
3.19.d.i.J	A CBTC panel;	Compliant	
3.19.d.i.K	Central dimming control knob for all displays and LED indicators	Compliant	
3.19.d.i.L	A Communication Control Panel which shall include interfaces to :	Compliant	
3.19.d.i.L.i	PEI	Compliant	
3.19.d.i.L.ii	Crew Intercom (cab to cab)	Compliant	
3.19.d.i.K.iii	PA (separate interior/exterior)	Compliant	
3.19.d.i.L.iv	Train voice radio (Public Safety Service Radio) as provided by others; and	Compliant	
3.19.d.i.L.v	*PIDS*	Compliant	
3.19.d.i.M	*A center forward facing camera with a clear view of the Tracks;*	Compliant	
3.19.d.i.N	Passenger door controls, which shall :		
3.19.d.i.N.i	Be a momentary recessed push buttons that preclude accidental activation. (collar type pushbutton); and	Compliant	
3.19.d.i.N.ii	Illuminated when activated (Color coded as follows: open = green, close = red, enable = yellow);	Compliant	
3.19.d.i.O	Irretrievable Emergency brake switch;	Compliant	
3.19.d.i.P	A low voltage voltmeter with a range as applicable for battery voltage; and	Compliant	
3.19.d.i.Q	An odometer.	Compliant	
3.19.e	Other Cab Controls		
3.19.e.i	Separate circuit breaker panels for each voltage.	Compliant	
3.19.e.ii	A bypass / cutout switch panel.	Compliant	
3.19.e.iii	A PTU interface panel for access to the Communications System and its attached systems.	Compliant	
3.19.e.iv	*Ventilation, cooling, and heating controls.*	Compliant	
3.19.e.v	*Platform camera monitor display screen(s).*	Compliant	
3.19.f	Cab Interior Appointments		
3.19.f.i	Hinged cab door, arranged to allow quick emergency egress into the passenger compartment (panic bar).	Compliant	
3.19.f.ii	Cab flooring, wall lining and ceiling consistent with passenger area.	Compliant	
3.19.f.iii	A lockable storage cab cabinet or box to store personal items. Volume shall be no less than 7,000cc.	Compliant	Size will be defined during project phase
3.19.f.iv	A fully adjustable, heated cab seat.	Compliant	
3.19.f.v	Independent cab heater with manual controls.	Compliant	
3.19.f.vi	Side window defrost (may be combined with cab heater).	Compliant	
3.19.f.vii	An adjustable footrest.	Compliant	
3.19.f.viii	Armrest(s).	Compliant	
3.19.f.ix	A fully adjustable visor for side and forward usage.	Compliant	
3.19.f.x	A recessed folding coat hook.	Compliant	
3.19.f.xi	A lockable convenience outlet.	Compliant	
3.19.f.xii	Two Fire extinguishers (10lb and 20lb, ABC).	Compliant	
3.19.f.xiii	deleted		
3.19.f.xiv	deleted		
3.19.f.xiii	Flashlight.	Compliant	
3.19.f.xiv	Flip down cab seat or alternative arrangement for training purposes.	Compliant	
3.19.f.xv	Lighting fixtures including:		
3.19.f.xv.A	Directionally adjustable and dimmable overhead lights on both sides of cab which shall be tied to the emergency lighting circuit; and	Compliant	
3.19.f.xv.B	Auxiliary lights for breaker and cutout switch panels.	Compliant	
3.19.g	Cab Exterior Appointments		
3.19.g.i	Windshield wipers:	Compliant	
3.19.g.i.A	Electrically operated (operable in the Lead cab only);	Compliant	
3.19.g.i.B	Speed control which includes Off, Low, High and adjustable Intermittent; and	Compliant	
3.19.g.i.C	*Blade shall park out of view and not be fouled by ice build-up.*	Compliant	
3.19.g.iii	Windshield washers with no less than 15 litres of washer fluid capacity.	Compliant	
3.19.g.iii	100dBA Horn with deflecting cone.	Compliant	
3.19.g.iv	85dBA Bell.	Compliant	
3.19.g.v	Three headlights, marker lights, turn signals.	Compliant	
3.19.h	Cab Mock up	Compliant	
3.19.h.i	Project Co shall build a mock-up of the cab, including cab console, Driver ergonomics, seating, window locations, cab wall and all cab amenities shall be reviewed with the City. Project Co shall implement any agreed ergonomic or functionality changes into the vehicle cab design.	Compliant	
3.19.i	Hostler Panel		
3.19.i.i	A hostler panel, if applicable, shall be provided to allow the Vehicle to be operated from the non-cab end of the LRV. The size and location of the hostler panel shall ensure that safe operation of the Vehicle can be performed while, at the same time, providing passenger seating/standee space to maximize Vehicle capacity.	Compliant	

3.20	**Passenger Doors and Controls**		
3.20.a	The passenger side door system shall be designed to afford minimum dwell time and shall be suitable for operations in the City of Ottawa environment in peak or non-peak times.	Compliant	
3.20.b	The door system shall be the bi-parting sliding plug type using high reliability overhead electric operators. Doors shall be arranged to ensure that the Platform may not be fouled under any circumstances.	Compliant	
3.20.c	Door Operator Design Features		
3.20.c.i	A single door operator shall control each pair of doors and ensure that the panels open and close simultaneously. The operator shall be a service proven Design with a history of reliability without the need for maintenance and adjustment. The door mechanism shall be suitable for operation in cold temperatures and snow and ice storms.	Compliant	
3.20.c.ii	The door operator shall be a simple, safe Design employing interlocking relay logic to prevent unintended operation. The door operator shall be interlocked with the no-motion relay.	Compliant	
3.20.c.iii	Door panels shall be closed and locked out of service with a mechanical lock which is independent from the motor and mechanically prevents panel movement. The lock shall cut out door motion, provide a close and locked indication to the door summary loop and energize a door out of service sign. Door operators shall operate from the low voltage battery power circuit.	Compliant	
3.20.c.iv	Door control operation, should provide the ability to adjust open and close time intervals using the maintenance PTU.	Compliant	
3.20.c.v	The door closing force shall not exceed the limits specified in APTA SS-M-18-10 or equivalent specification. Pressure sensitive obstruction detection or motor current monitoring shall automatically open the doors when an obstruction is encountered. The obstruction detection system shall stop the affected panel from closing when an obstruction is detected, fully reopen and recycle.	Compliant	
3.20.d	Door Panel Design Features		
3.20.d.i	The door panels shall be designed to blend seamlessly with the Vehicle exterior. Panel Design shall meet the following requirements:	Compliant	
3.20.d.i.A	Be fitted with laminated Safety glass windows. Window to be aligned with passenger side windows and tinted to match; and	Compliant	
3.20.d.i.B	Be provided with interior and exterior passenger pushbuttons in compliance with AODA and ADA to allow individual door control when enabled.	Compliant	
3.20.e	Door Controls		
3.20.e.i	Doors shall be operable via pushbuttons in the cab, trainline signals or local door open pushbuttons, depending on the mode set up within the consist.	Compliant	
3.20.e.ii	A Door Enable feature shall release door control and illuminate a "Door Open" LED pushbutton at each active door, in the interior and exterior of the Vehicle allowing passengers to open individual doors by pressing the "Door Open" button. A pictogram shall indicate the function of the pushbutton switch. Pushbuttons out of service will not display energized LEDs.	Compliant	
3.20.e.iii	Door open indicators shall audibly and visually indicate door open status.	Compliant	
3.20.e.iv	Crew switches shall have the capability to cycle the doors. Interior and exterior crew switches shall be installed on each side of the car adjacent to the doors nearest each end of the car.	Compliant	
3.20.e.v	The door shall have a control system that permits fault monitoring and recording and shall be networked with the VMU over the Train Control System (see Section 3.31 of this Article for VMU details).	Compliant	
3.20.e.vi	The door control system shall comply with the fault plan requirements of Section 3.31 of this Article.	Compliant	
3.20.f	Safety		
3.20.f.i	Door control on each car shall be interlocked with the no motion detection system on that car.	Compliant	
3.20.f.ii	Door operator Design shall include a Safety device to ensure doors recycle after contact with a 19mm round object or 9.5mm thick by 75mm wide object.	Compliant	
3.20.f.iii	Doors closed and locked status shall be interlocked with propulsion.	Compliant	
3.20.f.iv	All doors shall have a mechanical emergency release mechanism inside and outside the Vehicle.	Compliant	
3.20.f.v	*Door operators shall have a cut-out that locks the door and completes the door closed summary loop.*	Compliant	
3.20.f.vi	*Door system shall have an audio and visual warning while open and during closing. Provision for the ability to flash marker lights and brake lights shall flash whenever doors are open.*	Compliant	
3.20.f.vii	*Vehicle evacuation through a vehicle on its side shall be conceptually demonstrated.*	Compliant	
3.20.g	Side Door System Type Testing		
3.20.g.i	Door Operator Type Test		
3.20.g.i.A	The door system shall be proven to be reliable in service.	Compliant	
3.20.g.ii	Door Panel Strength Tests		
3.20.g.ii.A	One of the first door panels shall be tested to ensure its strength is sufficient to withstand a load of 90kg applied over a 20cm2 area. The maximum deflection of the panel shall be no more than 10mm, without permanent deflection.	Compliant	
3.20.g.iii	Side Door System Routine Testing		
3.20.g.iii.A	Each door operator shall pass a routine test before shipment from the supplier factory. All functions shall be verified to operate correctly, including passenger request pushbuttons.	Compliant	
3.21	**Heating, Ventilation and Air Conditioning**		
3.21.a	The HVAC Equipment shall provide safe, reliable climate control in accordance with the climatic and environmental conditions outlined in this Article. The system shall utilize microprocessor controls to automatically control interior temperatures (both in the cab and passenger area) and prevent snow or ice or water from accumulating on the Vehicle floor or at thresholds. The system shall incorporate a layover mode to maintain moderate interior temperatures when Vehicles are not in revenue service.	Compliant	
3.21.b	System Description		
3.21.b.i	The system shall be roof-mounted, fully unitized packages (no less than 2) with a height that meets the roof Equipment height limits detailed in this Article.	Compliant	
3.21.b.ii	Watertight and leak-proof seals shall be provided between carbody and HVAC unit return and supply air interfaces.	Compliant	
3.21.b.iii	The refrigerant circuit shall be hermetically sealed system charged with non-ozone depleting refrigerant. Refrigerant shall comply with all applicable Canadian standards and laws.	Compliant	
3.21.b.iv	Eight (8) m3/hr fresh air per passenger shall be provided (all seats occupied and 4 standees/square meter) to ensure compartment air quality. Fresh air dampers, or equivalent, shall allow a quicker warm-up or cool down during initial start-up by limiting fresh air.	Compliant	
3.21.b.v	The HVAC heating system shall be arranged to operate in stages. The system shall use duct sensors to keep supply air within 8°C of return air temperature.	Compliant	
3.21.b.vi	Over-temperature Safety protection shall be:		
3.21.b.vi.A	Self re-settable thermostats that disable control voltage to the heater contactors; and	Compliant	
3.21.b.vi.B	Fusible link(s), or equivalent, to protect the system in the event of a failure of the over-temperature thermostat.	Compliant	
3.21.c	System Capacity		
3.21.c.i	The system shall be designed to maintain interior conditions between 19°C and 22°C with 1% Design conditions for cooling and 99% Design conditions for heating as defined in ASHRAE fundamentals handbook. Load calculations shall be submitted as part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	
3.21.c.i.A	Setpoints shall be easily adjustable. Project Co shall adjust the setpoint as directed by the City.	Compliant	
3.21.c.ii	The relative humidity in the interior of the car shall be maintained between 30-60% during all operating conditions requiring cooling.	Compliant	Compliant for all termperatures above +10°C. Humidity control is ensured by HVAC units. Below +10°C HVAC units compressors can not start because of low temperature. In that case, no humidity control is done.
3.21.c.iii	A positive interior pressure shall be maintained at all times and at all Vehicle speeds.	Compliant	
3.21.c.iv	Vehicle interior temperature shall be within 1.5°C of setpoint, 2 minutes after a 30 second door opening cycle in worst case Design conditions.	Compliant	We are compliant in the following conditions: - External temperature -25,8°C / Setpoint 19°C (ASHRAE) - 30 second opening of one dual leaf door.
3.21.c.v	Temperature stratification shall be limited to 2°C within any vertical or horizontal plane.	Compliant	This requirement is not typical for this type of rolling stock with a large number of doors and frequent door opening. It might be requested on some main line vehicles with a different architecture where passenger compartment is separated by internal doors from the vehicle access door and interstation is longer. our LRV is designed to reach this performance after a last door opening. following by a lead time of approx. 15 mn (stabililized conditions)
3.21.d	HVAC Controls		
3.21.d.i	The HVAC controller shall allow software adjustments and modification to settings, including a ±2°C setpoint adjustment for all switching points. Setpoint accuracy shall be ±0.2°C.	Compliant	
3.21.d.ii	The HVAC controllers shall have fault monitoring and recording and shall be networked with the VMU over the Train Control System n Section 3.31 of this Article. The HVAC system shall comply with the fault plan requirements of Section 3.31 of this Article.	Compliant	
3.21.e	Additional HVAC Features		

3.21.e.i	Emergency shutdown switch for HVAC system (per car and consist control) shall be located in the cab.	Compliant	
3.21.e.ii	Emergency fresh air damper close switch (per car and consist control) shall be located in the cab.	Compliant	
3.21.e.iii	Smoke detectors shall be located in all fresh air intake ducts. Upon activation, the detector shall energize a signal that shall indicate a smoke alarm, including Vehicle number and location of alarm within the consist. Activation of either the damper closed or HVAC shutdown will silence the smoke alarm signal.	Compliant	
3.21.e.iv	A layover thermostat to maintain interior temperatures between 4°C and 8°C. (Dampers shall be closed and windshield heaters de-energized during layover).	Compliant	
3.21.f	Floor Heat		
3.21.f.i	The grilles/heater guards shall be designed to prevent passenger exposure to unsafe surface temperatures and electrical connections.	Compliant	
3.21.f.ii	Threshold heaters shall also be provided as part of the floor heat system. These heaters shall be sized to keep snow or ice from accumulating at the doorway or affecting the operation of the door system. Thresholds shall be arranged to allow drainage of melted snow and ice.	Compliant	
3.21.g	**Cab**		
3.21.g.i	The HVAC Equipment within the Driver's cab shall consist of:		
3.21.g.i.A	An electrically heated windshield;	Compliant	
3.21.g.i.B	Overhead air diffusers with volume and directional adjustability; and	Compliant	
3.21.g.i.C	Thermostatically controlled cab heater(s) with the following features:	Compliant	
3.21.g.i.C.i	Infinitely adjustable temperature control;	Compliant	
3.21.g.i.C.ii	OFF-LOW-HIGH rotary switch for air speed/volume control of both cab heaters;	Compliant	
3.21.g.i.C.iii	Heater noise level in HIGH speed not to exceed 72dBA;	Compliant	
3.21.g.i.C.iv	Heater coil and blower powered by AC circuits;	Compliant	
3.21.g.i.C. v	Manual adjustment to direct airflow to floor, cab side windows, or both;	Compliant	
3.21.g.i.C.vi	Cab heater surface temperatures shall not exceed 52°C; and	Compliant	
3.21.g.i.C.vii	Over-temperature protection shall include:	Compliant	
3.21.g.i.C.vii.1	An over-temperature thermostat which shall automatically cycle the heater contactors upon excessive temperatures; and	Compliant	
3.21.g.i.C.vii.2	Failure of the over-temp thermostat shall cause a manually resettable shunt trip breaker to open power to the heaters. Manual reset switch shall be easily accessible to the Driver.	Compliant	
3.21.h	**HVAC Type Tests**		
3.21.h.i	The first HVAC unit shall be evaluated or certified to comply with these test requirements outlined below before production Equipment manufacturing is commenced. Testing shall at a minimum include the following:	Compliant	
3.21.h.i.A	A. Cooling and heating capacity tests;		
3.21.h.i.B	Condensate carry-over test;	Compliant	
3.21.h.i.C	Heater safety tests; and	Compliant	
3.21.h.i.D	Smoke detector test.	Compliant	
3.21.i	Cab Heater Type Tests	Compliant	
3.21.i.i	Cab heater safety tests	Compliant	
3.21.i.ii	Windshield defrosting tests	Compliant	
3.21.j	HVAC Routine Tests	Compliant	
3.21.j.i	Each unit shall pass a routine test.	Compliant	
3.21.k	HVAC Climate Room Test		
3.21.k.i	Unless already certified in environmental conditions similar to Ottawa, a vehicle shall be completely instrumented and fully tested in a climate chamber to ensure the requirements of the RFP are met or exceeded.	Compliant	
3.22	**Lighting**		
3.22.a	The lighting system consists of all interior lighting, exterior lighting, and indicators. The Design shall provide lighting with a minimal degradation of color or luminosity over time. Safe levels of lighting shall be provided in the event of emergency conditions.	Compliant	
3.22.b	The Lighting system shall:	Compliant	
3.22.b.i	Be primarily LED based, operating entirely from the Vehicle low voltage system;	Compliant	
3.22.b.ii	Have two luminosity levels for the main interior lighting: normal and emergency;	Compliant	
3.22.b.iii	Be configured so that lighting in a multicar Train can be controlled from the lead car;	Compliant	
3.22.b.iv	Provide lighting levels in passenger compartments and at doors compatible with AODA/ADA requirements;	Compliant	
3.22.b.v	Have headlights, tail lights, marker lights, and stoplights consistent with the requirements of Canadian laws and regulations;	Compliant	
3.22.b.vi	Provide indications to passengers and crews of failed doors and doors out of service.	Compliant	
3.22.c	Interior Lighting		
3.22.c.i	The main lighting fixtures shall use LED cluster modules operating from the low voltage distribution network.	Compliant	
3.22.c.ii	The interior emergency lighting shall use LED modules operating from the Vehicle battery.	Compliant	
3.22.c.iii	LLEPM shall be provided along the aisle and vestibules leading to the doorways, utilizing a HPPL material strip embedded into the floor.	Compliant	
3.22.c.iv	An interior LED indicator light shall be provided over each door to indicate that the door is not closed and locked.	Compliant	
3.22.c.v	A small LED backlit sign shall be provided over each side door to indicate when the door is locked out of service.	Compliant	
3.22.d	Cab area :		
3.22.d.i	LED indicator and instrument lighting shall be provided.	Compliant	
3.22.d.ii	Overhead lighting shall be provided using two dimmable and directionally adjustable lights.	Compliant	
3.22.d.iii	LED cab Equipment compartment lighting shall be provided.	Compliant	
3.22.d.iv	Overhead and Equipment compartment lighting shall be included in the emergency lighting system.	Compliant	
3.22.e	Exterior Lighting		
3.22.e.i	The following exterior lighting shall be LED type, visible in all natural and artificial lighting conditions:	Compliant	
3.22.e.i.A	Dual color marker lights;	Compliant	
3.22.e.i.B	Provision for turn signals (for mixed traffic operation), tail lights;	Compliant	
3.22.e.i.C	Brake lights;	Compliant	
3.22.e.i.D	Propulsion fault light;	Compliant	
3.22.e.i.E	Door open LED indicator light at each door;	Compliant	
3.22.e.i.F	LED backlit sign over each door to indicate when the door is locked out of service;	Compliant	
3.22.e.i.G	ATP bypass light; and	Compliant	
3.22.e.i.H	Vehicle door summary status light, viewable from transverse and longitudinal directions.	Compliant	
3.22.e.ii	Headlights shall be provided on each cab end.	Compliant	
3.22.e.iii	A third, forward facing headlight shall be provided at the center line of the Vehicle, above the cab to distinguish the LRV from other types of vehicles	Compliant	
3.22.e.iv	Headlights shall have high and low beam functionality.	Compliant	
3.22.f	Lighting Controls		
3.22.f.i	All lighting controls switches and circuit breakers shall be located in the cab area.	Compliant	
3.22.f.ii	Passenger compartment lighting control shall be a trainline control function from the control panel on the lead car.	Compliant	
3.22.f.iii	Cab lighting shall be controlled through a switch with dimmer control.	Compliant	
3.22.f.iv	Equipment locker lighting shall be controlled by a switch on the control panel and a limit switch actuated by the locker door.	Compliant	
3.22.f.v	A dimmer switch shall be provided to control the intensity of indicator panel back lighting.	Compliant	
3.22.f.vi	Control of headlights, tail lights, stop lights, and marker lights shall be interlocked with the direction Train lines and coupler loop switches so that head lights, tail lights, stop lights and marker lights shall only be active at ends of the Train in accordance with Train direction.	Compliant	
3.22.g	Performance		
3.22.g.i	The cab and passenger area lighting intensity shall meet as a minimum, the requirements of EN 13272 or equivalent.	Compliant	
3.22.g.ii	Emergency lighting shall be available for 90 minutes after loss of the low voltage power supply and shall meet or exceed the minimum illumination requirements of APTA SS-E-013-99, Rev. 1.	Compliant	
3.22.g.iii	LLEPM shall meet APTA standard SS-PS-004-99 Rev. 2.	Compliant	
3.22.g.iv	Headlights shall meet all requirements of Canadian Motor Vehicle Safety Regulations, Technical Standard 108.	Compliant	

3.22.g.v	Amber marker lights shall be activated on the front of the lead car when the master controller is in the forward position.	Compliant	
3.22.g.vi	Marker Lights, tail lights and brake lights shall operate as follows:		
3.22.g.vi.A	Red marker lights and tail lights shall be activated on the last car at all times;	Compliant	
3.22.g.vi.B	Brake lights shall be active on the last car when the Train brakes are applied;	Compliant	
3.22.g.vi.C	Red marker lights and red tail lights shall be active on the front of the Train when no direction is selected;	Compliant	
3.22.g.vi.D	Tail light and stop light intensity shall meet the requirements all requirements of Canadian Motor Vehicle Safety Requirements, Technical Standard 108;	Compliant	
3.22.g.vi.E	Marker lights and brake lights shall flash when the Train is stopped and the doors are open. Marker and brake lights shall also flash when the Master Controller is in the reverse position; and	Compliant	
3.22.g.vi.F	Turn signals operated from the console shall be provided and shall operate in accordance with Canadian highway regulations.	Compliant	
3.22.g.vii	Interior passenger and cab lighting shall time out in 20 minutes after the Vehicle is turned off.	Compliant	
3.22.g.viii	Exterior Vehicle door summary status lights shall be visible from both the longitudinal and transverse directions.	Compliant	
3.22.h	Type Testing		
3.22.h.i	Verification of Design luminosity.	Compliant	
3.23	High Voltage Distribution and Auxiliary Electrical Equipment		
3.23.a	High voltage power shall be collected from the pantograph, which shall be:	Compliant	
3.23.a.i	Be capable of operation in both directions;	Compliant	
3.23.a.ii	Have tension characteristics compatible with overhead contact system Design;	Compliant	
3.23.a.iii	Be provided with a lightning arrestor rated for outdoor operation;	Compliant	
3.23.a.iv	Be equipped with an electrically controlled system for raising and lowering; and	Compliant	
3.23.a.v	Be equipped with a means of raising and lowering manually from inside the vehicle.	Compliant	
3.23.b	The high voltage power distribution network shall be protected by a HSCB.	Compliant	
3.23.c	The HSCB shall:	Compliant	
3.23.c.i	Be rated in excess of the worst case interrupt current and line voltage;	Compliant	
3.23.c.ii	Have trip settings coordinated with the Traction Power system Design to prevent nuisance tripping of Traction Power breakers; and	Compliant	
3.23.c.iii	Provide a remote trip and reset function to be controlled by the propulsion system and auxiliary power.	Compliant	
3.23.d	Output from the HSCB shall be split into three separately protected main circuits: Traction Power A, Traction Power B and Auxiliary Power.	Compliant	
3.23.d.i	Fuses for Auxiliary Power systems shall be roof mounted in a protective enclosure.	Compliant	It will be installed inside HSCB box.
3.23.d.ii	Circuitry shall allow the Auxiliary Power system, and only the Auxiliary Power system, to connect to a Shop Power Feed. When the shop power feed is connected, the pantograph feed shall be disconnected through an electrical and mechanical interlocking system.	Compliant	
3.23.e	Return Currents and Safety Grounding		
3.23.e.i	The high voltage return circuit Design shall return power safely to the rails in a manner that protects bearings, prevents return currents from interfering with trainline circuits and minimizes harmonic interference with the wayside systems.	Compliant	
3.23.e.ii	The grounding of the car body sections, trucks and Equipment shall be designed in a manner that provides maximally redundant paths to the return rail and that complies with the EMC management plan described in Part 4 Article 9 – EMI/EMC.	Compliant	
3.23.e.iii	The voltage rise between rail and car body shall not exceed 50mv with the loss of a single ground brush.	Compliant	
3.23.e.iv	Resilient wheels shall be provided with 2 or more shunt straps between the wheel hub and rim.	Compliant	
3.23.f	Auxiliary Power		
3.23.f.i	Auxiliary power converters shall include:		
3.23.f.i.A	3 phase 60Hz AC power inverters to supply power for HVAC, blower motors, compressors, fans, etc.; and	Compliant	
3.23.f.i.B	LVPS to provide low voltage DC power for control systems, and battery charging, lighting, etc.	Compliant	
3.23.f.ii	Redundant inverters and LVPS shall be provided with independent controls and control power supplies to provide maximum availability.	Compliant	
3.23.f.ii.A	In the case of failure of one inverter all essential Vehicle loads and 50% of HVAC loads shall be maintained by the remaining unit.	Compliant	
3.23.f.ii.B	In the case of failure of one LVPS all loads and limited battery charging shall be maintained.	Compliant	The actual LVPS scheme foresees two battery charger and two independent battery box
3.23.f.ii.Bi	If vehicles are provided as married pairs, LVPS redundancy may be achieved with a single LVPS on each car if all low voltage loads and limited battery charging can be provided from the single LVPS.	Compliant	
3.23.f.iii	Line filters shall be provided to protect the LVPS and auxiliary inverters and to minimize conducted emissions back into the OCS.	Compliant	
3.23.f.iii.A	Line filters shall protect against all positive and negative OCS transients in accordance with IEC 60850.	Compliant	
3.23.f.iii.B	If inverters and LVPS on each end of the Vehicle are located in a common enclosure with a common line filter, circuit breakers or contactors shall be provided to isolate shorted or failed units from the line filter.	Compliant	
3.23.f.iii.C	LVPS and auxiliary power inverters shall comply and the line filters shall comply with the EMC management plan described in Part 4 Article 9 – EMI/EMC.	Compliant	For harmonic emission requirements, not yet specified, AT will have to evaluate the impacts on actual input filter.
3.23.f.iv	Power IGBTs used for inverters and LVPS shall not be exposed to any circulating air, filtered or not. Cooling of IGBTs shall be through external heat sinks or sealed heat transfer tubes only.	Compliant	
3.23.f.v	Auxiliary Inverter output waveform and the Design of the attached motors shall be coordinated to prevent motor insulation and motor bearing damage.	Compliant	
3.23.f.vi	The LVPS output shall meet the power quality requirements of EN 50155 and the ripple requirements of IEC 60077-1.	Compliant	
3.23.f.vii	The LVPS shall have an automatic dead battery start feature.	Compliant	
3.23.f.viii	Monitoring and Diagnostics		
3.23.f.viii.A	The LVPS units and the auxiliary power inverters shall be provided with diagnostic and fault recording capability and shall report all faults to a VMU.	Compliant	
3.23.g	Battery		
3.23.g.i	A battery charged by the LVPS units shall be provided on each Vehicle.	Compliant	
3.23.g.ii	The battery shall be protected by a fuse and a positive and negative side disconnect switch and over voltage protection.	Compliant	
3.23.g.iii	The battery compartment shall be ventilated sufficiently to prevent build-up of explosive levels of hydrogen gas.	Compliant	
3.23.g.iv	The battery shall not be lead acid.	Compliant	
3.23.g.v	The battery shall be sized to meet the following loads:	Compliant	Battery sizing will be confirmed in project phase
3.23.g.v.A	In case of LVPS failure, 50% of lighting and all loads necessary for operation of the Train,; and	Compliant	
3.23.g.v.B	In case of loss of primary power, emergency lighting and communications functions and door operators (a minimum of 12 door opening cycles) shall be maintained for 90 minutes while other functions shall be progressively shed.	Compliant	
3.23.h	AC and Low Voltage Distribution		
3.23.h.i	All AC and low voltage DC circuits shall be circuit breaker protected.	Compliant	
3.23.h.ii	Low Voltage DC and AC Circuit breakers shall be located in locked enclosures in the cab.	Compliant	
3.23.h.iii	All AC and DC circuit breakers shall meet the requirements of IEEE Std C37-13 and IEEE Std C37-14 respectively.	Compliant	
3.23.h.iv	The low voltage DC system shall be grounded in a manner which prevents differences in potential between cars caused by traction return currents from interfering with trainline signals.	Compliant	
3.23.h.v	(v) Galvanically isolated, ground fault protected single phase 120VAC 60Hz power shall be provided to cab and passenger compartment outlets as needed for cleaning and for Vehicle maintenance.	Compliant	
3.23.i	Qualification Testing		
3.23.i.i	Auxiliary Inverter and LVPS components shall be type tested in accordance with the standards outlined.	Compliant	
3.23.i.ii	Auxiliary Inverter and LVPS shall be tested in accordance with IEC 61287.	Compliant	
3.23.i.iii	The converters shall be noise tested in accordance with IEC 61133.	Compliant	
3.23.i.iv	The battery shall be capacity tested at the point of manufacture in accordance with APTA RP-E-007-98-1999 and to demonstrate that it meets the capacity and emergency lighting requirements of this Article. The Battery cells shall be tested in accordance with IEC 60623.	Compliant	Compliant following IEC60623 if a nickel-cadmium will be the battery technology choice. Actual battery, used on AT LRV, will follow the standards IEC60623 and NFF64018;
3.23.i.v	The HSCB shall be tested to prove compliance with the requirements of this section and IEC 60077-3:2001.	Compliant	
3.24	**Propulsion and Dynamic Braking**		

3.24.a	General		
3.24.a.i	Propulsion shall be microprocessor controlled IGBT inverter drives with two AC motors for each motored truck.	Compliant	
3.24.a.iii	The propulsion system and its components shall meet the performance and duty cycle requirements of this Article.	Compliant	
3.24.a.iii	At least one inverter shall be provided for each power truck.	Compliant	
3.24.b	Propulsion Control shall:	Compliant	
3.24.b.i	Be based upon networked and trainlined tractive effort and braking effort commands with load weigh compensation to provide consistent acceleration and braking rates regardless of passenger loading;	Compliant	
3.24.b.ii	Detect and correct spins and slides in coordination with the friction brake and traction control system;	Compliant	
3.24.b.iii	Request sanding control to apply sand in front of both wheels of the leading axle when wheel spin or slide exceeds a preset level;	Compliant	
3.24.b.iv	Monitor direction, propulsion and braking control and friction brake status trainlines and inhibit or shutdown propulsion in case of conflicts;	Compliant	
3.24.b.v	Protect the inverter semiconductors by tripping the HSCB and or dropping the line contactor in event of a critical fault or out of tolerance voltage surge;	Compliant	
3.24.b.vi	Provide fault protection from events that may result in motor, wiring, or inverter or line filter damage or cause violations of electromagnetic emissions limits;	Compliant	
3.24.b.vii	Coordinate with the friction brake system to prevent roll back during start-up on the maximum grade;	Compliant	According to our parking brake architecture the roll back protection is provided by propulsion system
3.24.b.viii	Coordinate with the friction brake the blending of brakes to ensure smooth transitions from dynamic to friction braking;	Compliant	
3.24.b.ix	Provide fault recording and diagnostics for system troubleshooting and report faults to the Vehicle monitoring unit described in of this Article;	Compliant	
3.24.b.x	deleted		
3.24.b.x	Report all faults to the VMU described in this Article; and	Compliant	
3.24.b.xi	Meet all requirements for monitoring and diagnostic systems outlined in that section.	Compliant	
3.24.c	Line Filter		
3.24.c.i	Each traction inverter shall be protected by a line filter which shall protect it against any surges or spikes that may occur on the Traction Power system. Line filter shall comply with IEC 60850.	Compliant	
3.24.c.ii	The line filter and the inverter control Design shall meet the requirements of the EMC management plan of Part 4 Article 9 – EMI/EMC.	Compliant	For harmonic emission requirements, not yet specified, AT will have to evaluate the impacts on actual input filter.
3.24.c.iii	Line filter and inverter isolation shall be provided in case of an out of tolerance line voltage, an emergency brake request or a critical inverter, line filter or motor fault.	Compliant	
3.24.c.iv	Protection against energizing a dead section of the OCS with the line filter or regenerative braking energy shall be provided.	Compliant	
3.24.c.v	Filter capacitors shall be rated for 15 year life in the Design operating environment and selected in accordance with IEC 61071.	Compliant	AT designs its capacitors following the railway standard IEC61881. The industrial standard IEC61071 sinc is less than IEC61881 it's not used. The capacitors are designed for 30 years life
3.24.d	Traction Inverters		
3.24.d.i	Traction inverter units shall be microprocessor controlled with modular keyed IGBT semiconductor switches rated for the application voltage and all transients.	Compliant	
3.24.d.ii	Unless 4 quadrant Traction Power Supplies or a Traction Power energy storage system is provided, a brake chopper and resistors shall be provided to control DC link voltage and dissipate braking energy.	Compliant	
3.24.d.iii	The inverter container IGBTs, capacitors and control electronics shall be sealed from outside air. Cooling shall be through external heat sinks or sealed gas filled heat tubes only. The convection or forced cooling of the external heat sinks or heat tubes and the line inductor shall be provided.	Compliant	Inverter has a forced ventilation cooling with external heat sinks. Line inductor is natural cooled
3.24.d.iii.A	If forced cooling is utilized, diversification of blower motors shall be provided and the Design of intake screens shall permit easy removal and cleaning.	Compliant	
3.24.e	Traction Motors and Gear Units		
3.24.e.i	Traction motors shall be of a self-ventilated or totally enclosed Design. If motors are self-ventilated, air intakes shall be designed to preclude the ingestion of airborne material.	Compliant	Self-ventilated.
3.24.e.ii	Traction motor insulation shall be rated class H or better and be designed for the inverter output voltage and waveforms.	Compliant	Class H or higher
3.24.e.iii	Motor bearings shall be protected from high frequency IGBT switching harmonics capacitively coupled to the rotor.	Compliant	Insulated bearings against capacitively coupled currents
3.24.e.iv	Traction motors shall tolerate a minimum of 6mm difference in wheel diameters for the axles on a truck without overheating or causing a reduction in system performance or life.	Compliant	
3.24.e.v	Gears shall be rated for bi-directional service in accordance with the duty cycle requirements.	Compliant	
3.24.e.vi	Motor and gear unit bearings shall have an ANSI/AFBMA L10 rating or approved equivalent standard.	Compliant	
3.24.f	Efficiency		
3.24.f.i	The propulsion system shall provide an energy system of greater than or equal to 80% efficiency from the OCS to the wheel.	Compliant	
3.24.f.ii	Regenerative braking into a receptive line shall return 80% of the mechanical energy to the OCS when braking from 70km/hr to 8km/hr.	Compliant	
3.24.g	Propulsion and Dynamic Braking system Qualification Tests		
3.24.g.i	Project Co shall perform qualification tests of the first two traction motors in accordance with IEC Std 60349-2 and IEEE Std 11.	Compliant	
3.24.g.ii	Brake resistors shall be qualification tested in accordance with IEC 60077, 60322 and IEEE Std 16-2004	Compliant	
3.24.g.iii	Inverter and line filter components shall be type tested in accordance with the tests listed IEC 61287-1 Section 4.5.2.1 Test of converter components and subassemblies.	Compliant	
3.24.g.iv	A combined systems laboratory test shall be conducted on one complete set of propulsion Equipment, including the motors, brake resistor(s), power conditioning Equipment, inverters, protection devices, logic and controls, etc. A dynamometer shall be used for this test which simulates Vehicle inertia by various methods. The dynamometer test shall simulate the OLRT route profile to prove compliance with the normal, degraded mode, and towing mode requirements. Motor and inverter and IGBT temperatures shall be recorded to prove compliance with the thermal performance requirements. Worst case environmental conditions and wheel diameter variation shall be simulated.	Compliant	
3.25	**Trucks**		
3.25.a	Each LRV shall be supported by 4 wheeled trucks.	Compliant	
3.25.b	The leading and trailing trucks shall have freedom of rotation about a center pin.	Compliant	The rotation is performed by a crown bearing
3.25.c	All axles shall be fitted with hydraulic brake systems. Track brakes shall be fitted on all trucks.	Compliant	
3.25.d	Truck Components		
3.25.d.i	Shall be either cast steel or fabricated/welded steel construction.	Compliant	
3.25.d.ii	The secondary suspension shall be controlled by a levelling valve to fulfill AODA/ADA level boarding requirements.	Compliant	
3.25.d.iii	Secondary lateral and vertical dampers shall be used.	Compliant	
3.25.d.iv	Wheels shall be of resilient type and the wheel profile shall be selected by the car builder in concert with the Track Designer to ensure that a compatible wheel/rail interface is selected. The wheel/rail interface and truck Design shall be subject to a dynamic analysis, including wheel unloading, Vehicle overturning and truck hunting as described in APTA RP-M-009-98.	Compliant	
3.25.d.v	Axles shall be solid and designed in accordance with AAR M-101 and APTA RP-M-001-98, or equivalent.	Compliant	
3.25.d.vi	Journal bearings shall be tapered roller or spherical, designed with an L-10 life rating of 1,600,000km.	Compliant	
3.25.d.vii	Heated sand tubes and scatter units shall be provided to prevent clogging by snow, ice or wet sand.	Compliant	
3.25.d.viii	Stone guards and splash guards shall be provided.	Compliant	
3.25.d.ix	Hinged or easily removable skirts that blend with the exterior visual aesthetics of the Vehicle shall be provided.	Compliant	
3.25.d.x	Shock and vibration environment criteria for axle mounted components shall be:	Compliant	For components mounted on axle, essentially current return, we follow the NF EN 61373 year 2010 third category, associated with our own experience and based also on measurement.
3.25.d.x.A	10g vibration levels up to 100 Hz;	Compliant	
3.25.d.x.B	80g shock loads laterally and vertically; and	Compliant	
3.25.d.x.C	50g longitudinal shock loads.	Compliant	
3.25.d.xi	Shock and vibration environment criteria for truck mounted components shall be:	Compliant	For components mounted on truck, we follow the NF EN 61373 year 2010 second category, associated with our own experience and based also on measurement.
3.25.d.xi.A	6g vibration levels up to 100Hz; and	Compliant	
3.25.d.xi.B	20g shock loads – all directions.	Compliant	

3.25.e	Truck Motion Control		
3.25.e.i	The trucks shall control Vehicle motions such that the dynamic envelope defined in Section 3.36 of this Article is not violated.	Compliant	
3.25.e.ii	Primary suspension strokes shall never be exhausted under any condition of dynamic operation, Vehicle weight, weight variation and suspension creep.	Compliant	The primary suspension will be realised with an helicoïdal spring in association with a progressive rubber stop acting just before being on stroke. That means the creepage will be negligible, therefore the allowable displacement will be quite 100 % usable for loads variations. The stiffness will be defined roughly in order to begin to be on the rubber stop for AW3 load (6 p/m²) and the stroke will be reached roughly for 120% of the AW4 load (8 p/m²). Anyway, as the bogie will be a articulated one, being on rubber stop or on stroke will not affect the unloading performance of the vehicle.
3.25.e.iii	(iii) Primary and secondary vertical and lateral stops shall not be contacted under normal operating conditions. Stops shall be fabricated from replaceable elastomeric bumpers.	Compliant	
3.25.e.iv	A means for Vehicle height adjustment shall be provided to account for wheel wear and/or rail wear.	Compliant	
3.25.e.v	Equalization shall be such that with the car on level Track under an AW0 load, lifting or dropping any wheel up to 38mm shall not change the load on any other wheel of the car by more than 60%.	Compliant	
3.25.e.vi	Raising or lowering any wheel up to 50mm shall not result in loss of contact between any of the other wheels on the car and the rail.	Compliant	
3.25.f	Vehicle Modeling		
3.25.f.i	Vehicle modeling, including collision analysis, shall include the requirements of ASME RT-1 or equivalent.	Compliant	
3.25.f.ii	The analysis shall consider the limits of environmental conditions, Track deterioration, suspension wear, Vehicle weight and speed variations.	Compliant	Hypothesis for the analysis will be fixed during development phase.
3.25.f.iii	Modeling of Vehicle performance shall be by NUCARS, Vampire or equivalent.	Compliant	Simpack is used for vehicle modelling analysis and equivalent to proposed software tool
3.25.g	Stress Analysis		
3.25.g.i	For a service proven Vehicle, stress analysis and FEA results from a previous contract shall be submitted as part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	
3.25.g.ii	For a new or modified Vehicle a complete stress analysis shall be submitted as part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	Stress analysis is provided.
3.25.h	Design Ride Quality		
3.25.h.i	The methodology used to evaluate ride quality shall be ISO 2631 (latest edition), in the frequency range of 0.5 to 80Hz. Limits are valid for 3 axes.	Compliant	
3.25.h.i.A	Passenger RMS acceleration values shall not exceed 0.32m/s2.	Compliant	Depend on track Quality level
3.25.h.i.B	The vibration total value (root sum of squares summation) for each measurement point shall not exceed 0.50m/s2.	Compliant	Depend on track Quality level
3.25.i	Resonant Frequency		
3.25.i.i	To ensure Bridge/truck/Vehicle resonant frequency compatibility, Project Co shall determine truck primary suspension frequency that ensures dynamic stability under all conditions, with appropriate safety margins.	Compliant	
3.25.j	Truck Qualification Testing		
3.25.j.i	The first truck unit shall be type tested before production Equipment is commenced. Testing shall include the following, at a minimum:	Compliant	see here below details on achieved tests
3.25.j.i.A	Project Co shall perform a fatigue and static load test to verify that the maximum allowable stresses are not exceeded when the truck is subjected to the static loads;	Compliant	
3.25.j.i.B	After completion of the static tests outlined in A above, all critical welds of the tested truck frame shall be radiographically inspected; and	Compliant	
3.25.j.i.C	Project Co shall perform a wheel load equalization test to verify that the maximum allowable unloading is not exceeded.	Compliant	
3.25.k	Routine Testing		
3.25.k.i	QC inspection of all components shall be performed and included with the shipping documentation.	Compliant	
3.25.k.ii	100 % of the truck frames shall be tested via MPI.	Compliant	
3.26	**Friction Brakes, Track Brakes**		
3.26.a	General		
3.26.a.i	A disc brake friction brake system shall be provided for all trucks.	Compliant	
3.26.a.ii	Friction brakes shall be of an electro-hydraulic, microprocessor controlled Design with a spring applied/hydraulic release parking brake and shall coordinate with propulsion control to provide blended braking, slide control and roll back prevention.	Compliant	
3.26.a.iii	A Track brake system shall be supplied to provide the required emergency brake rate. A sanding system shall be provided to apply sand to the rails in front of the lead axles.	Compliant	
3.26.a.iv	The friction disk brake and the Track brake system shall meet all requirements of this Article.	Compliant	
3.26.b	Disc Brakes and Calipers		
3.26.b.i	Hydraulic actuated disc brakes shall be provided on all axles of all trucks.	Compliant	
3.26.b.ii	The friction surfaces of the disc rotors shall be replaceable without removing wheels or any truck parts other than brake calipers.	Compliant	
3.26.b.iii	Disc rotors shall have a wear limit indicator.	Compliant	
3.26.b.iv	Disc brake calipers shall:		
3.26.b.iv.A	Have a spring apply/hydraulic release parking brake;	Compliant	
3.26.b.iv.B	Be provided with a pump release from inside the car for towing purposes;	Compliant	for one bogie only / from cab of the related vehicle
3.26.b.iv.C	Have a manual release for the calipers in case of hydraulic failure . The release shall be either mechanical or from a hydraulic circuit separate from the service hydraulic line . access to the release shall be available either from the side of the Vehicle or inside the car ;	Compliant	
3.26.b.iv.D	Reset manually released calipers to normal operation after a maximum of three service brake applications, once the brakes are cut back in;	Compliant	
3.26.b.iv.E	Brake calipers shall include an automatic slack adjusting feature that functions during both service and parking brake operation; and	Compliant	
3.26.b.iv.F	The slack adjuster shall compensate for brake pad wear and shall ensure drag free operation.	Compliant	
3.26.c	Hydraulic Fluid		
3.26.c.i	The hydraulic fluid shall be fire-resistant and meet all requirements of the latest revision of MIL-H-83282.	Compliant	
3.26.d	Electro Hydraulic Unit		
3.26.d.i	The friction brake actuators on each truck shall be powered by the electro hydraulic unit for that truck.	Compliant	
3.26.d.ii	EHU shall be resiliently mounted above the secondary suspension and be capable of meeting the shock and vibration loads specified in this Article.	Compliant	
3.26.d.iii	The EHU shall contain a hydraulic fluid reservoir, motor driven pump and all necessary control valves, pressure switches and pressure transducers.	Compliant	
3.26.d.iv	External connections shall be made directly to the manifold plate using self-sealing, quick-connect couplers.	Compliant	
3.26.d.v	The reservoir shall be provided with a drain plug, fluid level sight glass and a quick-connect coupler for filling.	Compliant	
3.26.d.vi	The motor driven pump shall operate from the Vehicle low voltage power supply and shall function within specification over the range specified.	Compliant	
3.26.d.vii	Designs in which the pump motor operates continuously (100% duty cycle) shall not be permitted.	Compliant	
3.26.d.viii	The EHU shall report low fluid fault conditions through the Vehicle monitoring system.	Compliant	Discrepancy between brake demand and brake applied effort in case of low fluid level will be monitored. Low fluid level indicator is provided on EHU itself.
3.26.d.ix	Pressures in the brake cylinders shall be limited to 60% of the maximum system pressure.	Compliant	Pressure thresholds will be defined in project phase
3.26.d.x	The EHU shall have sufficient hydraulic capacity to provide continuous normal service operation with friction brakes only.	Compliant	
3.26.e	Accumulators		
3.26.e.i	Nitrogen charged accumulators shall be provided to store the hydraulic energy.	Compliant	
3.26.e.ii	The pressure level shall be sufficient to meet the required response times for all operating conditions including emergency and system cut-out.	Compliant	
3.26.e.iii	A manual cut-out valve shall be provided to hydraulically depressurize the accumulator for maintenance.	Compliant	
3.26.e.iv	The accumulator shall be protected from corrosion.	Compliant	
3.26.e.v	The accumulators shall be properly sized such that from EHU cut-in pressure, the accumulator has sufficient pressure to supply two AW3 full service and one AW3 emergency brake applications with 30 second applications and 2 minutes between applications.	Compliant	Sizing calculation will be confirmed in project phase
3.26.f	Friction Brake Control Unit		

3.26.f.i	The hydraulic disc brakes of each truck shall be controlled by a FBCU for that truck.	Compliant	
3.26.f.ii	The FBCU shall be physically independent or integrated with propulsion logic provided that the level of Safety, reliability and availability is the same as with an independent unit.	Compliant	
3.26.f.iii	The FBCU shall:		
3.26.f.iii.A	Read and interpret trainline requests and load weigh transducers;	Compliant	
3.26.f.iii.B	Communicate over a direct link with the propulsion system for that truck;	Compliant	Through MVB network and trainlines
3.26.f.iii.C	Read the dynamic braking effort signal from the propulsion system and command the friction brakes to provide the difference between braking request and the braking effort supplied by propulsion;	Compliant	
3.26.f.iii.D	Take over if the TCU cannot control a vehicle slide within a preset time;	Compliant	
3.26.f.iii.E	Request the sanding system to apply sand during low adhesion;	Compliant	Sanding in case of slide detection
3.26.f.iii.F	Perform Safety self-checks of the brake system and default to a restrictive state in case of failure;	Compliant	
3.26.f.iii.G	In coordination with the propulsion system, provide roll back protection when the Vehicle is starting from a dead stop;	Compliant	Rollback protection will be ensured by Traction System
3.26.f.iii.G.i	The roll back prevention function of the FBCU shall be coordinated with propulsion to prevent any rollback greater than 10cm during start-up on the absolute maximum grade for the OLRT System (6%).	Compliant	
3.26.f.iii.H	Provide fault recording and diagnostics for system troubleshooting;	Compliant	
3.26.f.iii.I	Meet all the requirements for fault reporting, system integration and local access;	Compliant	
3.26.f.iii.J	Provide a brake application and inhibit Train propulsion when any accumulator pressure falls below a level required to provide a friction only AW3 emergency brake stop;	Compliant	
3.26.f.iii.K	Control braking to provide the total trainline braking request in case of failure of the propulsion system to provide electric braking or in case of communications failure with the propulsion system; and	Compliant	
3.26.f.iii.L	Default to safe operating mode if a failure of the load weigh sensor occurs on the truck.	Compliant	
3.26.f.iii.M	Distinguish between speed sensor failures and vehicle slides.	Compliant	
3.26.g	Track Brakes		
3.26.g.i	Track brakes shall be provided on each truck.	Compliant	
3.26.g.ii	Track brakes shall be powered from low voltage DC system and the car battery.	Compliant	
3.26.g.iii	Track brakes shall be adjustable with hand tools to compensate for wheel and Track brake wear.	Compliant	
3.26.g.iv	Brake shoe material shall be removable without removing the whole Track brake assembly.	Compliant	
3.26.g.v	All Track brake magnetic coils shall be hermetically sealed and all electrical connections shall be waterproof to IP67 per IEC 60529 or NEMA equivalent.	Compliant	
3.26.g.vi	Track brake electrical connections shall be of a waterproof quick disconnect type.	Compliant	
3.26.h	Sanding System		
3.26.h.i	A sanding system shall be provided that shall deposit sand at the wheel rail interface of the lead axle of each Vehicle in the Train.	Compliant	
3.26.h.ii	The air system powering the sander shall store sufficient compressed air that it is capable of 20 seconds of sand application without running the air compressor.	Compliant	
3.26.h.iii	Sand boxes and nozzles shall be heated.	Compliant	
3.26.h.iv	Sanders shall be activated during spinning or sliding events and continuously down to zero speed during any emergency brake application.	Compliant	
3.26.h.v	A momentary switch shall be provided on the console to manually activate sanding.	Compliant	
3.26.i	Qualification Testing		
3.26.i.i	The following minimum tests shall be performed:		
3.26.i.i.A	Golden shoe force test of service brake and emergency brake application;	Compliant	
3.26.i.i.B	Golden shoe force test of parking brake application;	Compliant	
3.26.i.i.C	Emergency brake build up time;	Compliant	
3.26.i.i.D	Dynamometer test of brake pad wear rates;	Compliant	
3.26.i.i.E	Efficiency of the slide control system proven to be equal to or greater than 85% in braking over the entire speed range;	Compliant	Alstom proposal, based on return on experience on its LRV, will use the same type of WSP architecture in order to reach equivalent efficiency.
3.26.i.i.F	Dynamometer test for compliance with friction brake only operation performance requirements; and	Compliant	
3.26.i.i.G	Brake shoe and wheel noise test.	Compliant	Through Vehicle noise validation test
3.27	**Communications and Passenger Information System**		
3.27.a	Communications System Functional Requirements		
3.27.a.i	Provide synchronized audio and visual passenger information announcements and shall include, at a minimum destination, Station stops, time, emergency announcements.	Compliant	
3.27.a.ii	Coordinate emergency announcements on the Vehicle with station announcements so that station and Vehicle announcements do not compete.	Compliant	
3.27.a.iii	Provide a passenger emergency intercom system.	Compliant	
3.27.a.iv	Provide reliable voice communications with the TSCC.	Compliant	
3.27.a.v	Provide networked data communication with the wayside network in line with safety and security requirements and for downloading maintenance data passenger count information and for updating passenger announcements.	Compliant	
3.27.a.vi	Provide a CCTV video monitoring and recording system.	Compliant	
3.27.a.vii	Provide a display that shall provide a view of all Train doors and any passenger compartments in which there is an Emergency.	Compliant	
3.27.a.viii	Provide fault recording and diagnostics for system troubleshooting.	Compliant	
3.27.a.ix	Include a silent alarm reporting function.	Compliant	
3.27.b	Power Distribution and Supplies	Compliant	
3.27.b.i	Each subsystem listed in this section shall be powered from the low voltage DC power system and shall have its own isolated power supply.	Compliant	
3.27.b.ii	Communications and passenger information systems shall operate reliably from the low voltage DC power system within the ranges and power quality allowed by EN 50155.	Compliant	
3.27.b.iii	Each communications subsystem shall be protected by a separate circuit breaker.	Compliant	
3.27.c	System Requirements		
3.27.c.i	Train Voice and Radio	Compliant	
3.27.c.i.A	The vehicle PA system shall provide, as required, power, analog and digital interfaces and connections to the radio system supplied by others. Project Co shall work with the Radio System Supplier to determine the type and functionality required.	Compliant	
3.27.c.i.B	Project Co shall work in partnership with the Radio System Supplier to ensure that the antenna and transceiver do not cause intermodulation or interference with the other OLRT radio systems and equipment. Operational compatibility testing shall be coordinated with the City and the Radio System Supplier and operation shall be demonstrated to the satisfaction of Industry Canada.	Compliant	
3.27.c.ii	Hi-Speed Train-to-Wayside Data Radio		
3.27.c.ii.A	Project Co shall ensure that the high speed Train-to-Wayside data radio system is resilient and does not present a security risk to the OLRT Systems and vehicles.	Compliant	
3.27.c.ii.B	The high speed Train-to-Wayside data radio shall reliably support all required train wayside networked data communications loads required by Articles 3 and 6 of this Schedule 15-2 Part 4.	Compliant	
3.27.c.iii	Public Address System		
3.27.c.iii.A	The PA system shall accept input from the Driver's cab microphone, patched through TSCC announcements, and the automatic announcement system.	Compliant	
3.27.c.iii.A.i	TSCC and cab input shall take priority over automatic announcements.	Compliant	
3.27.c.iii.B	Voice shall be transmitted digitally over the CTS.	Compliant	
3.27.c.iii.C	The PA and speaker system shall meet the performance requirements of IEEE Std 1477-1998, for frequency response, ambient noise level adjustment range, speaker distribution and intelligibility.	Compliant	
3.27.c.iii.D	The PA system shall automatically compensate for ambient noise up to a 95dBA without exceeding Station platform noise level limits.	Compliant	
3.27.c.iii.E	The PA control shall emit an activation chime different from the door chime before any announcement.	Compliant	
3.27.c.iii.F	The PA system shall have both internal and external speakers. External speakers will not be active unless selected.	Compliant	
3.27.c.iii.G	Turning off or reducing external speaker volume at night at At Grade Stations shall be provided.	Compliant	
3.27.c.iii.H	Automatic selection of the correct side for external speaker activation based on location of the Station Platform shall be provided.	Compliant	
3.27.c.iii.I	The PA broadcasts shall be transmitted over the Train and Vehicle Communications Network as VoIP.	Compliant	
3.27.c.iv	Cab to Cab and Passenger Emergency Intercoms	Compliant	
3.27.c.iv.A	Voice shall be transmitted digitally over the Train communications network for all intercom systems.	Compliant	

3.27.c.iv.B	PEI and cab-to-cab intercom systems shall have a session hold function with ability to transfer between PEI and cab-to-cab sessions.	Compliant	
3.27.c.iv.C	Once activated, the PEI stations shall require no further intervention by the passenger to communicate with the Train. PEI stations shall meet ADA and AODA requirements.	Compliant	
3.27.c.iv.D	Queuing of multiple PEI or cab-to-cab intercom calls shall be possible.	Compliant	
3.27.c.iv.E	The PEI system shall permit a passenger speaking at a distance of 50cm from the PEI unit in a normal tone of voice with ambient noise levels up to 85dBA to be heard. Total harmonic distortion through the system from microphone to cab handset shall be less than 2%.	Compliant	
3.27.c.iv.F	If passenger announcement displays in the vehicle are not visible from a seated wheelchair position during peak hour ridership, the PEI in the accessible areas shall include a localized message display panel that also provides PA and announcement information.	Compliant	Messages are broadcasted through internal and external LED displays. According to ADA/AODA requirements, Passenger Displays will be located where they can be seen by a seated person.
3.27.c.iv.G	Activation of a PEI station shall be reported and identified on the Video display along with a video feeds from the car in which the PEI was activated. Video frame rate shall be increased to 30fps until cleared by security personnel.	Compliant	
3.27.c.iv.H	The passenger emergency video feed shall only appear when the Train has stopped. The Driver shall not be able to select video feeds.	Compliant	
3.27.c.v	Radio and Intercom Control Panel		
3.27.c.v.A	The Communications System control panel radio handset shall by default connect to the Train voice radio.	Compliant	
3.27.c.v.B	LED pushbuttons shall be provided to connect the handset to the cab-to-cab intercom and PEI systems. An LED pushbutton shall also be provided to activate the session hold functions described in the intercom section	Compliant	
3.27.c.v.C	Controls shall be provided to adjust the volume of the radio, and intercom speakers and handset volume above a preset minimum level.	Compliant	
3.27.c.vi	Automatic Announcement System		
3.27.c.vi.A	The automatic announcements shall provide pre-recorded simultaneous voice and visual announcements over the Train PA system and the transverse announcement signs located in each body section of each Vehicle.	Compliant	
3.27.c.vi.B	Station and connection announcements shall be provided as the Train enters each Station.	Compliant	
3.27.c.vi.C	Pre-recorded special announcements may be selected from the Communications Systems control panel at any time and override any other messages.	Compliant	
3.27.c.vi.D	The cab system may make direct announcements at any time over the PA system using the gooseneck microphone and a control switch.	Compliant	
3.27.c.vi.E	Special announcements, voice and visual may be relayed from the TSCC over the high speed Train-to-Wayside data radio. The list of pre-recorded messages may also be updated over the high speed Train-to-Wayside data radio along with message priorities, announcement frequency, and expiration dates.	Compliant	
3.27.c.vi.F	Station announcements shall be triggered based on Vehicle location provided by the CBTC system or alternative arrangement.	Compliant	
3.27.c.vi.G	All automatic announcements shall be made in English and French using the existing standards established by the City.	Compliant	
3.27.c.vi.H	Project Co shall provide all necessary management software and hardware for the City to generate and or modify announcements and upload the announcements to the Vehicles over the high speed Train-to-Wayside data radio system provided.	Compliant	
3.27.c.vi.I	Project Co shall provide training to City personnel in the use of the automatic announcement management systems.	Compliant	
3.27.c.vii	Passenger Information Control panel		
3.27.c.vii.A	A driver's passenger information Control Panel shall be provided to allow the driver to select pre-recorded announcements over the PA and to select destinations in case of the automatic system's failure.	Compliant	
3.27.c.vii.B	The Driver's Passenger Information Control Panel shall also display failure of PA sign or PEI equipment in any vehicle in a Train.	Compliant	
3.27.c.vii.C	The Passenger Information Control Panel shall be either an independent unit or a sub-screen of the train Display Screen of the Vehicle monitoring system described in this Article.	Compliant	
3.27.c.viii	Announcement Signs		
3.27.c.viii.A	Electronic passenger announcement signs shall be located throughout the passenger compartment so that passengers may read a sign from any location in that compartment.	Compliant	
3.27.c.viii.B	The announcement signs shall be controlled by the automatic announcement system from the lead Vehicle in the Train over the Train communications network.	Compliant	
3.27.c.viii.C	Signs shall display characters at least 5cm in height and shall be large enough to display up to 30 characters.	Compliant	
3.27.c.viii.D	Signs shall display longer messages by sequencing rather than scrolling.	Compliant	The sign length to be determined during the project phase
3.27.c.viii.E	Signs shall display time of day (military time) when not displaying a message.	Compliant	
3.27.c.ix	Destination Signs		
3.27.c.ix.A	One external electronic destination sign shall be provided and installed at the cab end of each Vehicle (only one end if a single cab is provided) and two electronic destination signs shall be provided and installed on each side of the Vehicle.	Compliant	
3.27.c.ix.B	The destination signs for the whole Train shall be controlled over the Train Communications Network.	Compliant	
3.27.c.ix.C	The destination sign control shall automatically display the correct destination of the Train based on Train travel direction and location.	Compliant	
3.27.c.ix.D	When a Train enters a terminal location the destination signs shall reverse direction as soon as the Train comes to a stop unless this action is overridden. The "Out of Service" message shall also be able to be selected.	Compliant	
3.27.c.x	Security Alarm System		
3.27.c.x.A	A pushbutton switch shall be provided in the cab compartment to activate the silent alarm.	Compliant	
3.27.c.x.B	Pushbutton location shall be determined during review of the cab mock-up.	Compliant	
3.27.c.x.C	Activation of the silent alarm shall:	Compliant	
3.27.c.x.C.i	Cause an alarm message to be sent over the Train radio system to the TSCC and BCC. This alarm message shall include the Vehicle number where the alarm was activated; and	Compliant	
3.27.c.x.C.ii	Cause a tag message to be sent to the NVR of the Vehicle where the alarm was initiated to prevent overwriting of the video data.	Compliant	
3.27.c.xi	CCTV and Non-Volatile Recorder System	Compliant	
3.27.c.xi.A	Network video cameras shall record in color to a NVR.	Compliant	
3.27.c.xi.B	The network cameras shall be directly networked to the NVR.	Compliant	
3.27.c.xi.C	Cameras shall record an image that is admissible in a court of law.	Compliant	
3.27.c.xi.D	Cameras views shall cover the entire passenger area such that there are no blind spots.	Compliant	
3.27.c.xi.E	Additional cameras shall be mounted to record the view out the cab front window and rear window.	Compliant	
3.27.c.xi.F	Cameras shall have an auto iris lens to compensate for variations in ambient light.	Compliant	
3.27.c.xi.G	Cameras shall compensate for ambient light changes within 1 second when entering or leaving a Tunnel.	Compliant	
3.27.c.xi.H	Cameras shall stream video adjustable up to 30 frames per second. Triggering the silent alarm shall set recording to 30 frames per second until reset by security personnel.	Compliant	
3.27.c.xi.I	Cameras and NVR shall be powered from the low voltage DC power with necessary DC to DC isolation converters.	Compliant	
3.27.c.xi.J	Data shall be transmitted from the cameras over shielded cabling with rugged transportation duty connectors.	Compliant	
3.27.c.xii	NVR		
3.27.c.xii.A	The NVR shall be networked into the communications network to provide video feeds to the Driver.	Compliant	
3.27.c.xii.B	Each NVR shall have storage capacity sufficient to store 30 days of video data from the attached cameras without overwriting. The storage device shall be shock and vibration hardened for rail transit duty.	Compliant	Storage capacity to be confirmed
3.27.c.xii.C	The NVR shall have an industrially rated RJ45 Ethernet or USB Port with a secure cover for local downloading of video data.	Compliant	
3.27.c.xii.D	The NVR system shall safeguard and maintain authenticity of the video images using security techniques such as digital image watermarking or encryption and shall be able to demonstrate a chain of custody for data that will be used as evidence in a court of law. When the NVR is activated it shall prevent the video data from being overwritten for 60 days.	Compliant	
3.27.c.xii.E	Activation of the silent alarm shall insert a tag in the files of all recording units in the Train.	Compliant	
3.27.c.xii.F	Any activation of the PEI, or silent alarm, shall insert a tag on the data files of the recording unit for the corresponding Vehicle.	Compliant	
3.27.c.xii.G	A means shall be provided to determine if the camera has been tampered with or vandalized, or if the camera has failed.	Compliant	
3.27.c.xiii	Cab Video Display		
3.27.c.xiii.A	The cab video display shall be energized only in the active cab.	Compliant	
3.27.c.xiii.B	The cab video display shall be blanked when the Train is moving.	Compliant	

3.27.c.xiii.C	The cab video display shall display views of Train doors while the Train is stopped in a Station. A method shall be provided to ensure that the view provided is from the correct platform.	Compliant	
3.27.c.xiii.D	During a PEI call camera views from the car in which the PEI is activated shall be transmitted to the cab display when the Train comes to a stop. No camera views of the passenger areas shall otherwise be provided to the cab.	Compliant	
3.27.c.xiii.E	Camera views from the Vehicle where a PEI request has been made shall take precedence over all other video feeds until cancelled by the cab.	Compliant	
3.27.c.xiv	APC System		
3.27.c.xiv.A	The APC system shall use an infrared or other non-mechanical system to detect passenger boarding or exiting.	Compliant	
3.27.c.xiv.B	The APC passenger detection system shall distinguish between passengers boarding and exiting and shall not count passengers standing in the doorway.	Compliant	
3.27.c.xiv.C	The APC system shall count passengers with 95% accuracy and provide data on ridership that can be compared on a trip, daily, monthly, or yearly basis at each Station.	Compliant	
3.27.c.xiv.D	Once installed the APC system shall not require calibrations or adjustmentfor the life of the unit.	Compliant	
3.27.c.xiv.E	The APC system shall have non-volatile memory capacity to store passenger data for all doors for 8 days assuming 20 round trips per day.	Compliant	
3.27.c.xiv.F	The APC system shall have a diagnostic and fault recording system and shall report failures to the VMS.	Compliant	
3.27.c.xiv.G	Diagnostics shall be remotely available over the communications network.	Compliant	
3.27.c.xiv.H	The data collected by the APC shall be provided to the Performance Monitoring System at TSCC in real time.	Compliant	Specific software tool shall be use to collect and anlyze the data from APC system. Conditions to download data will be discussed in project phase.
3.27.c.xiv.I	Project Co shall supply all relevant passenger counting data to the City. Data shall be downloaded every 24 hours.	Compliant	Specific software tool shall be use to collect and anlyze the data from APC system
3.27.c.xv	Monitoring and Diagnostics		
3.27.c.xv.A	Each networked communications, passenger information or security subsystem shall have its own diagnostics and fault recording system.	Compliant	
3.27.c.xv.B	Each subsystem shall report its health to the VMS described in this Article.	Compliant	
3.27.c.xv.C	Diagnostics of all networked communications and passenger information and security systems shall be accessible over the communications network using a laptop PC and a web browser.	Compliant	
3.27.c.xvi	Qualification Testing		
3.27.c.xvi.A	All communications Equipment and power supplies shall be tested for successful operation within the LVPS voltage supply ranges and power quality as described in this Article.	Compliant	
3.27.c.xvii	Routine Testing		
3.27.c.xvii.A	Each system shall be tested to prove the performance of all specified functions and to prove proper operation under network loading.	Compliant	
3.28	**Interior and Exterior Appointments**		
3.28.a	General Interior Design		
3.28.a.i	The Vehicle shall provide level boarding at Stations. The entire low floor section shall be ADA/AODA accessible and include longitudinal fixed seats as well as the appropriate number of flip up style seats, to provide accessibility for wheelchairs at all door vestibules.	Compliant	refer to ADA requirements description
3.28.a.i.A	in addition to the above, the Vehicle shall be designed and constructed to satisfy Transport Canada rules and regulations including, but not limited to the CTA Code of Practice, Passenger Rail Car Accessibility and Terms and Conditions of Carriage by Rail of Persons with Disabilities	Partially compliant	"CTA Code of Practice, Passenger Rail Car Accessibility and Terms and Conditions of Carriage by Rail of Persons with Disabilities" is a document that has been written for main-line coaches, not urban transport. Therefore some requirements are not applicable to a LRT. The proposed vehicle will comply with the requirement of section 1.2 with the exception of requirement 1.2.14 On-board Wheelchairs provided by Carriers: the train will not be equipped with an on-board wheelchair. Regarding section 1.3: 1.3.1 - Number of Wheelchair Tie-downs - Compliant 1.3.2 - Doorways - Not applicable. There are no doorways in the train. Passenger in wheelchair will not be able to go from one car to the other 1.3.3 - Washrooms: not compliant, there will not be washrooms aboard the train 1.3.4 - Partially compliant: the tie-down will not be equipped with a try or table 1.3.5 Armrests - Not applicable. Seats have no armrests Section 1.4 is not applicable Section 1.5, 1.6 and Part 2 have no impact on the rolling stock
3.28.a.ii	Project Co shall provide a method to convey the interior design to the riding public and associated stakeholders to elicit feedback and market the new vehicle and assist in finalizing the aesthetics and branding.	Compliant	
3.28.a.iii	Project Co shall provide a full size mock-up of the cab with proposed material finishes, to facilitate operating staff review of the ergonomics and aesthetics of the design. The cab mock-up shall be of suitable quality and construction to allow an efficient mechanism of showing equipment positioning and driver field of view to support the ergonomic study. The Driver's seat shall be the prototype proposed for production with complete adjustment and functionality. Where required, the mock-up shall be designed to be recyclable and maximise the ability to re-use components and equipment or place these back into maintenance spares. The cab mock-up shall be non-portable and be located at the MSF. Project Co shall dispose of the cab mock-up once all ergonomic and safety assessments have been completed.	Compliant	
3.28.a.iv	Project Co shall provide a mock-up half of the vehicle only to facilitate staff and public review of the functionality and aesthetic of the design (including 70% and 100 % low floor sections). The passenger mock-up shall be suitable quality and construction to allow an effcicient mechanism of demonstrating passenger movements for boarding, alighting and passenger movement within the vehicle. The passenger mock-up shall be non-portable and be located at a location to be determined. Project co may dispose of the mock-up once all staff and public assesments have benn completed.	Compliant	refer to narrative
3.28.a.v	The partition and door between the cab and the passenger area shall include large laminated Safety glass windows to allow visibility through the front of the LRV.	Compliant	
3.28.a.v	Seats		
3.28.a.v.A	The passenger seating shall be:		
3.28.a.v.A.i	Stainless steel or aluminum shell construction;	Compliant	
3.28.a.v.A.ii	Contoured seats with rail transit grade cushion and a vandal resistant material; and	Compliant	
3.28.a.v.A.iii	A minimum width of 457mm.	Compliant	
3.28.a.vi	Stanchions, Handrails and Grab Bars	Compliant	
3.28.a.vi.A	Stanchions shall be placed to not interfere with passenger flow during boarding / alighting, but one or more stanchion, handrail or grab bar shall be within reach from any standee areas, including the articulation section.	Compliant	
3.28.a.vii	Flooring		
3.28.a.vii.A	The floor panel material shall be composite construction. Wood based, or wood containing products shall not be accepted.	Compliant	
3.28.a.vii.B	The floor covering shall include the following:		
3.28.a.vii.B.i	High friction material in both wet and dry conditions; and	Compliant	
3.28.a.vii.B.ii	Smooth surface (non-ribbed or dotted).	Compliant	
3.28.a.viii	General Interior Design		
3.28.a.viii.A	FRP, gel coated sidewall lining panel/window masks.	Compliant	
3.28.a.ix	Interior Safety Equipment shall include:		
3.28.a.ix.A	PEI units located every accessible area at a height in accordance with AODA requirements.	Compliant	
3.28.a.ix.B	One (1) PEI unit located on each passenger compartment end wall.	Compliant	
3.28.a.ix.C	Manual door release at each side door; and	Compliant	
3.28.a.ix.D	First aid kits in the cab.	Compliant	
3.28.a.x	Miscellaneous interior appointments shall include:		
3.28.a.x.A	Advertising card frames for ceiling corners, side walls, and end walls;	Compliant	
3.28.a.x.B	Locked convenience outlets for car maintenance (110 VAC);	Compliant	
3.28.a.x.C	Signage placed adjacent to the accessible space and denote priority seating for persons with disabilities;	Compliant	
3.28.a.x.D	Additional interior graphics/signs/instructions in Canadian, English and French in consultation with the City; and	Compliant	
3.28.a.ix.E	Emergency and car number information in Braille. General interior signage shall be submitted in accordance with Schedule 10 – Review Procedure.	Compliant	
3.28.b	General Exterior Design		

3.28.b.i	The exterior Design of the Vehicle shall be sleek, modern and attractive. All electrical and mechanical Equipment shall be concealed behind easily replaceable roof shrouds, truck skirts, cab side skirts and the coupler cover. The pantograph and the ice scraper (when in use) shall be the only visible mechanical device on the Vehicle.	Compliant	
3.28.b.ii	Articulation sections shall be covered with internal and external bellows. Intercar dampers and linkage shall be located undercar or on the roof.	Compliant	
3.28.b.iii	All electrical connections, where feasible, shall be fitted with connectors between Vehicle wiring and components.	Compliant	
3.28.b.iv	Exterior Equipment shall include:		
3.28.b.iv.A	Roof Equipment shall include no less than:		
3.28.b.iv.A.i	Two (2) unitized HVAC units;	Compliant	
3.28.b.iv.A.ii	Two (2) propulsion inverters;	Compliant	
3.28.b.iv.A.iii	Two (2) auxiliary inverters, or a single inverter with backup protection to allow unassisted return to maintenance shop after a failure;	Compliant	
3.28.b.iv.A.iv	One (1) of each knife switch, HSCB, line filter, etc.;	Compliant	
3.28.b.iv.A.v	Two (2) LVPS/battery chargers, or a single LVPS if married pairs are provided and all loads of the pair can be powered from the single LVPS;	Compliant	
3.28.b.iv.A.vi	1 battery box;		
3.28.b.iv.A.vii	Braking resistors;	Compliant	
3.28.b.iv.A.viii	One (1) pantograph, equipped with protection (shear pin, or equivalent) that drives the arm to its lowest position in the event of excessive force applied to the head. Pantograph shall be heated, if required, to prevent build-up of snow on the head;	Compliant	
3.28.b.iv.A.ix	One (1) ice scraper (electrically isolated pantograph without carbon strip or cabling) or alternate means of removing ice from the catenary shall be provided; and	Compliant	
3.28.b.iv.A.x	All roof mounted equipment shall allow the use of cleaning agents that are reclaimed and controlled.	Compliant	
3.28.b.iv.B	Undercar Equipment shall include no less than:		
3.28.b.iv.B.i	Two (2) automatic couplers;	Compliant	
3.28.b.iv.B.ii	Three (3) hydraulic power units;	Compliant	
3.28.b.iv.B.iii	Three (3) complete truck assemblies, that comply with the following:	Compliant	
3.28.b.iv.B.iii.1	All powered trucks shall be interchangeable; and	Compliant	All powered truck are interchangeable and can be installed in any motor truck position in the vehicle. Depending on truck position, specific equipment will have to be installed on the truck (for example ATC antenna will only be installed on an end truck)
3.28.b.iv.B.iii.2	All non-powered trucks shall be interchangeable;	Compliant	idem than for power truck
3.28.b.iv.B.iv	One (1) Horn/Bell unit per vehicle end;	Compliant	
3.28.b.iv.B.v	Vehicle Location System transponder reader antenna; and	Compliant	
3.28.b.iv.B.vi	Sandboxes (if not underseat).	Compliant	
3.28.b.v	Exterior Appointments shall include:		
3.28.b.v.A	Passenger side windows;	Compliant	
3.28.b.v.A.i	Laminated Safety glass with a tint layer.	Compliant	
3.28.b.v.B	Exterior speakers next to each passenger side door;	Compliant	
3.28.b.v.C	Sand filling provisions;	Compliant	
3.28.b.v.D	Destination signs as follows:	Compliant	
3.28.b.v.D.i	LED type matrix displays shall be provided;	Compliant	
3.28.b.v.D.ii	One located at the front of each cab car;	Compliant	
3.28.b.v.D.iii	No less than two (2) located on each side of the car; and	Compliant	
3.28.b.v.D.iv	LED Exterior indicator lights;	Compliant	
3.28.b.v.E	At each passenger side doorway, the following crew access items shall be provided:	Compliant	
3.28.b.v.E.i	Exterior manual door release;	Compliant	
3.28.b.v.E.ii	Door indicator lights;	Compliant	
3.28.b.v.E.iii	Door audible chime;	Compliant	
3.28.b.v.E.iv	Door Open passenger pushbuttons; and	Compliant	
3.28.b.v.E.v	Door open/close crew switches at opposite corner doors of the LRV.	Compliant	
3.28.b.v.F	Exterior antennas for radio and high density wireless data communication to the station;	Compliant	
3.28.b.v.G	A method of viewing the entire consist length on both sides of the vehicle while the driver is seated.	Compliant	Through external rear vision camera
3.28.b.v.H	Options for exterior painting, vinyl wrapping, decals and color scheme shall be submitted by Project Co for consideration by the City;	Compliant	
3.28.b.v.I	General exterior signage shall be submitted in accordance with Schedule 10 – Review Procedures;	Compliant	
3.28.b.v.J	Car number shall be prominently displayed on both ends of the LRV, both sides of the center section and on the roof;	Compliant	
3.28.b.v.K	Exterior RFID tags, or equivalent, shall be provided to allow car number communication; and	Compliant	
3.28.b.v.L	CBTC antennas.	Compliant	
3.28.c	Qualification Testing		
3.28.c.i	Seats shall exhibit no permanent deflection when subjected to the following:	Compliant	
3.28.c.i.A	1100N shall be evenly distributed across the front edge of the seat. Load shall be applied in a vertical downward configuration;	Compliant	
3.28.c.i.B	1100N shall be evenly distributed across the top of the seat back. Load shall be applied in a horizontal direction, from front of seat to back; and	Compliant	
3.28.c.i.C	Fatigue loading of 15kg dropped from 300mm above the seat a total of 20,000 times.	Compliant	
3.28.c.ii	Low Floor Panels (supported at maximum beam spacing per Vehicle Design) shall exhibit no delamination, deflect no more than 3.18mm or permanently deform no more than 0.25mm under the following tests	Compliant	
3.28.c.ii.A	A 1300N load uniformly distributed over a 15mm x 15mm surface area;	Compliant	
3.28.c.ii.B	2700N over a 150mm x 150mm surface area; and	Compliant	
3.28.c.ii.C	An impact load resulting from a 3kg steel ball dropped from a height of 1.5m.	Compliant	
3.28.c.iii	Heater guard tests to ensure surface temperatures do not exceed 52°C.	Compliant	
3.28.c.iv	Stanchion mounting tests with 1.5kN applied to the midpoint of the span to ensure sturdy mounting. Cantilever mounted grab bars and hand-holds shall be tested with the load applied at the unsupported end.	Compliant	
3.29	**Communication Based Train Control**		
3.29 a	The onboard and wayside portions of the CBTC system are specified in Part 4 Article 5 – Train Control.	Not applicable	Noted
3.30	**Event Recorder**		
3.30.a	General Objectives		
3.30.a.i	Independent of the VMS, a separate event recorder shall be provided on each Vehicle.	Compliant	
3.30.a.ii	The Event recorder shall be crashworthy, meeting the Construction requirements of IEEE 1482-1999.	Compliant	
3.30.a.iii	The Event Recorder shall record all Safety critical data and allow retrieval after accidents or unsafe events.	Compliant	
3.30.b	Data Recorded		
3.30.b.i	As a minimum, the following data and signals shall be recorded:	Compliant	
3.30.b.i.A	Mandatory channels from IEEE Std 1482.1-1999;	Compliant	
3.30.b.i.B	Car number;	Compliant	
3.30.b.i.C	Brake cylinder pressure from each truck;	Compliant	
3.30.b.i.D	Deadman control;	Compliant	
3.30.b.i.E	Dynamic brake application;	Compliant	
3.30.b.i.F	Propulsion effort request of the Master Controller and the CBTC systems ATO function;	Compliant	
3.30.b.i.G	Time and date;	Compliant	
3.30.b.i.H	Irretrievable Emergency Brake Switch activation;	Compliant	
3.30.b.i.I	Distance (shall be defined, preset wheel diameter);	Compliant	
3.30.b.i.J	Emergency brake application;	Compliant	
3.30.b.i.K	Catenary voltage;	Compliant	
3.30.b.i.L	Horn activation;	Compliant	
3.30.b.i.M	All Bypass or cutout switches;	Compliant	
3.30.b.i.N	Tractive effort level;	Compliant	
3.30.b.i.O	CBTC mode of operation;	Compliant	
3.30.b.i.P	All communications to and from the Zone Controller;	Compliant	

3.30.b.i.Q	All commands of the CBTC system to the trainlines and to the Emergency brake system;	Compliant	
3.30.b.i.R	CBTC cut in/cut out status;	Compliant	
3.30.b.i.S	Speed;	Compliant	
3.30.b.i.T	Current authorized speed; and	Compliant	
3.30.b.i.U	All cab initiated PA announcements.	Compliant	
3.30.c	Diagnostics and Self-Test		
3.30.c.i	Event recorder shall have fault indication.	Compliant	
3.30.c.ii	Event recorder shall perform automatic self-tests.	Compliant	
3.30.c.iii	The Event recorder shall report its health to the VMS via a discrete output.	Compliant	
3.30.d	Data Storage and Retrieval		
3.30.d.i	Data storage shall be FIFO, such that the latest information is retained.	Compliant	
3.30.d.ii	The event recorder shall have sufficient storage to store 48 hours of continuous operation data before overwriting.	Compliant	
3.30.d.iii	Data retrieval shall be retrievable by a laptop computer or similar portable device.	Compliant	
3.30.d.iv	Downloaded raw data shall be converted into an easily readable format and visual display.	Compliant	
3.30.d.v	Retrieval of data shall not delete data from the internal hardened memory module.	Compliant	
3.30.d.vi	Event recorder Design shall prevent unauthorized access.	Compliant	
3.30.e	The event recorder shall be powered from the battery backed up low voltage bus through a dedicated magnetic push to reset circuit breaker which cannot be turned off.	Compliant	
3.30.f	Event Recorder Qualification Testing		
3.30.f.i	On the first car the Event Recorder shall be tested to ensure that all required data is accurately recorded.	Compliant	
3.31	**Monitoring & Diagnostics System**		
3.31.a	General		
3.31.a.i	The VMS shall be the central collection point for fault data on each Vehicle and shall provide access to diagnostic features of various subsystems. The VMS shall consist of:	Compliant	
3.31.a.i.A	A. A VMU in each Vehicle which shall collect fault and event data from all Vehicle subsystems in that car and transfer that data to all other VMUs.	Compliant	
3.31.a.i.B	TDS in each cab.	Compliant	
3.31.a.i.C	A connection to the high speed data radio for uploading fault data to the wayside maintenance database.	Compliant	Protocol to be defined with customer radio
3.31.b	System Description		
3.31.b.i	At a minimum, the VMU shall interface with the following subsystems:		
3.31.b.i.A	LVPS;	Compliant	
3.31.b.i.B	Door control system;	Compliant	
3.31.b.i.C	HVAC system;	Compliant	
3.31.b.i.D	CBTC system;	Compliant	
3.31.b.i.E	Brake system;	Compliant	
3.31.b.i.F	Communications and Passenger information sub systems;	Compliant	
3.31.b.i.G	Propulsion system;	Compliant	
3.31.b.i.H	Auxiliary Inverters; and	Compliant	
3.31.b.i.I	Event Recorder system.	Compliant	
3.31.b.ii	The VMU and the TDS shall operate from the Vehicle low voltage system and operate as a critical load from the Vehicle battery supply. The VMU shall use non-volatile solid state or battery backed memory to store recorded faults and events.	Compliant	
3.31.b.iii	The real time clocks of all VMUs and subsystems shall be synchronized to the CBTC system time.	Compliant	CBTC System shall provide valid date and time. TCMS equipment will be synchronized accordingly.
3.31.c	Local Access for Subsystems		
3.31.c.i	Each subsystem reporting to the VMS over the network shall also have a local access port for access by a portable laptop computer.	Compliant	
3.31.c.i.A	The access port shall be of a type supported by the most current laptop computers and most likely to have continued support, for example USB 2.0 or higher or Ethernet, but not RS232.	Compliant	
3.31.c.i.B	The access port shall be industrial grade with a dust cover.	Compliant	
3.31.d	Train Display Screen		
3.31.d.i	The TDS in the operating cab shall display a default screen showing a graphic of all cars in the Train.	Compliant	
3.31.d.ii	The graphic shall highlight any doors open or brakes applied and indicate the malfunction.	Compliant	
3.31.d.iii	Vehicles with any faults affecting Train operation shall be highlighted.	Compliant	
3.31.d.iv	Clicking on the highlighted Vehicle shall list the current fault and recommended action.	Compliant	
3.31.d.v	More detailed fault and diagnostic information shall be available to maintenance personnel in a key or password protected mode.	Compliant	
3.31.d.vi	Fault logs of every subsystem on every car shall be selectable and viewable from the TDS without moving from car to car.	Compliant	Compliant
3.31.e	Performance		
3.31.e.i	The VMU shall record and store not less than a rolling 60 days of faults in non-volatile solid state or battery backed memory in a circular first in first out file.	Compliant	
3.31.e.ii	The VMU shall upload fault data and odometer reading to the MSF maintenance database upon request providing all new faults and flagged events since the last upload.	Compliant	
3.31.e.iii	Transferring fault data to a PTU or to the wayside maintenance database shall not erase that data from VMU or subsystem memory.	Compliant	
3.31.f	Project Co shall be responsible for systems integration of the monitoring and diagnostic system, including:	Compliant	
3.31.f.i	Integration of the subsystems with the VMU; and	Compliant	
3.31.f.ii	Train network integration of the VMUs with the TDS.	Compliant	
3.31.g	Reliability		
3.31.g.i	Failure of the TDS or a VMU shall not disable the Train.	Compliant	
3.31.g.ii	There shall be no loss of data due to memory degradation or failure.	Compliant	Train Driver Display Screen (DDU) and Vehicle Monitoring Unit (MPU) are able to record data on non-volatile memory protected against basic failures. However these memories can not be considered as juridical recorders. The Event recorder will record all the safety critical data and will be crashworthy according to requirements from IEEE 1482-1999.
3.31.g.iii	If battery backed memory is used then batteries shall not require replacement more often than every 5 years.	Compliant	
3.31.h	VMS Qualification Testing		
3.31.h.i	All subsystems reporting to the VMU shall be tested for ability to send and record data and faults in accordance with the Design fault plan.	Compliant	
3.32	**Trainlines and Networks**		
3.32.a	(a) General		
3.32.a.i	The provided LRVs shall operate as a trainset through:	Compliant	
3.32.a.i.A	Discrete trainlines for critical functions;	Compliant	
3.32.a.i.B	An IEEE 1473 type T, or similar standard WTB/MVB Train Control System for Vehicle monitoring and Train Control functions;	Compliant	
3.32.a.i.C	An IEEE 1473 draft type E network or similar standard for communications and passenger information;	Compliant	
3.32.b	Discrete Trainlines		
3.32.b.i	Safety critical functions such as door control, the all doors closed and locked interlock, emergency brake control, shall be transmitted either as double break trainlines or as two independent trainlines. Propulsion and braking control shall be implemented over the Train Control System with a discrete Train line check.	Compliant	
3.32.b.ii	Power for trainline signals shall be provided from circuits off the LVPS/battery network of the lead car. Return power shall be through the battery negative trainline.	Compliant	
3.32.b.iii	Cab control make up, and certain trainlines necessary for Train operation (but not necessarily Safety critical) and trainlines which may be cross checked may be implemented as single break trainlines.	Compliant	
3.32.b.iv	Lighting control shall be provided by discrete trainlines.	Compliant	
3.32.c	Train Control Network		
3.32.c.i	Vehicle monitoring communications within and between Vehicles shall take place over the Train Control Network.	Compliant	
3.32.c.ii	WTB Train sequencing data shall be available for other systems.	Compliant	Understood as: Train composition (vehicle number, position in consist, status) will be made available to other system via connection on the vehicle MVB Network or through the radio interface.

3.32.c.iii	Train propulsion and brake control, and other critical Train-wide functions as specified shall be implemented over the Train Control network or discrete trainlines.	Compliant	
3.32.d	On Board Communications Network		
3.32.d.i	All Train-wide voice communications, control of destination signs and passenger information signs and transmission of video within the Train shall take place over the OBCN.	Compliant	
3.32.d.ii	The VMU which is connected to the Train Control System shall also connect to the OBCN to:	Compliant	
3.32.d.ii.A	Report Vehicle status to the wayside Maintenance database;	Compliant	
3.32.d.ii.B	Provide Train sequencing information to the communications systems which need it; and	Compliant	
3.32.d.ii.C	Receive health status from communications systems.	Compliant	
3.32.e	CBTC System Network		
3.32.e.i	The CBTC system shall use the Train Control System or its own dedicated network for communications between its subsystems or between Vehicles. The OBCN shall not be used for this purpose.	Compliant	
3.32.f	Performance		
3.32.f.i	Trainlines and networks shall be designed to allow operation of the Train, and control of doors from any active cab.	Compliant	
3.32.f.ii	The networks shall have capability of increasing data loads by 50% without missing deadlines or losing data.	Compliant	
3.32.f.iii	The OBCN transmission through the electrical coupler shall have the capability to simultaneously support four video streams plus a PEI session and PA and sign announcements with no visible or audible delays.	Compliant	
3.32.g	Reliability and Availability		
3.32.g.i	Trainlines and networks shall be redundant across all coupler connections.	Compliant	
3.32.g.ii	If any node fails, network communications shall be maintained between all unaffected nodes.	Compliant	
3.32.g.iii	All networks shall be redundant through the Train.	Compliant	Compliant. All network with the exception of CAN are redundant.
3.32.g.iv	All network Equipment and relays shall be located in the interior of the Vehicle.	Compliant	
3.32.g.v	All network Equipment shall be compliant with EN 50155.	Compliant	
3.32.h	Network Security		
3.32.h.i	Project Co shall provide an assessment of all network security threats in particular to the Communications System and the Train Control Systems and their potential impact as well as an analysis of the efficacy of all countermeasures designed to mitigate each threat.	Compliant	
3.32.h.i.ii	The analysis provided shall be in accordance with the guidelines of the IEC/ISO 27000 series standards.	Compliant	
3.33	**Materials and Workmanship**		
3.33.a	Standards		
3.33.a.i	All materials shall conform to APTA, AISI, ANSI ASTM, ASME, IEEE, CEC, CAN/CSA and other specifications as stated herein or as otherwise applicable.	Compliant	
3.33.b	Prohibited Materials		
3.33.b.i	The Vehicle shall comply with the Toxic Reductions Act of 2009, Ontario Regulation 455/09.	Compliant	
3.33.b.ii	In addition, the following materials shall be prohibited from use on the Vehicles:	Compliant	
3.33.b.ii.A	PVC;	Compliant	
3.33.b.ii.B	Asbestos;	Compliant	
3.33.b.ii.C	Cadmium (except for battery);	Compliant	
3.33.b.ii.D	Lead (except in solder used for electrical purposes);	Compliant	
3.33.b.ii.E	PCBs;	Compliant	
3.33.b.ii.F	Carcinogenic materials as listed by current Publication of TLV and BEIs guidelines published by the ACGIH;	Compliant	
3.33.b.ii.G	Materials that, in their normal installed state, emit products that are known to be toxic or irritants as per materials listed in 29 CFR 1910.19;	Compliant	
3.33.b.ii.H	All CFC and HCFC compounds classified as ozone depleting substances per 40 CFR 82; and	Compliant	
3.33.b.ii.I	Urethane Foam.	Compliant	
3.33.c	Fasteners		
3.33.c.i	Fasteners – General		
3.33.c.i.A	No protruding screws, rivets, mounting bolts, or similar items shall be permitted on the exterior of the Vehicle. Interior fasteners shall not protrude enough to become a tripping or snagging hazard.	Compliant	
3.33.c.i.B	Fasteners exposed to passengers shall be tamperproof.	Compliant	
3.33.c.i.C	All carbon steel fasteners shall be zinc plated.	Compliant	
3.33.c.ii	Fasteners – Locking Requirements		
3.33.c.ii.A	All threaded fasteners shall be self-locking or provided with locking devices.	Compliant	
3.33.d	Elastomers		
3.33.d.i	Elastomers – General		
3.33.d.i.A	Elastomeric parts used for interior decorative trim shall be coloured to harmonize with adjacent surfaces. All colors shall be as approved by the City.	Compliant	
3.33.d.i.B	Elastomers shall meet the combustibility requirements of this Article.	Compliant	
3.33.d.ii	Elastomers – Floor Covering	Compliant	
3.33.d.ii.A	Project Co shall submit color and material samples and material friction tests in wet and dry conditions to demonstrate safety of Passengers as Part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	
3.33.e	Laminated Safety Glass		
3.33.e.i	Laminated Safety glass shall be used exclusively and shall conform to the following general, manufacturing, and finish requirements:	Compliant	
3.33.e.i.A	Float glass quality shall conform to ASTM C1036, Type 1, Class 1, quality Q3.	Compliant	
3.33.e.i.B	Tinted assemblies shall use a tinted PVB layer with clear glass laminate. Tinting shall be applied to the perimeter of the glass to mitigate UV damage of the elastomer surround or bonding agent.	Compliant	
3.33.e.i.C	Manufacturers stamp shall be positioned in lower right hand corner as viewed from inside the Vehicle.	Compliant	
3.33.e.ii	Group I glass shall:	Compliant	
3.33.e.ii.A	Be clear laminated Safety glass used for forward facing glazing;	Compliant	
3.33.e.ii.B	Meet the requirements of 49 CFR 223, FRA Type I rating, having a minimum thickness of 14 mm; and	Compliant	
3.33.e.ii.C	Be certified to comply with the requirements of ANSI Z26.1.	Compliant	
3.33.f	Tempered Safety Glass		
3.33.f.i	Tempered Safety glass that may be used for internal glazing and partitions, shall be manufactured to ASTM C1048, Kind FT, Condition A, Type 1 clear, Class 1 clear, quality Q3 (or Class 3, tinted, light reducing).	Compliant	
3.33.g	Piping and Fittings		
3.33.g.i	Piping and Fittings – General		
3.33.g.i.A	Project Co shall perform a leak test on the final air and/or hydraulic piping system, with all components installed, on each Vehicle in accordance with IEC 61133. A copy of the test report for each Vehicle, including retest reports if appropriate, shall be included with each vehicle history book.	Compliant	
3.33.g.ii	Piping and Tubing		
3.33.g.ii.A	Piping and tubing shall be fastened with insulated clamps.	Compliant	
3.33.g.ii.B	After full installation on the Vehicle, and before connection or installation of system components, the piping system shall be completely flushed to remove and/or dissolve all contaminants from manufacture and installation. The piping systems shall be purged, following completion of component installation.	Compliant	
3.33.h	Wire and Cable		
3.33.h.i	Wire and Cable – General		
3.33.h.i.A	All wire and cable shall be in accordance with AAR RP-585 and the recommendations of APTA RP-E-009-98 section 6.0 (or latest version).	Compliant	
3.33.h.i.B	New wire and cable shall be soft annealed copper, tinned, stranded, and jacketed with radiation cross linked polyolefin (Exane), or City accepted equal, in accordance with ASTM B33 and AAR Standard S 501.	Compliant	
3.33.h.i.C	The use of aluminum wire and/or cable is prohibited.	Compliant	
3.33.h.i.D	The insulation system for all internal wires and cables shall be flame retardant and be specifically formulated to minimize smoke, noxious emissions or corrosive fumes in the event of severe overheating or fire. Materials used for the insulation shall be free of halogens.	Compliant	
3.33.h.i.E	All wires and cables shall be protected against movement, chafing and contact with other components that might cause damage to the insulation.	Compliant	
3.33.h.i.F	All wiring shall be printed with manufacturer's identification, conductor size, voltage rating and temperature rating.	Compliant	

3.33.h.ii	Wire and Cable – High Temperature	Compliant	
3.33.h.ii.A	High temperature wire and cable shall be used in locations where the operating temperatures shall exceed the limits of the other indicated insulations.	Compliant	
3.33.h.ii.B	High temperature insulated wire shall not be used in conduit or raceways. This type of wire and cable shall not be bundled together or run with any other type of cable.	Compliant	
3.33.i	Wiring		
3.33.i.i	Wiring – General		
3.33.i.i.A	Wiring which operates at 120Vac and 208Vac shall not be placed in the same conduits or ducts with wires operating at battery voltage.	Compliant	
3.33.i.i.B	Wiring shall be in conduit, raceways or ducts.	Compliant	
3.33.i.i.C	Safety grounds shall utilize dedicated grounding bosses or grounding pads.	Compliant	
3.33.i.i.D	Power Train line cables shall be supported by insulated cable cleats with sufficient spacing between individual conductors to permit adequate ventilation.	Compliant	
3.33.i.i.E	For proper identification of phases, color coded shrink type markers shall be used on 208 volt cable ends.	Compliant	
3.33.i.i.F	Low and high voltage cables shall have separate individual raceways.	Compliant	
3.33.i.i.G	Splicing of conductors is prohibited.	Compliant	
3.33.i.ii	Wiring – Terminals		
3.33.i.ii.A	All wiring shall be fitted with pre-insulated diamond grip terminals.	Compliant	
3.33.i.iii	Wiring – Grounding		
3.33.i.iii.A	Battery (low voltage DC) circuits shall not be individually grounded.	Compliant	
3.33.i.iii.B	All Equipment enclosures and frames of all resiliently mounted electrical apparatus, with the exception of the battery box, shall be suitably grounded to the car body.	Compliant	
3.33.i.iii.C	The Vehicle grounding system shall meet all technical requirements of IEEE Std 16-2004 and APTA SS-E-005-98 (or latest version).	Compliant	
3.33.i.iv	Wiring – Conduits and Fittings		
3.33.i.iv.A	Wires shall not occupy more than 50% of the free cross-sectional area of any conduit.	Compliant	
3.33.i.iv.B	Where necessary to facilitate component removal and replacement, minimum lengths of flexible liquid tight conduit may be used.	Compliant	
3.33.i.iv.C	Insulated bushings shall be used in all conduit and conduit fittings.	Compliant	
3.33.j	Welding		
3.33.j.i	Welding – General		
3.33.j.i.A	All welding practice shall be in accordance with the applicable requirements and recommendations of the AWS.	Compliant	
3.33.k	General Corrosion Control		
3.33.k.i	All materials used shall be corrosion resistant. Equipment located in areas highly susceptible to corrosion shall be made from inherently corrosion resistant materials.	Compliant	
3.33.k.i.A	Areas exposed to corrosive fluids or cleaning solutions shall be protected with coatings resistant to those fluids.	Compliant	
3.33.l	Dissimilar Metal Treatment		
3.33.l.i	Direct contact between electrically dissimilar metals is prohibited except for electrical connections between copper and aluminum where appropriate joint compounds are used. Isolating and moisture-proofing materials, appropriate to the materials being joined, shall be used at all times.	Compliant	
3.33.l.ii	All metals used in the fabrication process shall be surface treated with corrosion-resistant materials prior to assembly.	Compliant	
3.33.l.iii	All ferrous metal surfaces, other than stainless steel, shall be protected by painting or zinc plating.	Compliant	
3.33.m	Flammability, Toxicity and Smoke Emission		
3.33.m.i	Materials shall comply with the flammability, smoke emission, toxic gas and fire retardation requirements specified herein.	Compliant	
3.33.m.ii	Materials shall be low halogen in addition to meeting the low-smoke requirements specified herein.	Compliant	
3.33.m.iii	As a minimum, all materials used in the Construction of the Vehicle shall meet the requirements of the 49 CFR 238.103, and Appendix B to Part 238 – Test Methods and Performance Criteria for the Flammability and Smoke Emission Characteristics of Materials Used in Passenger Cars and Locomotive Cabs. Unless otherwise specified, all materials and Construction shall meet the requirements of NFPA 130-2010.	Compliant	
3.33.m.iv	Should a conflict exist between the NFPA requirements, federal requirements and requirements listed elsewhere in these provisions, the more restrictive requirement shall govern.	Compliant	
3.33.m.v	Project Co shall retain a list of materials (flammability matrix) used in the Vehicles showing location of material, weight and total weight), heat value per pound and per Vehicle, flame spread, flashpoint, smoke generation and toxicity.	Compliant	
3.33.m.vi	Project Co shall retain laboratory test results for each test, including a technical data sheet.	Compliant	
3.33.m.vii	Test report documentation shall specifically identify the tested material by the same description that appears on the technical data sheet and other related references. This documentation shall be directly traceable to the applicable carbuilder drawings.	Compliant	
3.33.m.viii	Flammability and Smoke Generation Criteria, Flammability and Smoke Generation Criteria requirements are outlined in Table 4-3.8.	Compliant	
3.33.m.viii	**Table 4-3.8**		
3.33.m.viii	**Function of Material - Test Procedure /Performance Criteria**		
3.33.m.viii	All Vehicle materials and components except as otherwise noted.	Compliant	
3.33.m.viii	ASTM E162 : Is ≤ 35	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 165	Compliant	
3.33.m.viii	HVAC Ducting		
3.33.m.viii	ASTM E162 : Is ≤ 35	Compliant	
3.33.m.viii	ASTM E662 : Ds (4.0) ≤ 100	Compliant	
3.33.m.viii	Lighting Diffusers / Plastic Glazing		
3.33.m.viii	ASTM E162 : Is ≤ 100	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	Thermal and Acoustical Insulation		
3.33.m.viii	ASTM E162 : Is ≤ 25	Compliant	
3.33.m.viii	ASTM E662 : Ds (4.0) ≤ 100	Compliant	
3.33.m.viii	Flexible Cellular Foams		
3.33.m.viii	ASTM D3675 : Is ≤ 25	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 175	Compliant	
3.33.m.viii	Elastomers – Lock strip gaskets		
3.33.m.viii	ASTM C542 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	Elastomers – Other gaskets or seals		
3.33.m.viii	ASTM C1166 : 100mm (4.0in), maximum flame propagation (15)	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	Structural – Floor, Roof		
3.33.m.viii	ASTM E119 : Pass (30 minutes minimum endurance at AW3 loading)	Compliant	
3.33.m.viii	Floor Covering		
3.33.m.viii	ASTM E648 : CRF ≥ 0.5W/cm2	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤100, Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	Seat Cushion, Mattresses		
3.33.m.viii	ASTM D3675 : Is ≤ 25	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 175	Compliant	
3.33.m.viii	Seat Frame, Seat Shroud		
3.33.m.viii	ASTM E162 : Is ≤ 35	Compliant	
3.33.m.viii	ASTM E662 : Ds (1.5) ≤ 100, Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	Upholstery		
3.33.m.viii	14 CFR (FAR) 25.853 (Appendix F, vertical, textiles) : Flame Time ≤ 10s	Compliant	
3.33.m.viii	ASTM E662 : Burn Length ≤ 150mm (6in) / Ds (4.0) ≤ 200	Compliant	
3.33.m.viii	Wire Insulation		
3.33.m.viii	IEEE Std 383 – Flammability : Pass	Compliant	
3.33.m.viii	ASTM E662 : Ds (4.0) ≤ 50	Compliant	
3.33.m.ix	Toxic Content Limits In Combustion Products		

3.33.m.ix.A	A. The maximum toxic gas concentration in the combustion products of any materials used in the Construction of the Vehicle shall not exceed the values outlined in Table 4-3.9:	Compliant	
3.33.m.ix.A	Table 4-3.9		
3.33.m.ix.A	Toxic Gas – BSS-7239 Maximum Concentration		
3.33.m.ix.A	CO : 3500ppm	Compliant	
3.33.m.ix.A	Hydrogen Fluoride (HF) : 200ppm	Compliant	
3.33.m.ix.A	Nitrogen dioxide (NO2) : 100ppmp	Compliant	
3.33.m.ix.A	Hydrogen Chloride (HCL) : 500ppmp	Compliant	
3.33.m.ix.A	Hydrogen cyanide (HCN) : 150ppm	Compliant	
3.33.m.ix.A	Sulphur dioxide (SO2) : 100ppm	Compliant	
3.33.n	Panel Flatness		
3.33.n.i	The maximum allowable deviation of any point on the panel measured from a reference plane taken from any three corners shall be 3mm. The overall deviation of the panel thickness shall not exceed 1mm.	Compliant	
3.33.o	Acoustic Insulation		
3.33.o.i	Sound damping material used in the fabrication of the Vehicle shall be resistant to diluted acids, greases, gasoline, fuel oils, aliphatic oils, and vermin. Material shall be resistant to fungus and shall not support combustion. The material shall not be affected by sunlight or ozone, and shall not become brittle with age.	Compliant	
3.33.p	Thermal Insulation		
3.33.p.i	Thermal insulation materials shall be transportation grade of the rigid, non-rigid, or spray-on type. Insulation shall be installed with a vapour barrier as required to preclude moisture accumulation.	Compliant	
3.33.p.ii	The type of thermal insulation to be used shall not be susceptible to mould or rot and shall not absorb water. Metals, which are attached to the insulation shall be corrosion resistant and not settle under Vehicle vibration.	Compliant	
3.33.p.iii	Urethane foam insulation is prohibited.	Compliant	
3.33.q	FRP		
3.33.q.i	FRP shall be polymeric-reinforced laminated material, composed of a gel-coated surface, fibreglass reinforcement, and polyester, acrylic, phenolic, or approved equal resin.	Compliant	
3.33.r	Films and Graphics		
3.33.r.i	Films and Graphics – General		
3.33.r.i.A	All graphic materials shall be transportation grade materials. Signage graphics shall have an opaque background with clear, vandal resistant overlayment. Printed signage graphics shall be either reverse printed on the back of the clear overlayment, or printed on opaque background and covered by the clear overlayment.	Compliant	
3.33.r.i.B	Films and graphics shall withstand effects of detergents and brushes used in washing procedures for removal of multiple applications of graffiti.	Compliant	
3.33.r.i.C	Films shall use a removable grade adhesive that upon removal does not require use of solvents, or secondary operations to remove adhesive or graphic residue.	Compliant	
3.33.r.ii	Films and Graphics – Emergency Exit Signage		
3.33.r.ii.A	Emergency exit signage shall comply with APTA SS-PS-004-99, Standard for Low-Location Exit Path Marking and 49 CFR, Part 238.	Compliant	
3.33.r.ii.B	LLEPM material shall be provided to illuminate the path to each emergency exit.	Compliant	
3.33.r.ii.C	The LLEPM and emergency exit signage shall be passive and independent of the car's normal and emergency lighting systems.	Compliant	
3.33.r.ii.C.i	HPPL material shall be used in the fabrication of the exit signage and the LLEPM.	Compliant	
3.33.r.iii	Films and Graphics – Emergency Access Signage		
3.33.r.iii.A	Each door intended for use by Emergency responders for rescue access shall be identified with emergency access signs and instructions consisting of retro-reflective materials.	Compliant	
3.33.s	Electrical Devices and Hardware		
3.33.s.i	Electrical Devices and Hardware – Contactors, Relays and Switches		
3.33.s.i.A	All devices shall be readily identifiable by means of a permanent, durable marking strip giving the device circuit Designation.	Compliant	
3.33.s.i.B	Switches shall be provided with a "keying" feature that prevents the body of the switch from rotating.	Compliant	
3.33.s.ii	Electrical Devices and Hardware – Circuit Breakers		
3.33.s.ii.A	The "on", "off" and "tripped" positions of all circuit breakers shall be permanently marked.	Compliant	
3.33.s.ii.B	All circuit breakers shall be sized by current rating and tripping time to protect both the associated Equipment and the minimum size wire.	Compliant	
3.33.s.ii.C	All circuit breakers shall be of a high shock-resistant Design.	Compliant	
3.33.s.iii	Electrical Devices and Hardware – Fuses		
3.33.s.iii.A	Fuses shall be used only where the use of a circuit breaker is not technically feasible.	Compliant	
3.33.s.iii.B	Each fuse shall be permanently identified and readily accessible.	Compliant	
3.33.s.iii.B.i	The rating of each fuse shall be clearly and permanently marked on the fuse and holder.	Compliant	
3.33.s.iii.C	The fuse holder shall have fuse retention devices at both ends.	Compliant	
3.33.s.iii.D	Blown fuse indication shall be provided.	Compliant	Visual indication on the fuse
3.33.s.iv	Electrical Devices and Hardware – Bus Bars		
3.33.s.iv.A	Bus bars shall conform to the requirements of IEEE Std 16-2004.	Compliant	or equivalent EN standards
3.33.s.v	Electrical Devices and Hardware – Switch, Circuit Breaker, and Fuse Panels		
3.33.s.v.A	All live portions of the protected circuitry shall be completely concealed so that no danger of electrocution or shock exists from the touching of the panel or any appurtenances or devices mounted thereto.	Compliant	
3.33.s.v.B	All switches, circuit breakers, fuses, and indicating lights shall be provided with a nameplate clearly identifying the circuit which each controls and its circuit Designation.	Compliant	
3.33.s.vi	Electrical Devices and Hardware – Illuminated Status Indicators and Annunciators		
3.33.s.vi.A	All illuminated status indicators, annunciators or similar devices shall be long-life LED type lamps.	Compliant	
3.33.s.vii	Electrical Devices and Hardware – Rotating Equipment	Compliant	
3.33.s.vii.A	Rotating machinery shall be suitable for continuous duty, and the continuous duty shall be confirmed in accordance with IEEE Std 11-2000.	Compliant	
3.34	**Vehicle Testing**		
3.34.a	General		
3.34.a.i	Qualification tests may be waived, at the sole discretion of the City.	Compliant	
3.34.a.ii	Project Co shall notify the City of the planned test date no less than 30 calendar days prior to the planned start of the test.	Compliant	
3.34.a.iii	Additional tests shall be performed by Project Co as required to ensure complete compliance to the specification, as well as all Applicable Laws, regulations and standards.	Compliant	
3.34.a.iv	Production tests shall take place on all Vehicles.	Compliant	
3.34.b	Test Documentation		
3.34.b.i	Test Plan		
3.34.b.i.A	Project Co shall prepare a Master Test Plan. The Test Plan shall include all tests required to prove complete compliance to the Vehicle Article/specification.	Compliant	
3.34.b.i.B	The Master Test Plan shall be submitted as Part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	
3.34.b.i.C	Test order shall be arranged, to the maximum extent possible, such that failures resulting in re-Design do not nullify the results of successfully completed tests.	Compliant	
3.34.b.i.D	Subsystem performance requirements may be addressed in one or more comprehensive tests, as elected by Project Co.	Compliant	
3.34.c	Test Procedures		
3.34.c.i	All test procedures authored by Project Co or sub-supplier shall be submitted as Part of the Works Submittals according to Schedule 10 – Review Procedure.	Compliant	
3.34.d	Test Reports		
3.34.d.i	Test reports shall be produced by Project Co and be available for review by the City, at the City's request.	Compliant	
3.34.e	Test Protocol		
3.34.e.i	Labs shall be certified to perform tests, if required by applicable agency or administration.	Compliant	
3.34.e.ii	All Equipment used in the performance of tests shall be calibrated by an independent test laboratory on an annual basis, or more often, if required by the specific test.	Compliant	
3.34.f	Test Notification		
3.34.f.i	The City reserves the right to witness any test or portion of a test required on any Vehicle delivered under this contract. Project Co shall notify the City of any planned tests a minimum of 30 calendar days prior to the test taking place.	Compliant	
3.34.g	Types of tests		

3.34.g.i	Component Qualification Tests		
3.34.g.i.A	Components shall be Qualification tested before they are presented for review and approval at the FAI. FAI approval is required prior to sub-system installation on the first production car.	Compliant	
3.34.g.i.B	Component qualification testing is documented in the previous sections of this Article.	Compliant	
3.34.g.ii	Component Production Tests		
3.34.g.ii.A	Components shall be production tested at the sub-suppliers factory before shipment to Project Co.	Compliant	
3.34.g.ii.B	Test reports shall be shipped with each component. Copies of the test reports shall be included in each car history book.	Compliant	
3.34.g.iii	Vehicle Production Tests		
3.34.g.iii.A	Vehicle Production Tests shall be completed before Project Co requests permission to ship each car.	Compliant	
3.34.g.iii.B	Test reports shall be shipped with each Vehicle. Copies of the test report shall be included in the Car history Book.	Compliant	
3.34.g.iii.C	Production Tests shall include:		
3.34.g.iii.C.i	All of the tests necessary to prove proper functionality of the Vehicle;	Compliant	
3.34.g.iii.C.ii	Verification that water shall not enter the Vehicle during revenue service operation; and	Compliant	
3.34.g.iii.C.iii	Vehicle weighing.	Compliant	
3.34.g.iv	On-Site Commissioning Tests		
3.34.g.iv.A	Vehicles arriving on City property shall be commissioned to ensure they are ready to run in revenue service.	Compliant	
3.34.g.iv.B	Testing shall include all tests required to ensure the Vehicle is safe to operate.	Compliant	
3.34.g.iv.C	Testing shall also include all production tests required to verify complete functionality of all Equipment.	Compliant	
3.34.g.v	Vehicle Qualification Testing		
3.34.g.v.A	Qualification tests are one-time tests on the first production Vehicles produced by Project Co. The tests are required to prove that the Vehicle performs as required by the specification.	Compliant	
3.34.g.v.B	Vehicles other than the first production car may be used to complete tests, such as carbody compression and HVAC climate room, as deemed appropriate by the City.	Compliant	
3.34.g.v.C	Testing shall be performed on the completed Vehicles with production components.	Compliant	
3.35	**Dynamic Envelope**		
3.35.a	The dynamic envelope shown below represents the clearance envelope that has been utilized in the preparation of the Reference Documents. Project Co is responsible for definition of the dynamic envelope resulting from their design and the implications of the dynamic envelope on all aspects of the design, recognizing the constraints of this Schedule 15-2.	Compliant	
3.35.b	Proponents shall size the structures based on the dynamic envelope of their selectedVehicle. If the envelope allows a reduction of the dimensions listed in Schedule 15-2 Part 2, Article 2.5 or in Schedule 15-2 Part 4 Article 8, the proponent may propose modified dimensions with appropriate supporting drawings detailing the resulting clearances and demonstrate that system safety is not compromised.	Compliant	

APPENDIX A5
VEHICLE SUBCONTRACT DELIVERABLES LIST

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

APPENDIX A5
VEHICLE SUBCONTRACT DELIVERABLES LIST

OLRT - Vehicule Subcontract deliverables list according to Schedule 10

Final - Rev 3

Legend

PDS	Preliminary design submittal
DS # 1	Design Submital #1
DS # 2	Design Submital #2 (final)

N°	Associated Vehicle Design Submittal	DOCUMENT	Milestone	Ref	Rev
1	(i) Work breakdown structure (WBS) for vehicle and its associated subassemblies	Work breakdown Structure	PDS	_____	_____
2	(ii) Passenger Capacity Calculation	Vehicle Layout	PDS	_____	_____
3	(ii) Passenger Capacity Calculation	Surface Area	PDS	_____	_____
4	(iii) Passenger flow modeling at 12,000 and 24,000 PPHPD	Passenger flow modeling at 12,000 and 24,000 PPHPH	DS # 1	_____	_____
5	(iv) Applicability of design for OLRT passenger load	First pre-final design review presentation - Applicability of design for OLRT passenger load	DS # 1	_____	_____
6	(v) Applicability of design for OLRT climatic conditions	First pre-final design review presentation - Applicability of design for OLRT climatic conditions	DS # 1	_____	_____
7	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Vehicle Cross Section	PDS	_____	_____
8	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Prehension (Lifting points)	DS # 1	_____	_____
9	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Gauge study (Specification)	DS # 1	_____	_____
10	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Gauge in 25m Curve	DS # 1	_____	_____
11	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Clearance Platform Curve	DS # 1	_____	_____
12	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Clearance at straaight tramstop	DS # 1	_____	_____
13	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Gauge in alignement	DS # 1	_____	_____
14	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Sag-Crest study	DS # 1	_____	_____
15	(vi) Overall vehicle dimension and vehicle dynamic enveloppe	Roof Arrangment	DS # 1	_____	_____
16	(vii) Basic design parameters - acceleration, deceleration, top speed	First pre-final design review presentation - Basic design parameters - acceleration, deceleration, top speed	DS # 1	_____	_____
17	(viii) Experience with multiple car consists	First pre-final design review presentation - Experience with multiple car consists	DS # 1	_____	_____
18	(ix) RAMS data for proposed vehicle	First pre-final design review presentation - RAMS forecast	DS # 1	_____	_____
19	(x) Carbody details	First pre-final design review presentation - Carbody details	DS # 1	_____	_____
20	(x) Carbody details	Second pre-final design review presentation - Carbody details	DS # 1	_____	_____
21	(x) Carbody details	Final design review presentation - Carbody details	DS # 2	_____	_____
22	(x) Carbody details	MC1 Underframe assembly drawing	DS # 2	_____	_____
23	(x) Carbody details	MC2 Underframe assembly drawing	DS # 2	_____	_____
24	(x) Carbody details	IMC1 Underframe assembly drawing	DS # 2	_____	_____
25	(x) Carbody details	CC Underframe assembly drawing	DS # 2	_____	_____
26	(x) Carbody details	Cab Underframe assembly drawing	DS # 2	_____	_____
27	(x) Carbody details	MC1 Roof Structure	DS # 2	_____	_____
28	(x) Carbody details	MC2 Roof Structure	DS # 2	_____	_____
29	(x) Carbody details	IMC1 Roof Structure	DS # 2	_____	_____
30	(x) Carbody details	CC Roof Structure	DS # 2	_____	_____
31	(x) Carbody details	Equipped MC1 Underframe assembly drawing	DS # 2	_____	_____
32	(x) Carbody details	Equipped MC2 Underframe assembly drawing	DS # 2	_____	_____
33	(x) Carbody details	Equipped IMC1 Underframe assembly drawing	DS # 2	_____	_____
34	(x) Carbody details	Equipped CC Underframe assembly drawing	DS # 2	_____	_____
35	(x) Carbody details	Equipped Cab Underframe assembly drawing	DS # 2	_____	_____
36	(x) Carbody details	Equipped MC1 Roof	DS # 2	_____	_____
37	(x) Carbody details	Equipped MC2 Roof	DS # 2	_____	_____
38	(x) Carbody details	Equipped IMC1 Roof	DS # 2	_____	_____
39	(x) Carbody details	Equipped CC Roof	DS # 2	_____	_____

OLRT - Vehicule Subcontract deliverables list according to Schedule 10

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PDS	Preliminary design submittal
DS # 1	Design Submital #1
DS # 2	Design Submital #2 (final)

N°	Associated Vehicle Design Submittal	DOCUMENT	Milestone	Ref	Rev
40	(xi) Propulsion details	First pre-final design review presentation - Propulstion details	DS # 1	_____	_____
41	(xi) Propulsion details	Second pre-final design review presentation - Propulsion details	DS # 1	_____	_____
42	(xi) Propulsion details	Final design review presentation - Propulsion details	DS # 2	_____	_____
43	(xi) Propulsion details	HV Schematic	DS # 2	_____	_____
44	(xii) Truck details	First pre-final design review presentation - Truck details	DS # 1	_____	_____
45	(xii) Truck details	Second pre-final design review presentation - Truck details	DS # 1	_____	_____
46	(xii) Truck details	Final design review presentation - Truck details	DS # 2	_____	_____
47	(xii) Truck Details	Bogie Gauge	DS # 2	_____	_____
48	(xii) Truck details	Motor truck assembly drawing	DS # 2	_____	_____
49	(xii) Truck details	Motor Bogie Part List	DS # 2	_____	_____
50	(xii) Truck details	Trailer Truck assembly drawing	DS # 2	_____	_____
51	(xii) Truck details	Trailer Truck parts list	DS # 2	_____	_____
52	(xii) Truck details	Installation of Motor Truck	DS # 2	_____	_____
53	(xii) Truck details	Installation of Trailer Truck	DS # 2	_____	_____
54	(xiii) Communication system details	Communication system installation drawing	DS # 2	_____	_____
55	(xiii) Communication system details	Communication system antenna installation drawing	DS # 2	_____	_____
56	(xiv) Brake System details	First pre-final design review presentation - Brake System details	DS # 1	_____	_____
57	(xiv) Brake System details	Second pre-final design review presentation - Brake System details	DS # 1	_____	_____
58	(xiv) Brake System details	Final design review presentation - Brake System details	DS # 2	_____	_____
59	(xiv) Brake System details	Disc Brake Assembly drawing	DS # 2	_____	_____
60	(xiv) Brake System details	Motor truck brake calliper assembly drawing	DS # 2	_____	_____
61	(xiv) Brake System details	Trailer truck brake calliper assembly drawing	DS # 2	_____	_____
62	(xiv) Brake System details	Accumulator assembly drawing	DS # 2	_____	_____
63	(xiv) Brake System details	Magnetic Track Brake assembly drawing	DS # 2	_____	_____
64	(xiv) Brake System details	Electro Hydraulic Unit Assembly Drawing	DS # 2	_____	_____
65	(xiv) Brake System details	Brake Control Uinit Assembly Drawing	DS # 2	_____	_____
66	(xiv) Brake System details	Sand Ejector Assembly Drawing	DS # 2	_____	_____
67	(xiv) Brake system details	Brake Calculation Note	DS # 1	_____	_____
68	(xiv) Brake system details	Brake Architecture Diagram	DS # 1	_____	_____
69	(xv) Propportioning valve requirements	*Non applicable*	_	_____	_____
70	(xvi) Passenger door system details	Passenger Door System Assembly Drawing	DS # 2	_____	_____
71	(xvi) Passenger door system details	Passenger Door Operator Assembly Drawing	DS # 2	_____	_____
72	(xvi) Passenger door system details	Passenger Door Operator in Carbody Assembly Drawing	DS # 2	_____	_____
73	(xvi) Passenger door system details	Passenger Door Panels Assembly Drawing	DS # 2	_____	_____
74	(xvi) Passenger door system details	Passenger Door Roller swingarms Assembly Drawing	DS # 2	_____	_____
75	(xvi) Passenger door system details	Passenger Door Actuators Assembly Drawing	DS # 2	_____	_____
76	(xvii) Auxiliary/LVPS/battery system details	Second pre-final design review presentation - Auxiliary/LVPS/battery system details	DS # 1	_____	_____
77	(xviii) HVAC and heating system details	Second pre-final design review presentation - HVAC and heating system details	DS # 1	_____	_____
78	(xviii) HVAC and heating system details	HVAC assembly drawing	DS # 2	_____	_____

OLRT - Vehicule Subcontract deliverables list according to Schedule 10

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PDS	Preliminary design submittal
DS # 1	Design Submittal #1
DS # 2	Design Submittal #2 (final)

N°	Associated Vehicle Design Submittal	DOCUMENT	Validation	Ref	Rev
79	(xviii) HVAC and heating system details	Cab booster assembly drawing	DS # 2	_____	_____
80	(xviii) HVAC and heating system details	Air diffusion ducts drawing	DS # 2	_____	_____
81	(xviii) HVAC and heating system details	Cab heater assembly drawing	DS # 2	_____	_____
82	(xviii) HVAC and heating system details	Passenger compartement heaters (if applicable)	DS # 2	_____	_____
83	(xviii) HVAC and heating system details	Heating floor (if applicable)	DS # 2	_____	_____
84	(xix) HVAC heating and cooling calculation	HVAC heating and cooling calculations	DS # 1	_____	_____
85	(xx) Friction brake and propulsion thermal calculation	Friction brake and propulsion thermal calculation	DS # 1	_____	_____
86	(xxi) Pantograph design and interface with catenary	Pantograph Installation	DS # 2	_____	_____
87	(xxi) Pantograph design and interface with catenary	Pantograph Assembly drawing	DS # 2	_____	_____
88	(xxi) Wheel profile and interface with rail	Wheel profile drawing	DS # 2	_____	_____
89	(xxiii) Vehicle dynamics modeling results	Dynamics Analysis	DS # 2	_____	_____
90	(xxiv) Vehicle electrical modeling results	Conducted EMI calculation	DS # 1	_____	_____
91	(xxv) Cab layout/ergonomics	First pre-final design review presentation - Cab layout/ergonomics	DS # 1	_____	_____
92	(xxv) Cab layout/ergonomics	Second pre-final design review presentation - Cab layout/ergonomics	DS # 1	_____	_____
93	(xxv) Cab layout/ergonomics	Final design review presentation - Cab layout/ergonomics	DS # 2	_____	_____
94	(xxv) Cab layout/ergonomics	Equipped cabin M1	DS # 2	_____	_____
95	(xxv) Cab layout/ergonomics	Equipped cabin M2	DS # 2	_____	_____
96	(xxv) Cab layout/ergonomics	Visibility diagram (Complete Driver's cab sub-assembly)	DS # 2	_____	_____
97	(xxvi) Passenger seating/stanchions/level of comfort	First pre-final design review presentation - Passenger compartment	DS # 1	_____	_____
98	(xxvi) Passenger seating/stanchions/level of comfort	Second pre-final design review presentation - Passenger compartment	DS # 1	_____	_____
99	(xxvi) Passenger seating/stanchions/level of comfort	Final design review presentation - Passenger compartment	DS # 2	_____	_____
100	(xxvi) Passenger seating/stanchions/level of comfort	ADA and OADA Clause by Clause from a RS point of view	DS # 2	_____	_____
101	(xxvi) Passenger seating/stanchions/level of comfort	Passenger seat assembly drawing	DS # 2	_____	_____
102	(xxvi) Passenger seating/stanchions/level of comfort	Stop request button location	DS # 2	_____	_____
103	(xxvi) Passenger seating/stanchions/level of comfort	stanchions and grab-bar location and gripping layout	DS # 2	_____	_____
104	(xvii) On Board CBTC system	CBTC cubicle installation drawing	DS # 2	_____	_____
105	(xvii) On Board CBTC system	CBTC screen installation drawing	DS # 2	_____	_____
106	(xvii) On Board CBTC system	CBTC speed sensor installation drawing	DS # 2	_____	_____
107	(xvii) On Board CBTC system	CBTC antennas installation drawing	DS # 2	_____	_____
108	(xvii) On Board CBTC system	CBTC proximity sensor installation drawing	DS # 2	_____	_____
109	(xvii) On Board CBTC system	CBTC accelerometer installation drawing	DS # 2	_____	_____
110	(xvii) On Board CBTC system	CBTC transponder installation drawing	DS # 2	_____	_____
111	(xvii) On Board CBTC system	CBTC radio installation drawing	DS # 2	_____	_____
112	(xvii) On Board CBTC system	CBTC desk push buttons installation drawing	DS # 2	_____	_____
113	(xxviii) Emergency lightning and signage	First pre-final design review presentation - Emergency lightning and signage	DS # 1	_____	_____
114	(xxviii) Emergency lightning and signage	Second pre-final design review presentation - Emergency lightning and signage	DS # 1	_____	_____
115	(xxviii) Emergency lightning and signage	Final design review presentation - Emergency lightning and signage	DS # 2	_____	_____
116	(xxix) FMECA and hazard analyses	Preliminary Hazard Analysis	DS # 1	_____	_____
117	(xxix) FMECA and hazard analyses	FMECA Analysis	DS # 2	_____	_____

OLRT - Vehicule Subcontract deliverables list according to Schedule 10

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PDS	Preliminary design submittal
DS # 1	Design Submittal #1
DS # 2	Design Submittal #2 (final)

Nº	Preliminary Vehicle Design Submittal	DOCUMENT	Validation	Ref	Rev
118	(xxix) FMECA and hazard analyses	Hazard Log (HZL)	DS # 2	_____	_____
119	(xxix) FMECA and hazard analyses	Safety Related Documents List	DS # 2	_____	_____
120	(xxx) Waiver request	First pre-final vehicle design submittal waiver	DS # 1	_____	_____
121	(xxx) Waiver request	Second pre-final vehicle design submittal waiver	DS # 1	_____	_____
122	(xxx) Waiver request	Final vehicle design submittal waiver	DS # 2	_____	_____
123	(xxxi) Compression test results	Compression test results	DS # 2	_____	_____
124	(xxxii) FEA results and stress analyses	FEA results and stress analyses	DS # 1	_____	_____
125	(xxxiii) Crashworthiness analyses	Crashworthiness analyses	DS # 1	_____	_____
126	(xxxiii) FEA Results	FEA Results	DS # 1	_____	_____
127	(xxxiv) Climate room test results	Climate room test specification	DS # 1	_____	_____
128	(xxxiv) Climate room test results	Climate room test results	DS # 2	_____	_____
129	(xxxv) Noise test results	Type Test Specification Acoustic comfort	DS # 1	_____	_____
130	(xxxv) Noise test results	Type Test Report Acoustic comfort	DS # 2	_____	_____
131	(xxxvi) Flange lubrication/wayside squeeal suppression	Second pre-final design review presentation - Flange lubrication	DS # 1	_____	_____
132	(xxxvi) Flange lubrication/wayside squeeal suppression	Flange lubrication mounting	DS # 2	_____	_____
133	(xxxvi) Flange lubrication/wayside squeeal suppression	Flange lubrication assembly drawing	DS # 2	_____	_____
134	(xxxvii) Load leveling functional description	First pre-final design review presentation - Flange lubrication	DS # 1	_____	_____
135	(xxxvii) Load leveling functional description	Load leveling functional description	DS # 1	_____	_____
136	(xxxviii) Diagnostics and monitoring functional description;	Operational Context Description	DS # 2	_____	_____
137	(xxxviii) Diagnostics and monitoring functional description;	Train RSAD	DS # 1	_____	_____
138	(xxxix) Operator's display functional description	First pre-final design review presentation - Driver display	DS # 1	_____	_____
139	(xxxix) Operator's display functional description	Second pre-final design review presentation - Driver display	DS # 1	_____	_____
140	(xxxix) Operator's display functional description	Final design review presentation - Driver display	DS # 2	_____	_____
141	(xxxix) Operator's display functional description	Operator display functional description	DS # 2	_____	_____
142	(xl) Bench test units and portable test unit details	*Non applicable*	_	_____	_____
143	(xli) Spin/slide control functional description	Spin/slide control functional description	DS # 1	_____	_____
144	(xlii) Cab mock-up	Cab mock-up prensentation report	DS # 2	_____	_____
145	(xliii) Passenger compartment mock-up	Passenger compartment mock-up inspection report	DS # 2	_____	_____
146	(xliv) Vehicle Electrical Schematic	Principal Schematic F10 - Traction - Braking system	DS # 2	_____	_____
147	(xliv) Vehicle Electrical Schematic	Principal Schematic F21 - Auxiliary Energy Sypply	DS # 2	_____	_____
148	(xliv) Vehicle Electrical Schematic	Principal Schematic F22 - Préparation of Rolling Stock	DS # 2	_____	_____
149	(xliv) Vehicle Electrical Schematic	Principal Schematic F23 - Surveillance of security state of vehicle (safety loop)	DS # 2	_____	_____
150	(xliv) Vehicle Electrical Schematic	Principal Schematic F24 - Driving safety	DS # 2	_____	_____
151	(xliv) Vehicle Electrical Schematic	Principal Schematic F25 - Friction braking	DS # 2	_____	_____
152	(xliv) Vehicle Electrical Schematic	Principal Schematic F26 - Electromagnetic braking	DS # 2	_____	_____
153	(xliv) Vehicle Electrical Schematic	Principal Schematic F27 - Exterior signalling	DS # 2	_____	_____
154	(xliv) Vehicle Electrical Schematic	Principal Schematic F28 - Lighting	DS # 2	_____	_____
155	(xliv) Vehicle Electrical Schematic	Principal Schematic F30 - Doors	DS # 2	_____	_____
156	(xliv) Vehicle Electrical Schematic	Principal Schematic F31 - Access surveillance	DS # 2	_____	_____

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PDS	Preliminary design submittal
DS # 1	Design Submittal #1
DS # 2	Design Submittal #2 (final)

Nr	Description Vehicle Design Submittal	DOCUMENT	Validation	Ref	Rev
157	(xliv) Vehicle Electrical Schematic	Principal Schematic F32 - Tachometer	DS # 2	_____	_____
158	(xliv) Vehicle Electrical Schematic	Principal Schematic F33 - Public address system	DS # 2	_____	_____
159	(xliv) Vehicle Electrical Schematic	Principal Schematic F34 - Operation aid system	DS # 2	_____	_____
160	(xliv) Vehicle Electrical Schematic	Principal Schematic F35 - Climatic comfort	DS # 2	_____	_____
161	(xliv) Vehicle Electrical Schematic	Principal Schematic F36 - Windscreen wiper, wash, de-frosting and de-misting	DS # 2	_____	_____
162	(xliv) Vehicle Electrical Schematic	Principal Schematic F37 - Sanding	DS # 2	_____	_____
163	(xliv) Vehicle Electrical Schematic	Principal Schematic F38 - Track point switching	DS # 2	_____	_____
164	(xliv) Vehicle Electrical Schematic	Principal Schematic F39 - Wheel flange lubrication	DS # 2	_____	_____
165	(xliv) Vehicle Electrical Schematic	Principal Schematic F40 - Public information system	DS # 2	_____	_____
166	(xliv) Vehicle Electrical Schematic	Principal Schematic F42 - Drivers / CCR communication	DS # 2	_____	_____
167	(xliv) Vehicle Electrical Schematic	Principal Schematic F43 - Interior Surveillance	DS # 2	_____	_____
168	(xliv) Vehicle Electrical Schematic	Principal Schematic F48 - Coupling/ uncoupling	DS # 2	_____	_____
169	(xliv) Vehicle Electrical Schematic	Wiring diagram: LV MC1	DS # 2	_____	_____
170	(xliv) Vehicle Electrical Schematic	Wiring diagram: LV Roof MC1	DS # 2	_____	_____
171	(xliv) Vehicle Electrical Schematic	Wiring diagram: LV Roof IMC	DS # 2	_____	_____
172	(xliv) Vehicle Electrical Schematic	Wiring diagram: LV Roof CC	DS # 2	_____	_____
173	(xliv) Vehicle Electrical Schematic	Wiring diagram: LV Roof MC2	DS # 2	_____	_____
174	(xliv) Vehicle Electrical Schematic	Wiring diagram: HV Roof MC1	DS # 2	_____	_____
175	(xliv) Vehicle Electrical Schematic	Wiring diagram: HV Roof IMC1	DS # 2	_____	_____
176	(xliv) Vehicle Electrical Schematic	Wiring diagram: HV Roof CC	DS # 2	_____	_____
177	(xliv) Vehicle Electrical Schematic	Wiring diagram: HV Roof MC2	DS # 2	_____	_____
178	(xliv) Vehicle Electrical Schematic	Wiring diagram: Passenger saloon MC1	DS # 2	_____	_____
179	(xliv) Vehicle Electrical Schematic	Wiring diagram: Passenger saloon IMC	DS # 2	_____	_____
180	(xliv) Vehicle Electrical Schematic	Wiring diagram: Passenger saloon CC	DS # 2	_____	_____
181	(xliv) Vehicle Electrical Schematic	Wiring diagram: Passenger saloon MC2	DS # 2	_____	_____
182	(xliv) Vehicle Electrical Schematic	Wiring diagram: Cab MC1	DS # 2	_____	_____
183	(xliv) Vehicle Electrical Schematic	Wiring diagram: Cab MC2	DS # 2	_____	_____
184	(xliv) Vehicle Electrical Schematic	Wiring diagram: Cab Electrical cubicle MC1	DS # 2	_____	_____
185	(xliv) Vehicle Electrical Schematic	Wiring diagram: Cab Electrical cubicle MC2	DS # 2	_____	_____
186	(xliv) Vehicle Electrical Schematic	Wiring diagram: Drivers desk MC1/MC2	DS # 2	_____	_____
187	(xliv) Vehicle Electrical Schematic	Wiring diagram: Cab ceiling MC1/MC2	DS # 2	_____	_____
188	(xliv) Vehicle Electrical Schematic	Wiring diagram: Under-frame MC1-MC2	DS # 2	_____	_____
189	(xliv) Vehicle Electrical Schematic	Wiring diagram: Under-frame IMC	DS # 2	_____	_____
190	(xliv) Vehicle Electrical Schematic	Wiring diagram: Under-frame CC	DS # 2	_____	_____
191	(xliv) Vehicle Electrical Schematic	Wiring diagram: Inter carbody MC1-IMC	DS # 2	_____	_____
192	(xliv) Vehicle Electrical Schematic	Wiring diagram: Inter carbody IMC-CC	DS # 2	_____	_____
193	(xliv) Vehicle Electrical Schematic	Wiring diagram: Inter carbody CC-MC2	DS # 2	_____	_____
194	(xliv) Vehicle Electrical Schematic	Wiring diagram: Battery box	DS # 2	_____	_____
195	(xliv) Vehicle Electrical Schematic	Wiring diagram: Câblot SD-UM MC1	DS # 2	_____	_____

OLRT - Vehicule Subcontract deliverables list according to Schedule 10

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PDS	Preliminary design submittal
DS # 1	Design Submittal #1
DS # 2	Design Submittal #2 (final)

Nr	Associated Vehicle Design Submittal	DOCUMENT	Validation	Ref	Rev
196	(xliv) Vehicle Electrical Schematic	Wiring diagram: Câblot SD-UM MC2	DS # 2	_____	_____
197	(xliv) Vehicle Electrical Schematic	Wiring diagram: Emergency earthing cable	DS # 2	_____	_____
198	(xliv) Vehicle Electrical Schematic	Wiring diagram: Headlight strip	DS # 2	_____	_____
199	(xlv) Ride Quality test plan	Ride Quality Test Plan	DS # 1	_____	_____
200	(xlvi) Ride Quality test report	Ride Quality Test Report	DS # 2	_____	_____
201	(xlvii) Train to wayside emission safety analysis	Safety Studies Report (SSR) - External signalling	DS # 2	_____	_____
202	(xlviii) fatigque allowable stress	Covered by (xlix)	DS # 1	_____	_____
203	(xlix) FEA Models and load cases and	FEA Models and load cases	DS # 1	_____	_____
204	(l) FEA results	Covered by (xxxii) FEA results and stress analyses	DS # 1	_____	_____
205	(li) Carbody clearances	Carbody clearance	DS # 1	_____	_____
206	(lii) Hostler Panel Layout Drawing	*Non applicable*	--	_____	_____
207	(liii) Battery load calculations	Battery load calculations	DS # 1	_____	_____
208	(liv) Battery load Shec Schedule	Battery load shed schedule	DS # 1	_____	_____
209	(lv) Tow mode performance simulation	Tow mode performance simulation	DS # 1	_____	_____
210	Not related to a Design Submittals	Quality management plan of the vehicle	PDS	_____	_____
245	Not related to a Design Submittals	Design Book D&S	DS # 1	_____	_____
246	Not related to a Design Submittals	Interior Design Book D&S	DS # 1	_____	_____
247	Not related to a Design Submittals	Decoration and signaletic Adhesives	DS # 1	_____	_____
248	Not related to a Design Submittals	Interface specification : RS / CBTC-ATO system	DS # 1	_____	_____
249	Not related to a Design Submittals	Interface specification: RS / Wayside Communication	DS # 1	_____	_____
250	Not related to a Design Submittals	Interface specification: RS / Platform supervision system	DS # 1	_____	_____
251	Not related to a Design Submittals	Interface specification : RS / Citadis Interface with Overhead Contact System	DS # 1	_____	_____
252	Not related to a Design Submittals	Interface specification : RS / Workshop	DS # 1	_____	_____
253	Not related to a Design Submittals	Interface specification : RS / Network Interface Specifications	DS # 1	_____	_____
254	Not related to a Design Submittals	Citadis predefined sounds	DS # 1	_____	_____
255	Not related to a Design Submittals	Sand for Citadis Tram Sandboxes	DS # 2	_____	_____
256	Not related to a Design Submittals	Weight Assessment	DS # 1	_____	_____
257	Not related to a Design Submittals	Safety Plan	DS # 1	_____	_____
258	Not related to a Design Submittals	Final safety file	DS # 2	_____	_____
259	Not related to a Design Submittals	Feared Events Targets	DS # 1	_____	_____
260	Not related to a Design Submittals	Exported Requirements to O&M (430)	DS # 2	_____	_____
261	Not related to a Design Submittals	Safety Related Items List (SRIL)	DS # 2	_____	_____
262	Not related to a Design Submittals	Safety Studies Report (SSR) - Traction & Brake	DS # 2	_____	_____
263	Not related to a Design Submittals	Safety Studies Report (SSR) - Gauge	DS # 2	_____	_____
264	Not related to a Design Submittals	Safety Studies Report (SSR) - Doors	DS # 2	_____	_____
265	Not related to a Design Submittals	Safety Studies Report (SSR) - Rear view equipment	DS # 2	_____	_____
266	Not related to a Design Submittals	Safety Studies Report (SSR) - Driver visibility	DS # 2	_____	_____
267	Not related to a Design Submittals	Safety Studies Report (SSR) - Interior Lighting	DS # 2	_____	_____
268	Not related to a Design Submittals	Safety Studies Report (SSR) – Body-catcher	DS # 2	_____	_____

OLRT - Vehicule Subcontract deliverables list according to Schedule 10

Final - Rev 3

Legend

PDS	Preliminary design submittal
DS # 1	Design Submital #1
DS # 2	Design Submital #2 (final)

N°	Associated Vehicle Design Submittal	DOCUMENT	Milestone	Ref	Rev
269	Not related to a Design Submittals	Safety Studies Report (SSR) - Gravity 2 feared events	DS # 2	_____	_____
270	Not related to a Design Submittals	Safety Studies Report (SSR) - Front end design	DS # 2	_____	_____
271	Not related to a Design Submittals	Fire & Smoke Classification plan	DS # 2	_____	_____
272	Not related to a Design Submittals	Fire and Smoke Classification	DS # 2	_____	_____
273	Not related to a Design Submittals	Rolling Stock RAM Plan	DS # 2	_____	_____
274	Not related to a Design Submittals	Reliability Monitoring Demonstration Test (RMDT) Plan	DS # 2	_____	_____
276	Not related to a Design Submittals	Test Management Plan + Appendices	DS # 2	_____	_____
277	Not related to a Design Submittals	Serial Test Plan	DS # 1	_____	_____
278	Not related to a Design Submittals	Type Test Plan	DS # 1	_____	_____
279	Not related to a Design Submittals	Type Test Specification Static Gauge	DS # 1	_____	_____
280	Not related to a Design Submittals	Type Test Specification Lighting	DS # 1	_____	_____
281	Not related to a Design Submittals	Mechanical braking type test specification	DS # 1	_____	_____
282	Not related to a Design Submittals	Type Test Specification Traction and Electrical braking	DS # 1	_____	_____
283	Not related to a Design Submittals	Type Test Specification Water tightness	DS # 1	_____	_____
284	Not related to a Design Submittals	Type Test Procedure on current collection (pantograph)	DS # 1	_____	_____
285	Not related to a Design Submittals	Type Test Specification Battery charging and autonomy	DS # 1	_____	_____
286	Not related to a Design Submittals	Type test specification EMC	DS # 1	_____	_____
287	Not related to a Design Submittals	Type Test Specification Weighting	DS # 1	_____	_____
288	Not related to a Design Submittals	Type Test Report Static Gauge	DS # 2	_____	_____
289	Not related to a Design Submittals	Type Test Report Lighting	DS # 2	_____	_____
290	Not related to a Design Submittals	Mechanical braking type test report	DS # 2	_____	_____
291	Not related to a Design Submittals	Type Test Report on Push / Pull operation	DS # 2	_____	_____
292	Not related to a Design Submittals	Type Test Report Traction and braking	DS # 2	_____	_____
293	Not related to a Design Submittals	Type Test Report Water tightness	DS # 2	_____	_____
294	Not related to a Design Submittals	Type Test Report on Current collection (pantograph)	DS # 2	_____	_____
295	Not related to a Design Submittals	Type Test Report Battery charging and autonomy	DS # 2	_____	_____
296	Not related to a Design Submittals	Type Test Report Passenger compartment HVAC	DS # 2	_____	_____
297	Not related to a Design Submittals	Type Test Report EMC	DS # 2	_____	_____
298	Not related to a Design Submittals	Type Test Report Weighting	DS # 2	_____	_____
299	Not related to a Design Submittals	Acceptance test plan	DS # 1	_____	_____
300	Not related to a Design Submittals	ATC system installation drawings	DS # 2	_____	_____
301	Not related to a Design Submittals	Type test specification ATC	DS # 1	_____	_____
302	Not related to a Design Submittals	Type test report ATC	DS # 2	_____	_____
303	Not related to a Design Submittals	CCTV system installation drawings	DS # 2	_____	_____
304	Not related to a Design Submittals	Type test specification CCTV	DS # 1	_____	_____
305	Not related to a Design Submittals	Type test report CCTV	DS # 2	_____	_____
306	Not related to a Design Submittals	Event recorder installation drawings	DS # 2	_____	_____
307	Not related to a Design Submittals	Type test specification Event recorder	DS # 1	_____	_____
308	Not related to a Design Submittals	Type test report Event recorder	DS # 2	_____	_____

APPENDIX B
PRICE BREAKDOWN

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ALSTOM PROPOSAL – 48,5 m VEHICLES WITH FLEET CALCULATION: 34 VEHICLES OF 48,5 M Updated on 2013/08/02

OTTAWA LIGHT RAIL TRANSIT PROJECT

SCHEDULE OF PRICES

SUBCONTRACT AGREEMENT
APPENDIX B
SCHEDULE OF PRICES

ITEM NO.	QTY	DESCRIPTION	UNIT	UNIT PRICES (CADS)	TOTAL (CADS)
1.0	**34 vehicles of 48,5m**	**Design, supply, manufacture, inspection, testing, commissioning, packaging, delivery DDP Project Site, in accordance with INCOTERMS 2010, and all other associated Work required for Vehicle supply including items 1.1 to 1.01:**	**Each**	**Component pricing**	
1.1	1	Project Management and Engineering	Lump Sum		
1.2	1	Final Testing and Commissioning in Ottawa, ON	Lump Sum		
1.3	1	~~Operation and Maintenance Manuals~~	Lump Sum		
1.4	1	~~Training in Ottawa~~	Lump Sum		
1.5	1	~~Recommended Spare Parts for 2 Years Operation as listed in Appendix A2~~	Lot		
1.6	1	~~Special Tools and Test Equipment as listed in Appendix A3~~	Lot		
1.7	1	Cost of 10% Letter of Credit as per appendix F	Lump Sum		
1.8	1	Cost of 15% Letter of Credit as per appendix F	Lump Sum		
1.9	1	Export Packaging and DDP Project Site in Ottawa	Lump Sum		
1.10	1	Warranty – 2 years from revenue service	Lump Sum		
1.11	1	Maintenance before revenue service	Lump Sum		
2.0	**1**	**Provision of on-board Communications Systems as defined in Section Vehicles Requirement Specification item 1.4**	**Lump Sum**		
		Vehicle Price (1.0 +2.0)			

ITEM NO.	QTY	DESCRIPTION	UNIT	UNIT PRICES (CAD$)	TOTAL (CAD$)
3.0	1	**Inflation for base offer + inflation of the additional vehicles for 7 years after NTP i.e. until February 14, 2020**		**Component pricing**	
4.0	1	**Currency exchange rate cover for the base offer + Currency exchange rate of the additional vehicles for 7 years after NTP, i.e. until February 14, 2020**			
5.0	1	**Cost related to the latest payment scheme as described in the cover letter for the base contract with a final payment milestone of 10% at Revenue Service + cost related to the payment scheme of schedule 35 for the additional vehicles**			
6.0	1	**Discount for escalation formula applied at NTP +3years instead of NTP +5 years on Additional Vehicles price (2,5%)**			
		Total Vehicle Price – base Proposal price + coverage for additional three items) (1.0 + 2.0 + 3.0 + 4.0 +5.0+6.0)			

Performance Security Included : (refer to subcontract agreement chap 4.2)

(b) LOC 10%: up to NTP + 88 month

(c) LOC 15%: Rate 0,76 % per annum up to milestone – [to be reduced to ten percent (10%) after the achievement of Payment Milestone 3b]

Parent Company guarantee by ALSTOM TRANSPORT SA

VEHICULE UNIT PRICE FOR ADDITIONAL VEHICLES ACCORDING TO SCHEDULE 35 :

ITEM NO.	QTY	DESCRIPTION	UNIT PRICE (CAD$)
6.0		**Base calculation for additional vehicle**	Component pricing
7.0	1	**Discount for additional vehicles Terms of Payment improvement**	
		Unit price for additional vehicle (6.0 + 7.0)	

ITEM NO.	QTY	DESCRIPTION	UNIT PRICE (CAD$)
6.0		**Base calculation for additional vehicle**	Component pricing
6.1		**Discount for "reduced price" vehicle**	
7.0	1	**Discount for additional vehicles Terms of Payment improvement**	
		Unit price for additional "reduced price " vehicle (6.0 +6.1+7.0)	

7 213 216 CAD per Vehicle as the "Reduced Price" provided that:

(A) The Option to Purchase is exercised on or before the expiry of 18 months following Financial Close;
(B) The Reduced Price shall be applicable to a maximum of 8 Vehicles with respect to which the City requires delivery on or prior to the expiry of 59 months following Financial Close; and
(C) The Reduced Price shall be applicable to a maximum of 20 Vehicles with respect to which the City requires delivery on or prior to the expiry of 68 months following Financial Close

Nota 1: The additional vehicles do not contemplate to comply with the 25 % Canadian Content. Any changes would be subject to variation order.

Nota 2: The MSF shall be available to manufacture the additional vehicles for option B and C and vehicle supplier will benefit of the same access rights and usage in the MSF under the main Vehicle subcontract to be able to perform its obligations. Any interference will be subject to project relief or variation order.

Option : BACKUP SOLUTION TO DELETE CAN NETWORK :

Backup solution to delete the CAN network and connect the Door, HVAC, APS monitoring system for 34 vehicles: Component pricing
In case such option would be imposed, Alstom would assume 50% of such price and would be paid by Construction Contractor Component pricing AD as defined per subcontract..

APPENDIX C
OPTION AGREEMENT

Vehicle Option Agreement

This Vehicle Option Agreement (the "Option Agreement") is made as of this 12th day of February, 2013

BETWEEN

OLRT CONSTRUCTORS, an unincorporated joint venture, comprising SNC-LAVALIN CONSTRUCTORS (PACIFIC) INC. ("SNC"), DRAGADOS CANADA, INC. ("Dragados") and ELLISDON CORPORATION ("EllisDon"), and having an office at 195 The West Mall, Toronto, Ontario M9C 5L5 (hereinafter called the "Construction Contractor"), and

RIDEAU TRANSIT MAINTENANCE GENERAL PARTNERSHIP, a general partnership established under the laws of Ontario, and having an office at 1 First Canadian Place, 100 King Street West, Suite 6000, Toronto, Ontario, M5X 1E2 (hereinafter called the "Maintenance Contractor"), of the first part; and

ALSTOM POWER & TRANSPORT CANADA INC., having its registered office at 1010 Sherbrooke Street, Suite 2320, Montreal, Quebec H3A 2R7 (hereinafter called the "Subcontractor") of the second part

(the Construction Constructor, the Maintenance Contractor and Subcontractor, the "Parties" and, individually any one of them, a "Party")

In consideration of the execution of an agreement with the Construction Contractor of the supply of vehicles for the Project (the "Vehicle Supply Agreement") and other good and valuable consideration, the receipt of which is hereby acknowledged and confirmed, each of the Parties agrees to abide by the terms of this Option Agreement as set forth below.

1. Interpretation

1.1 All capitalized terms not defined in this Option Agreement will have the meanings ascribed thereto in the Vehicle Supply Agreement.

1.2 All provisions of the Vehicle Supply Agreement incorporated by reference herein or in any P&S Agreement will be those in effect at the date of execution of the Vehicle Supply

Agreement. No amendment of the Vehicle Supply Agreement will be effective for such purpose unless agreed to in writing by all Parties.

1.3 The inclusion herein of Sections 5.11 and 6 through 12 shall not be interpreted to limit the incorporation by reference in each P&S Agreement of the terms contained in the Vehicle Supply Agreement not in conflict with the terms hereof and Attachment 35.

1.4 In the case of any conflict between the provisions of the various document forming this Option Agreement or incorporated by reference herein, the following order of precedence shall apply:

(a) Main body of this Option Agreement
(b) Exhibits to this Option Agreement, other than Exhibits A, B and C
(c) CC Attachment 35 and MC Attachment 35
(d) Schedule 35
(e) Vehicle Supply Agreement

1.5 In this Option Agreement, the following terms have the following meanings:

(a) "Attachment 35" means CC Attachment 35 or MC Attachment 35, as appropriate in the circumstances.

(b) "CC Attachment 35" means Attachment 35 – CC Additional Vehicles to the Construction Contract, attached hereto for reference as Exhibit A.

(c) "CC Option Term" has the meaning given to it in CC Attachment 35.

(d) "Closing Date" has the meaning given to it in Schedule 35.

(e) "Contract" means the Construction Contract or the Maintenance Contract, as appropriate in the circumstances.

(f) "Contractor" means the Construction Contractor or the Maintenance Contractor as appropriate in the circumstances.

(g) "Contractor Indemnified Parties" means the Contractors, Project Co, the City, the Lenders' Technical Advisor, the Independent Certifier, and the directors, officers, employees and agents of each of them.

(h) "Equivalent Project Relief Provisions" means the provisions of Clause 9 to the Vehicle Supply Agreement as incorporated in this Option Agreement and in each P&S Agreement in accordance with Section 2.7 hereof.

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(i) "MC Attachment 35" means Attachment 35 – MC Additional Vehicles to the Maintenance Contract, attached hereto for reference as Exhibit B.

(j) "MC Option Term" has the meaning given to it in MC Attachment 35.

(k) "MSF" has the meaning given to it in the Project Agreement.

(l) "Option Notice" means the Option Notice under CC Attachment 35 or MC Attachment 35, as appropriate in the circumstances.

(m) "Option to Purchase" means the Option to Purchase under CC Attachment 35 or MC Attachment 35, as appropriate in the circumstances.

(n) "Option Vehicles" means Additional Vehicles that the Subcontractor is required to supply pursuant to this Option Agreement and any P&S Agreement arising hereunder.

(o) "Option Vehicle Unit Price" means the price per Option Vehicle, as follows:

(i) Component pricing per Option Vehicle, subject to Section 5.3(b) and subparagraph (ii) below;

(ii) Component pricing per Option Vehicle (the "Option Vehicle Reduced Price"), rather than as set out in subparagraph (i) above; provided that:

(A) the City exercises its Option to Purchase on or before the expiry of 18 months following Financial Close;

(B) the Option Vehicle Reduced Price shall be applicable to a maximum of 8 Option Vehicles with respect to which the City requires delivery on or prior to the expiry of 59 months following Financial Close; and

(C) the Option Vehicle Reduced Price shall be applicable to a maximum of 20 Option Vehicles with respect to which the City requires delivery on or prior to the expiry of 68 months following Financial Close.

(p) "P&S Agreement" has the meaning given thereto in Section 5.1.

(q) "Schedule 35" means Schedule 35 – Additional Vehicles to the Project Agreement, attached hereto for reference as Exhibit C.

1.6 List of Exhibits

A. CC Attachment 35

B. MC Attachment 35
C. Schedule 35
D. Capital Spares
E. Responsibility Matrix for Option Vehicles
F. Form of Option Vehicle Guarantee
G. Form of Letter of Credit
H. Vehicle Tests

2. Option to Purchase

2.1 Unless otherwise indicated in this Option Agreement, the Parties agree that

(a) during the CC Option Term, all obligations, liabilities and risks borne by Construction Contractor under CC Attachment 35, which is attached hereto for reference as Exhibit A, (including representations, warranties, covenants, indemnities and liabilities of every kind and nature except as expressly excluded hereunder), as well as any rights and entitlements available to the Construction Contractor in respect under CC Attachment 35, other than the Excluded Attachment 35 Provisions, shall be passed through to the Subcontractor under this Agreement under the back-to-back principle.

(b) during the MC Option Term, all obligations, liabilities and risks borne by Maintenance Contractor under MC Attachment 35, which is attached hereto for reference as Exhibit B, (including representations, warranties, covenants, indemnities and liabilities of every kind and nature except as expressly excluded hereunder), as well as any rights and entitlements available to the Maintenance Contractor in respect under MC Attachment 35, other than the Excluded Attachment 35 Provisions, shall be passed through to the Subcontractor under this Agreement under the back-to-back principle.

2.2 The back-to-back principle means that:

(a) the Subcontractor is obliged to the respective Contractor to the same extent as the respective Contractor is obliged to Project Co other than the Excluded Attachment 35 Provisions, and for certainty, where the respective Contractor is required to exercise any discretion under this Option Agreement, it will be deemed to be acting reasonably in requiring the Subcontractor to comply with any such back-to-back obligation; and

(b) subject to and in accordance with the Equivalent Project Relief Provisions, the Subcontractor is entitled to, and the respective Contractor is obliged to exercise, all rights and obligations (including the benefit of any representations and warranties of, or indemnification by, Project Co under the respective Attachment 35), so that the Subcontractor will be able to avail itself, through the Contractor, of the Contractor's rights under such Attachment 35 other than the Excluded

Attachment 35 Provisions, to the extent of harm or loss suffered by the Subcontractor.

2.3 The Construction Contractor and Maintenance Contractor will be severally (and not jointly) responsible for their obligations hereunder.

2.4 The Maintenance Contractor will not be responsible for any obligation or liability to the Subcontractor that arises

(a) hereunder prior to the commencement of the MC Option Term or
(b) under any P&S Agreement prior to its assignment or novation to the Maintenance Contractor, or
(c) out of acts or omissions of the Construction Contractor made prior to the commencement of the MC Option Term,

and, except in the case of a With Recourse Assignment, will not assume such obligations or liabilities, and such obligations and liabilities will continue to be obligations and liabilities of the Construction Contractor.

2.5 The Construction Contractor will not be responsible for any obligation or liability to the Subcontractor that arises

(a) hereunder after the commencement of the MC Option Term (except for any obligation or liability arising hereunder in respect of a P&S Agreement not then assigned or novated in accordance with this Option Agreement) or
(b) under any P&S Agreement arising between the Construction Contract and the Subcontractor during the CC Option Term after the assignment or novation thereof in accordance with this Option Agreement

except for any obligation or liability arising out of acts or omissions of the Construction Contractor made prior to the commencement of the MC Option Term, and such obligations and liabilities will be obligations and liabilities of the Maintenance Contractor.

2.6 Each Contractor agrees to defend, indemnify and hold harmless the other Contractor against any claims in respect of obligations and liabilities of the indemnifying Contractor, in order to give effect to Sections 2.4 and 2.5.

2.7 The Equivalent Project Relief provisions of Clause 9 of the Vehicle Supply Agreement will apply *mutatis mutandis* to any claims arising under this Option Agreement or any P&S Agreement; provided that Sub-Clause 9.4 of the Vehicle Supply Agreement shall not apply during the MC Option Term.

3. Excluded and Qualified Rights and Obligations

3.1 Notwithstanding the provisions above, Subcontractor shall have no right or obligation with respect to:

(a) Section 2.1(d) of either Attachment 35, provided that the Subcontractor acknowledges the provisions of Section 2.1(d) of each Attachment 35;

(b) Sections 2.4 and 2.5 of either Attachment 35;

(c) Sections 2.6 and 3.4 of either Attachment 35, provided that these exclusions will not limit the Subcontractor's obligations with respect to inspection, testing and commissioning of Option Vehicles under the provisions of the Vehicle Supply Agreement incorporated by reference into any P&S Agreement, including the Subcontractor's obligation to assist the respective Contractor in performing its testing and commissioning obligation under certain provisions of Schedule 14 - Commissioning to the Project Agreement;

(d) Sections 3.2 and 3.3 of either Attachment 35, except where the respective Contractor and the Subcontractor have agreed to the purchase of Option Vehicles pursuant to the negotiations under Section 3.1(a) of the respective Attachment 35, in which case Section 3.2 of the respective Attachment 35 will apply and the price of such Option Vehicles will be the price agreed to between the respective Contractor and the Subcontractor.

(e) Part 4 (Vehicle Procurement), other than Section 4.1, of either Attachment 35; and

(f) Part 5 (Maintenance Services of Additional Vehicles), Part 6 (Adjustment of Lifecycle Payments) or Part 7 (Handover Maintenance of Additional Vehicles) of either Attachment 35

(collectively, the "Excluded Attachment 35 Provisions")

4. Option Vehicles Guarantee

4.1 Concurrently with the execution of this Option Agreement, the Subcontractor has provided the Contractors with a duly executed guarantee in the form attached hereto as Exhibit F from ALSTOM Transport SA (the "Option Vehicles Guarantee", the guarantor under the Option Vehicles Guarantee being, the "Option Vehicles Guarantor"). The Option Vehicles Guarantee will be a guarantee of all of the Subcontractor's obligations under this Option Agreement and any P&S Agreement arising according to the terms hereof.

4.2 At the option of the Construction Contractor during the CC Option Term or the Maintenance Contractor during the MC Option Term, Subcontractor will replace the Option Vehicles Guarantee with a guarantee from ALSTOM Holdings in the same form

and substance (the "ALSTOM Holdings Guarantee", which will become the "Option Vehicles Guarantee" from the time it becomes effective). The cost of the ALSTOM Holdings Guarantee will be 0.3% of the price of the Option Vehicles to be purchased and sold under each P&S Agreement. Such amount will be payable for each order of Option Vehicles concurrently with the first milestone payment for such order of Option Vehicles after such replacement occurs.

5. Purchase and Sale Agreement

5.1 When Project Co delivers an Option Notice to the Construction Contractor during the CC Option Term or to the Maintenance Contractor during the MC Option Term, there shall be deemed to be a binding agreement of purchase and sale between Project Co and the respective Contractor results pursuant to the respective Attachment 35. Concurrently, there shall be deemed to be a binding agreement of purchase and sale between such Contractor and Subcontractor (each an "P&S Agreement"), which shall be subject to the provisions herein which apply to Option Vehicles which have been the subject of an Option Notice, including the other provisions of this Section 5, which shall apply to each P&S Agreement. In addition, and to the extent not in conflict with the provisions herein, the terms and conditions of each P&S Agreement shall be in accordance with the respective Attachment 35 and the terms otherwise provided in the Vehicle Supply Agreement not in conflict with the respective Attachment 35. The respective Contractor will forward to Subcontractor any Option Notice that it receives pursuant to Attachment 35 as soon as reasonably practicable after receipt thereof.

5.2 Vehicle schedule

(a) No later than twenty-nine (29) months after the City's delivery of a notice to proceed, which shall be deemed to occur on the City's delivery of an Option Notice unless otherwise specified, the Subcontractor will provide the Option Vehicles on-site, having completed the serial tests described in "Vehicle testing schedule" attached hereto as Exhibit H, and ready for testing and commissioning by the respective Contractor in accordance with Schedule 14 of the Project Agreement. For certainty, the acceptances tests described in Exhibit H will be performed concurrently with the respective Contractor's respective testing and commissioning activities.

(b) Exhibit H is included for reference purposes only and shall not limit the Subcontractor's obligations with respect to the inspection and testing of Option Vehicles, which are more particularly described in the Vehicle Supply Agreement and the Output Specifications to the Project Agreement.

5.3 Price and Payment

(a) Subject to the provisions of this Section 5.3 and 5.4(b) providing otherwise, the price of each of the Option Vehicles to be purchased by the respect Contractor pursuant to this Option Agreement shall be the Option Vehicle Unit Price, which price specifically exclude operation and maintenance manuals, capital spares and any training required in connection with any Option Vehicle, the documented cost of any Letter of Credit in excess of 0.48% per annum up to a cost of the Letter of Credit of 2.00% per annum, as well as HST.

(b) The price of each of the Option Vehicles as provided for in Section 5.3(a) shall be subject to price escalation or reduction as follows:

(i) there shall be no price escalation or reduction for the initial three (3) years of the CC Option Term; and

(ii) for the remainder of the CC Option Term and for the MC Option Term, the Option Vehicle Unit Price in respect of the Option Vehicles may increase or decrease in accordance with the Price Change Formula (as defined in Schedule 35). The Vehicle Unit Price for each of the Additional Vehicles shall be increased or decreased by applying the Price Change Formula to 100% of the Option Vehicle Unit Price.

(c) The respective Contractor will pay the following milestone payments in respect of Option Vehicles under a P&S Agreement within 10 Business Day after the 30-day period following invoicing by the Subcontractor upon completion of the milestone. If the respective Contractor fails to make timely payment, the Subcontractor will be entitled to suspend performance of the P&S Agreement until payment is made, unless the Contractor and the Subcontractor otherwise agree. The Subcontractor will not be entitled to terminate the P&S Agreement for nonpayment due to nonpayment by the City until Project Co has the right to terminate the Project Agreement:

(i) ten percent (10%) of the Option Vehicle Unit Price upon issuance by the City of a notice to proceed and satisfaction of the conditions set out in Section 5.3(d);

(ii) twenty percent (20%) of the Option Vehicle Unit Price upon sourcing orders of doors, HVAC, brake, gangway and pantograph;

(iii) twenty-five percent (25%) of the Option Vehicle Unit Price upon completion of the carbody shell;

(iv) ten percent (10%) of the Option Vehicle Unit Price upon completion of the subassembly;

(v) ten percent (10%) of the Option Vehicle Unit Price upon completion of fitting;

(vi) ten percent (10%) of the Option Vehicle Unit Price upon completion of the serial test; and

(vii) fifteen percent (15%) of the Option Vehicle Unit Price on Closing Date.

(d) All payments under a P&S Agreement shall be conditional on their being in place a valid and enforceable Letter of Credit in accordance with Section 5.7, the Option Vehicle Guarantee, and insurance required by Appendix J – Insurance to the Vehicle Supply Agreement, which has been incorporated by reference into each P&S Agreement pursuant to Section 5.1.

5.4 Design and Specifications of Option Vehicles

(a) Option Vehicles will be designed and manufactured according to the same configuration (the "Initial Fleet Configuration") as the Vehicles (the "Initial Vehicles") supplied by the Subcontractor pursuant to the Vehicle Supply Agreement, subject to the obligations in respect of Required Upgrades and Included Upgrades under Section 2.3(b) of each Attachment 35.

(b) To the extent that the respective Contractor requires changes to the configuration of the Option Vehicles from the Initial Fleet Configuration, including because of a City Variation pursuant to Section 2.3(c) of Schedule 35 or changes to installed equipment or other interfaces outside of the Subcontractor's scope of supply, the Subcontractor will be entitled to a Variation under any P&S Agreement, subject to the Equivalent Project Relief Provisions.

(c) Where a Variation has been agreed to or determined under the Vehicle Supply Agreement, then to the extent that such Variation agreement or determination specifically provides for the same Variation to apply to the Option Vehicles, including any adjustment to the price of each Option Vehicle, then the Subcontractor will be entitled to such Variation under any P&S Agreement, subject to the Equivalent Project Relief Provisions.

5.5 Liquidated Damages

(a) Delay Liquidated Damages, as set forth in Sub-Clause 8.6 of the Vehicle Supply Agreement, are not applicable to any P&S Agreement. Section 2.7 of the respective Attachment 35 shall apply in respect of the Option Vehicles, and the Subcontractor shall be responsible for the liquidated damages and other costs payable to Project Co thereunder where due to a failure by the Subcontractor to deliver the Option Vehicles by the date required or to provide assistance to the respective Contractor's testing and commissioning activities, as required under the relevant P&S Agreement.

(b) For certainty, the liquidated damages levied against the Subcontractor under Section 5.5(a) will not exceed those levied against Project Co by the City pursuant to Schedule 35 for the relevant failure.

5.6 Option to purchase capital spares

(a) Under any P&S Agreement, the respective Contractor shall have the option to purchase capital spares at the fixed price set forth in Exhibit D, which shall form part of the contract price of the P&S Agreement for the purposes of the limit of liability described in Section 9.1 below.

5.7 Letter of Credit

(a) Upon entry into force of each P&S Agreement, Subcontractor will deliver a letter of credit ("Letter of Credit") in form set out in Exhibit G in the amount of 10% of the price of the Option Vehicles to be purchased and sold under the P&S Agreement. The Letter of Credit will remain in place for two years after the Closing Date under such P&S Agreement. Except as otherwise provided herein, the terms and conditions of the Vehicles Supply Agreement related to the 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.

5.8 Interface Obligations and MSF Usage

(a) Until the Revenue Service Availability Date, the Subcontractor will have the same rights of usage of the MSF as set forth in the Vehicle Supply Agreement.

(b) After the Revenue Service Availability Date, the respective Contractor will provide the Subcontractor reasonable access to the MSF for all purposes reasonably connected with the assembly (prior to the end of the 68th month after Financial Close), testing and commissioning of all Option Vehicles purchased pursuant to this Option Agreement. The respective Contractor shall provide a storage area for any such Option Vehicles, parts and components and related tools, as well as a work and office space within the MSF during the CC Option Period, which shall be shared between the Subcontractor and the Construction Contract. The respective Contractor shall grant the Subcontractor reasonable access to the System for purposes of testing and commissioning such Option Vehicles, provided they follow all the Operational Rules and Procedures applicable. In exercising its access rights, the Subcontractor shall ensure that its subcontractors and employees shall: (i) abide by all reasonable restrictions and requirements of the Maintenance Contractor; and (ii) at all times, avoid or minimize any disruption, hindrance or impedance to the progress of any ongoing MC Activities.

(c) For certainty, in the event that the option to purchase Option Vehicles is exercised in the 18-month period following the Financial Close with a Delivery Date that is after the Revenue Service Availability Date, Subcontractor shall be entitled to a Variation, subject to Equivalent Project Relief and Section 10.2, in respect of any interference with or any limitation of Subcontractor's right of access to the MSF set forth in Section 5.8(b).

(d) The Subcontractor and respective Contractor will fulfill their assigned obligations in connection with the Option Vehicles and the use of the MSF and System, as set out in Exhibit E1 for Option Vehicles assembled in the MSF (prior to the end of the 68th month after Financial Close) and Exhibit E2 for Option Vehicles assembled outside of the MSF.

(e) During the CC Option Period until the period two years after the Revenue Service Availability Date, the Contractors will fulfill their assigned obligations in connection with the Option Vehicles and the use of the MSF and System, as set out in Exhibit E3 hereto.

5.9 Option Vehicles Guarantee

(a) The Option Vehicles Guarantee delivered under Section 4 will be a guarantee of the Subcontractor's obligations under each P&S Agreement, and no separate guarantee will be required unless the Parties otherwise agree.

5.10 Warranty

(a) The warranty provisions of the Vehicle Supply Agreement, namely Clause 12 thereof, will apply *mutatis mutandis* to the Option Vehicles. The General Warranty Period for the Option Vehicles will commence on the Closing Date for the relevant order of Option Vehicles and continue until two years after the Closing Date for the relevant order of Option Vehicles. The Epidemic Defect Warranty Period will continue until 4 years after the Closing Date for the relevant order of Option Vehicles, and the Latent Defect Warranty Period will continue until 15 years after issuance of the Closing Date for the relevant order of Option Vehicles.

5.11 Liability

(a) The indemnities set forth in Sections 6 and 7 shall apply to the performance of any P&S Agreement in substitution of Sub-Clauses 17.1 and 17.2 of the Vehicle Supply Agreement, which would otherwise be incorporated by reference therein.

(b) The limitation of liability set forth in Section 9 shall apply to liability arising under or in connection with any P&S Agreement in substitution of Sub-Clause

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17.5 of the Vehicle Supply Agreement, which would otherwise be incorporated by reference therein.

(c) The waiver of claims for Indirect Losses and other claims set forth in Section 10 shall apply to Indirect Losses arising under any P&S Agreement in substitution of Sub-Clause 17.6 of the Vehicle Supply Agreement, which would otherwise be incorporated by reference therein.

5.12 Miscellaneous

(a) The provisions of Section 11 (Notices) shall apply to each P&S Agreement in accordance with its terms.

(b) The provisions of Sections 12.1, 12.2, 12.3 and 12.4 (Termination of Vehicle Supply Agreement and Related Agreements) shall apply to each P&S Agreement in accordance with their terms and in addition to the termination provisions of the Vehicle Supply Agreement, which are incorporated by reference therein.

(c) The provisions of Section 13 (Assignment) shall apply to each P&S Agreement in accordance with its terms.

6. Subcontractor Indemnities to Construction Contractor

6.1 The Subcontractor shall indemnify and save harmless the Contractors and the Contractor Indemnified Parties from and against any and all Direct Losses which may be suffered, sustained, incurred or brought against them as a result of in respect of, or arising out of any one or more of the following in connection with its performance of its obligations under this Option Agreement or any P&S Agreement:

(a) any physical loss of or damage to all or any part of the Site, the Highway Site, the System or the Highway or to any equipment, assets or other property related thereto to the extent occurring directly or indirectly caused by an act or omission of the Subcontractor or any Subcontractor Personnel;

(b) the death or personal injury of any person directly or indirectly caused by an act or omission of the Subcontractor or any Subcontractor Personnel;

(c) any physical loss of or damage to property or assets of any third party directly or indirectly caused by an act or omission of the Subcontractor or any Subcontractor Personnel;

(d) any other loss or damage of any third party including injurious affection arising from or in consequence of any act or omission of the Subcontractor in respect of its supply of Option Vehicles that is not in compliance with the requirements set

out in this Option Agreement, in any P&S Agreement and in the Applicable Law including the City's by-laws;

(e) any negligent acts or omissions or willful misconduct of the Subcontractor or any Subcontractor Personnel;

(f) any liability incurred by a Contractor under their respective Contracts or any CC Project Document (as defined in the Construction Contract) or MC Project Document (as defined in the Maintenance Contract) that, in each case, arises as a result of any breach by the Subcontractor under this Option Agreement or any P&S Agreement;

(g) the costs of enforcement incurred by a Contractor in enforcing any Letter of Credit or the Option Vehicles Guarantee provided or procured by the Subcontractor pursuant to this Option Agreement or any P&S Agreement;

(h) any increases in insurance premiums payable by a Contractor or Project Co, or any loss of insurance coverage or denial of claims, under any policies of insurance that any Party or Project Co is required to procure under the respective Contracts, which, in either case, is directly attributable to an act or omission of the Subcontractor or any Subcontractor Personnel;

(i) the exercise by the City of any step-in rights under the Project Agreement as a result of any breach by the Subcontractor under the Subcontract;

(j) the exercise by the City of any remedy under Section 45 of the Project Agreement as a result of any breach by the Subcontractor under this Option Agreement or any P&S Agreement;

(k) the performance by the Subcontractor of this Option Agreement or any P&S Agreement not in accordance with or in breach of the requirements of any Permits, Licences and Approvals, Applicable Law or requirements of Governmental Authorities, or the failure of Subcontractor to obtain all necessary Project Co Permits, Licences and Approvals in relation to the Subcontracted Works that the Subcontractor is required to obtain in accordance with this Option Agreement or any P&S Agreement;

(l) any Contamination for which the Subcontractor is responsible;

(m) any amount payable by a Contractor to Project Co pursuant to the respective Contracts in relation to a Change in Law affecting the recoverability of the HST or an irrecoverable sales tax levied by the Legislative Assembly of Ontario in lieu of all or a portion of HST, but only to the extent that the Subcontractor is able to recover or be credited with input tax credits, refunds, rebates or exemptions for such HST or other irrecoverable sales tax;

in each case, except to the extent caused, or contributed to, by breach of this Option Agreement or any P&S Agreement by the relevant Contractor or any deliberate or negligent act or omission of such Contractor or any person for whom such Contractor is responsible at law.

6.2 The Subcontractor shall indemnify and save harmless each Contractor and the Contractor Indemnified Parties from and against any and all Direct Losses which may be suffered, sustained, incurred or brought against them as a result of, in respect of, or arising out of any breach of a representation or warranty by the Subcontractor herein or in any document, instrument or agreement delivered by the Subcontractor to the Contractor as specifically required by the terms of this Option Agreement or any P&S Agreement.

6.3 Where a demand, claim, action or proceeding is made or brought against a Contractor or any Contractor Indemnified Party that any Vehicle Intellectual Property or the Use thereof by the City, any City Party, Project Co or any Project Co Party (as defined in the Project Agreement, but not including the Subcontractor or any Subcontractor Personnel) or the use in connection with the Project Scope of any materials, machinery or equipment which was supplied by Subcontractor or any Subcontractor Personnel infringes an Intellectual Property Right of a third party or misappropriates any confidential information or otherwise violates any right of a third party, unless such infringement has arisen out of the use of the allegedly infringing Vehicle Intellectual Property, materials, machinery or equipment by the City, any City Party, Project Co or any Project Co Party (as defined in the Project Agreement, but not including the Subcontractor or any Subcontractor Personnel) otherwise than in accordance with the terms of this Option Agreement or any P&S Agreement, the Subcontractor shall defend the Contractor and such Construction Contractor Indemnified Party from and against all such demands, claims, actions and proceedings in accordance with the conduct of claims procedure described in Sub-Clause 17.3 to the Vehicle Supply Agreement; and shall indemnify and save harmless the Contractor and such Construction Contractor Indemnified Party from and against all Direct Losses arising out of or relating to such demands, claims, actions and proceedings or the settlement thereof.

7. Construction Contractor's Indemnities to Subcontractor

7.1 The Construction Contractor will indemnify and keep the Subcontractor and the Subcontractor Indemnified Parties indemnified at all times from and against all Direct Losses that any of them may sustain arising out of any one or more of the following in connection with its performance of its obligations under this Option Agreement or any P&S Agreement:

(a) negligent act or omission or wilful misconduct of the Construction Contractor or any person for whom the Construction Contractor is responsible on the basis of Clause 3 of the Vehicle Supply Agreement; and

(b) non-compliance by the Construction Contractor or any person for whom the Construction Contractor is responsible on the basis of Clause 3 of the Vehicle Supply Agreement with any of its obligations under any Law.

7.2 The Maintenance Contractor will indemnify and keep the Subcontractor and the Subcontractor Indemnified Parties indemnified at all times from and against all Direct Losses that any of them may sustain arising out of any one or more of the following in connection with its performance of its obligations under this Option Agreement or any P&S Agreement:

(a) negligent act or omission or wilful misconduct of the Maintenance Contractor or any person for whom the Maintenance Contractor is responsible at law; and

(b) non-compliance by the Maintenance Contractor or any person for whom the Maintenance Contractor is responsible at law with any of its obligations under any Law.

7.3 Except as set out in Section 13.4 in the case of a With Recourse Assignment, notwithstanding anything to the contrary in this Option Agreement, neither Contractor will be responsible to the Subcontractor for any liability of the other Contractor to Subcontractor, and the Subcontractor shall not make a claim against either Contractor in respect of the liabilities of the other Contractor to the Subcontractor.

8. Conduct of Claims

8.1 The conduct of claims procedure described in Sub-Clause 17.3 to the Vehicle Supply Agreement is incorporated herein and shall apply to indemnified claims arising under this Option Agreement or any P&S Agreement.

9. Limitation of Liability

9.1 The total liability of the Subcontractor to the Contractors, collectively, under or in connection with this Option Agreement, including liability under any indemnity, shall not exceed the aggregate price of the Option Vehicles pursuant to the P&S Agreements arising hereunder. For certainty, the limitations of liability provision of the Vehicle Supply Agreement and the maintenance subcontract between the Maintenance Contractor and the Subcontractor (the "Maintenance Subcontract") do not apply to any liability arising under or in connection with this Option Agreement or any P&S Agreement, and the limitations of liability provisions of this Option Agreement do not apply to any liability arising under or in connection with Vehicle Supply Agreement or the Maintenance Subcontract.

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9.2 The Parties acknowledge that the liability of the Contractors for indemnity claims is limited by Part 2, Section 57.4(a) to the respective Contracts, by virtue of a similar limitation of liability of Project Co under Section 57.4(a) of the Project Agreement. The Parties agree that the Subcontractor's liability will be limited according to the proportion that the Subcontractor's liability for claims that result from the flow-down of claims arising from the City under 56 of the Project Agreement bears to the Contractors' total liability for such claims. This proportion will be calculated by taking into account the amounts for which the Parties would have been liable but for the application of Section 57.4(a) of the Project Agreement and Part 2, Section 57.4(a) of the respective Contracts.

9.3 The limitation of liability in Section 9.1 shall not apply to, nor shall the calculation thereof include:

(a) any liabilities or obligations to the extent that:

(i) the amount thereof is paid from the proceeds of insurance maintained by the City, Project Co, the Construction Contractor or the Maintenance Contractor or maintained by the Subcontractor under the Option Agreement or any P&S Agreement; 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 the Option Agreement or any P&S Agreement or if the Subcontractor had otherwise complied with its obligations under applicable insurance policies and diligently pursued the relevant insurance claim;

(b) liabilities that arise out of third-party claims (other than claims from the City or the Lenders or Project Co or either Contractor) associated with the Subcontractor's supply of Option Vehicles or the performance by the Subcontractor or any Subcontractor Personnel of any obligations under this Option Agreement or any P&S Agreement (including, without limitation, any third-party claims (other than claims from the City or the Lenders or Project Co or either Contractor) for any damage or destruction of property, death or personal injury or third-party Intellectual Property);

(c) liabilities that arise out of abandonment (other than as a consequence of a Construction Contractor Event of Default under the Vehicle Supply Agreement or an event of default of the respective Contractor under any P&S Agreement), gross

negligence, willful misconduct or fraud of the Subcontractor or any Subcontractor Personnel;

(d) liabilities that arise out of any failure on the part of the Subcontractor to make payment to a Contractor when the same is due to the extent that such failure gives rise to any liability on the part of the Contractor to pay interest, fees or penalties on overdue amounts;

(e) fines and penalties under statute or any costs incurred by a Contractor in complying with statutory obligations that arise out of any breach by the Subcontractor of any applicable laws, regulations, or rules or guidelines having the force of law (including breaches relating to workman's compensation, employment or health and safety laws or regulations);

(f) any amount paid to a Contractor by the Subcontractor, to the extent that same is subsequently recovered by the Subcontractor from the other Contractor; and/or

(g) any reasonable amount incurred by a Contractor in enforcing any claim against the Subcontractor under or in connection with this Option Agreement or any P&S Agreement, including any costs, losses, fees, expenses or damages incurred in the enforcement of any Letter of Credit or the Option Vehicle Guarantee.

10. Indirect Losses

10.1 Without prejudice to each Contractor's rights to receive liquidated damages under a P&S Agreement, the Parties' rights in respect of payments provided for herein or the Contractors respective rights to recover from the Subcontractor losses suffered under a CC Project Document or MC Project Document (as defined in respective Contracts), the indemnities under this Option Agreement shall not apply and there shall be no right to claim damages for breach of this Option Agreement, in tort or on any other basis whatsoever, to the extent that any loss claimed by either Party is:

(a) for punitive, exemplary or aggravated damages;

(b) for loss of profits, loss of use, loss of production, loss of business or loss of business opportunity sustained by either Party, the City or the Lenders or Project Co or either Contractor and not by third parties; or

(c) a claim for consequential loss or for indirect loss of any nature suffered or allegedly suffered by any Party,

(collectively, "Indirect Losses").

10.2 Notwithstanding anything to the contrary in this Option Agreement or any P&S Agreement, the Subcontractor shall have no claim under or in connection with this this Option Agreement or any P&S Agreement in respect of loss or delay that is caused by the Subcontractor or any of its affiliates acting as a supplier of maintenance services or otherwise in connection with the Project.

11. Notices

11.1 Each respective Contractor 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 P&S Agreement, without undue delay, and in any case within two Business Days of receipt by such Contractor. The Contractors and Subcontractor acknowledge that Project Co is bound by an equivalent provision under each Contract.

11.2 If any notice, information, consent, claim, request, response, submission or other communication (a "Communication") is required or permitted under the terms of this Option Agreement to be given or made by Subcontractor pursuant to this Agreement or any P&S Agreement, Subcontractor shall:

(a) provide such Communication to the respective Contractor not less than ten (10) Business Days prior to the time by which Project Co is required under Schedule 35 to submit the same, unless otherwise agreed in writing by such Contractor, acting reasonably; or

(b) upon written request from the respective Contractor, submit the Communication directly to the City or Project Co, with a copy to such Contractor.

12. Termination of Vehicle Supply Agreement and Related Agreements

12.1 Subject to the provisions of this Section 12, the Subcontractor agrees that it shall have the rights and obligations of the respective Contractors pursuant to Section 8.1 of each Attachment 35 and that any termination of a CC Additional Vehicles Agreement or an MC Additional Vehicles Agreement pursuant to Section 8.1 of the respective Attachment 35 will result automatically in the termination of the related P&S Agreement.

12.2 A Contractor shall agree with the Subcontractor, each acting reasonably, prior to reaching any agreement with Project Co under Section 8.1(b)(i) of the respective Attachment 35 on whether to continue to perform or to terminate any CC Additional Vehicles Agreement or MC Additional Vehicles Agreement, and consequently the related P&S Agreement.

12.3 If during the CC Option Term or MC Option Term, the respective Contract is not terminated, but this Option Agreement is terminated pursuant to Section 12.5 (other than

where the Vehicle Supply Agreement is terminated by reason of a Construction Contractor Event of Default thereunder) or Section 12.6, the respective Contractor may elect, at its option (a) to require the Subcontractor continue to carry out any or all P&S Agreements; or (b) to terminate any or all P&S Agreements with immediate effect, in which case the Contractor shall be entitled to a refund of the payments that it has made in respect of the Option Vehicles together with interest thereon up until the date of repayment by the Subcontractor.

12.4 If during the CC Option Term or MC Option Term, the respective Contract is not terminated, but this Option Agreement is terminated pursuant to Section 12.5 (where the Vehicle Supply Agreement is terminated by reason of a Construction Contractor Event of Default thereunder), any P&S Agreement will also automatically terminate, provided the Subcontractor has complied with Section 13.2.

12.5 Prior to the Revenue Service Availability Date, this Option Agreement will terminate automatically upon termination of the Vehicle Supply Agreement.

12.6 After the Revenue Service Availability Date, this Option Agreement may be terminated on written notice to the Subcontractor from the Construction Contractor during the CC Option Term or from the Maintenance Contractor during MC Option Term, upon the occurrence of any of the below listed events (each a "Subcontractor Event of Default"):

(a) any of the events described in Sub-Clause 16.1.1(h) of the Vehicle Supply Agreement occurs in respect of the Subcontractor or the Option Vehicles Guarantor;

(b) the Subcontractor assigns this Option Agreement in contravention of Section 13.1,

(c) the Subcontractor fails to comply with Sub-Clause 6.11 (Restricted Persons) or 6.12 (Prohibited Acts) of the Vehicle Supply Agreement, which are hereby incorporated by reference herein;

(d) the Option Vehicles Guarantee ceases to be in full force and effect and is not replaced within 10 Business Days;

(e) the Subcontractor or the Option Vehicles Guarantor ceasing to be, directly or indirectly, controlled by ALSTOM Holdings (within the meaning of the *Canada Business Corporations Act*);

(f) a default by the Option Vehicles Guarantor under the terms of the Option Vehicles Guarantee, which default has not been cured within the applicable cure period or the Option Vehicles Guarantor taking the position that the Option Vehicles Guarantee is invalid or unenforceable;

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(g) the accumulation of liability generally in excess of the limit of liability provided in Section 9.1 unless the Subcontractor agrees to re-set the relevant limit at a level acceptable to the respective Contractor, in its absolute discretion;

(h) any P&S Agreement being terminated due to an event of default of the Subcontractor thereunder; or

(i) the Subcontractor commits any other breach of this Option Agreement which has a material adverse effect on the ability of the Subcontractor to perform its obligations or carry out its rights under this Option Agreement or on the ability of the respective Contractor to perform its obligations under this Option Agreement or under the respective Attachment 35.

12.7 Prior to termination becoming effective under Section 12.6, the respective Contractor will first give the Subcontractor 10 Business Days in which to cure the default or put forward a remedial plan that is reasonably satisfactory to the respective Contractor given the nature of the default, provided that such time period will be 2 Business Days in the case of an event described in Section 12.6(c) and further provided that the respective Contractor may terminate this Option Agreement with immediate effect in the case of an event described in Section 12.6(h).

12.8 After the Revenue Service Availability Date, this Option Agreement may be terminated on written notice from the Subcontractor to the Construction Contractor during the CC Option Term, upon the occurrence of any of the below listed events in respect of the Construction Contractor (each a "Construction Contractor Event of Default"), or to the Maintenance Contractor during MC Option Term, upon occurrence of any of the below listed events in respect of the Maintenance Contractor (each a "Maintenance Contractor Event of Default", and together with the Construction Contractor Events of Default, the "Contractor Events of Default"):

(a) the respective Contractor breaches any other term, condition, covenant or undertaking contained herein (other than as a consequence of a breach by the Subcontractor of its obligations under this Option Agreement 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 Option Agreement and the respective Contractor fails to cure such default within 65 days of receiving written notice from the Subcontractor or, if such breach cannot reasonably be cured within such 65-day period, such longer period as is reasonably required to cure such breach provided the respective Contractor continuously makes diligent efforts to cure such breach until so cured;

(b) the occurrence of any of the following events other than as a consequence of a breach by the Subcontractor of its obligations under this Option Agreement:

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(i) the respective Contractor or any member or partner 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 respective Contractor or any member thereof, unless the appointment is canceled within 30 days;

(iii) the respective 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 will have a material adverse effect on the respective Contractor's ability to perform its obligations under any this Option Agreement; or

(iv) if any execution, sequestration, extent, garnishment or other process of or order by any court becomes enforceable against the respective Contractor or any member thereof or if a distress or analogous process is levied against any property of the respective Contractor, any member thereof that materially adversely affects the respective Contractor's ability to perform its obligations under this Option Agreement;

provided that such an event shall not constitute a Contractor Event of Default if any one of members or partners of the respective Contractor have not undergone such an event and are not otherwise in default hereunder, provided the respective Contract has not been terminated.

12.9 Whichever of the Subcontractor and the respective Contractor Has Knowledge of any Contractor Event of Default, will notify the other Party of the occurrence, and details, of any such Contractor Event of Default promptly upon becoming aware of its occurrence.

12.10 On the occurrence of a Contractor Event of Default, and while it is still subsisting, the Subcontractor may serve notice on the respective Contractor of the occurrence specifying details of such Contractor Event of Default and:

(a) suspend performance of its obligations under this Option Agreement until such time as the Contractor Event of Default is no longer subsisting or the respective Contractor has demonstrated to the reasonable satisfaction of the Subcontractor that it will perform and is capable of performing its obligations under the Option Agreement; and

(b) if the relevant matter or circumstance has not been rectified or remedied within thirty (30) Business Days of the Subcontractor's notice, the Subcontractor may

serve a further notice on the respective Contractor terminating this Option Agreement with immediate effect.

12.11 The Subcontractor will not exercise, or purport to exercise, any right to terminate this Option Agreement as a result of a Contractor Event of Default, except as expressly set out in this Option Agreement.

12.12 Sub-Clause 16.4 (Effect of Termination) of the Vehicle Supply Agreement will apply *mutatis mutandis* in the case of any termination of this Option Agreement.

12.13 Compensation on Termination

(a) *Subcontractor Default*. If this Option Agreement is terminated pursuant to this Section 12 as a result of a Subcontractor Event of Default, included any termination of either Contract caused by a Subcontractor Event of Default, the Subcontractor shall indemnify the Contractors against all Direct Losses suffered or incurred by the Contractors as a result of such termination and/or the acts or omissions of the Subcontractor leading to such termination, including but not limited to:

(i) where the respective Contract continues, the additional expenses attributable to the employment of a different Subcontractor to complete the supply of the Additional Vehicles and perform the Subcontractor's obligations hereunder, and any loss of revenue attributable to the delay and disruption of the Works or the Maintenance Services as a result of such termination; and

(ii) where the respective Contract has also been terminated, all Direct Losses incurred by the respective Contractor due to such termination including without limitation, the compensation on termination payable by the respective Contractor to Project Co pursuant to the respective Contract and amounts owed to other Project subcontractors, and

(iii) in either case, all Direct Losses incurred by the respective Contractor in exercising its termination rights (including any relevant increased administrative expenses and legal expenses) under this Option Agreement.

(b) *Contractor Default*. If this Option Agreement is terminated as a result of a Contractor Event of Default, including any termination of the respective Contract caused by a Contractor Event of Default, the respective Contractor shall indemnify the Subcontractor against all Direct Losses incurred by the Subcontractor in exercising its termination rights (including any relevant increased administrative expenses and legal expenses) under this Option Agreement, without prejudice to any liability of the respective Contractor to pay compensation on termination pursuant to any P&S Agreement.

(c) *Project Co Default*. If this Option Agreement is terminated as a result a termination of a Contract due to a Project Co Event of Default under the respective Contract or Project Agreement, but not including any Project Co Event of Default caused by a Contractor Event of Default or a Subcontractor Event of Default, the respective Contractor shall pay to the Subcontractor the sum of the amounts indicated in Section (b), but only to the extent it receives such amounts from Project Co and in proportion to the claims of the Construction Contractor and other subcontractors to the amounts received.

(d) *City Events of Default, other Project Agreement Termination, and/or Force Majeure*. If this Option Agreement is terminated due to a City Event of Default, an event of Force Majeure or a Relief Event, or for the City's convenience, the Contractor shall pay to the Subcontractor the sum of the amounts indicated in Section (b), but only to the extent it receives such amounts (directly or indirectly) from the City and in proportion to the claims of the respective Contractor and other subcontractors to the amounts received.

(e) *Full Settlement*. Any and all amounts paid by a Party to another Party under this Section 12.13 (a "Termination Payment") will be in full and final settlement of each Party's rights and claims against each other for termination of this Option Agreement, whether under contract, tort, restitution or otherwise, but without prejudice to:

(i) any liability of either Party to the other, including under the indemnities in this Option Agreement, that arose prior to the date of termination of this Option Agreement (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; or

(ii) any liabilities arising under or in respect of any breach by either Party of their obligations under Section 14.6 of this Option Agreement, or the sections referred to therein, which did not lead to such termination and which arises or continues after the date of termination of this Option Agreement.

13. Assignment

13.1 The Subcontractor shall not assign the whole or any part of this Option Agreement or any P&S Agreement or any benefit or interest in or under this Option Agreement without the consent of the Construction Contractor during the CC Option Term or the consent of the Maintenance Contractor during the MC Option Term or any P&S Agreement without the consent of the Contractor who is a party thereto, which the Contractors may withhold in their sole discretion. Such consent is deemed granted to an assignment of the Option Agreement and all P&S Agreements thereunder to another, directly or indirectly, wholly-

owned subsidiary of ALSTOM Holdings (which assignment must, during the CC Option Term, be made in conjunction with an assignment of the Vehicle Supply Agreement to the same assignee), provided that the Option Vehicles Guarantee remains in place and the Subcontractor has demonstrated to the reasonable satisfaction of the Contractors that the assignee possesses equivalent financial capacity and technical expertise and qualifications, upon delivery of substitute Letter of Credit from the assignee and documentation reasonably required by the Contractors to give effect to the assignment.

13.2 Upon the occurrence of any event which would entitle the Subcontractor to terminate this Option Agreement or any P&S Agreement, the Subcontractor shall serve notice (a "Default Notice") on the Contractors, 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 Contractors (or otherwise) within 30 Business Days of delivery of the Default Notice (the "Default Period"), the Subcontractor may serve a further notice on the Contractors terminating this Option Agreement or any P&S Agreement 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 Contractors' rights under this Option Agreement and any P&S Agreement to a replacement contractor and/or (ii) cure the event which gave rise to the Subcontractor's right to terminate this Subcontract, provided that, in each case, the Subcontractor shall not be obligated to perform its obligations under this Option Agreement or any P&S Agreement until such event which gave rise to the Subcontractor's right to terminate this Option Agreement or any P&S 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 Contractors (or the replacement contractor) arising from future performance of this Option Agreement or any P&S Agreement.

13.3 A Contractor may, upon 45 days written notice, assign or require the novation of this Option Agreement or any P&S Agreement to the other Contractor or Project Co upon written notice to the Subcontractor.

13.4 Upon receiving 45 days' written notice of a proposed assignment from the Construction Contractor to the Maintenance Contractor, the Subcontractor will prepare a list of unresolved claims against the Construction Contractor ("Identified Claims") and present it to the Contractors no later than 15 days prior to the proposed assignment date. Any potential assignment or novation from the Construction Contractor to the Maintenance Contractor will be considered a "With Recourse Assignment" unless one of the following conditions is met:

(a) the Subcontractor waives any rights it may have against the Maintenance Contractor in respect of the Identified Claims; or
(b) all Identified Claims are finally resolved.

If a potential assignment or novation constitutes a With Recourse Assignment, such potential assignment or novation will only be valid and become effective upon receipt of written confirmation from the Maintenance Contractor to the Construction Contractor and the Subcontractor, to be provided in the Maintenance Contractor's sole discretion, confirming that it will assume responsibility for all unresolved Identified Claims. For the avoidance of doubt the assumption of responsibility shall not be construed in any manner as an admission of guilt or liability. Upon receipt of such confirmation, as between the Contractors and the Subcontractor, responsibility for the Identified Claims will be assumed by the Maintenance Contractor and will no longer be the responsibility of the Construction Contractor.

Notwithstanding the acceptance of any With Recourse Assignment by the Maintenance Contractor, the indemnities provided by the Contractors to each other in Section 2.6 will continue to apply as if there were no such With Recourse Assignment.

Upon an assignment or novation from the Construction Contractor to the Maintenance Contractor, the Construction Contractor will continue to be fully responsible for all obligations and liabilities arising:

(c) hereunder prior to the commencement of the MC Option Term;
(d) under any P&S Agreement prior to its assignment or novation to the Maintenance Contractor; and
(e) out of acts or omissions of the Construction Contractor made prior to the commencement of the MC Option Term,

and the Maintenance Contractor will not assume such obligations and liabilities except to the extent of an accepted With Recourse Assignment, in which case the Maintenance Contractor will assume responsibility for the Identified Claims (but no other claims or potential claims).

13.5 Each Party shall do all things, from time to time, and execute all further documents necessary to give full effect to any assignment or novation hereunder, including anything required to ensure that the assignee or novatee is in a position to exercise the assigning Contractor's right under any Letter of Credit or Option Vehicles Guarantee, including, if applicable, the issuance of a new Letter of Credit or Option Vehicles Guarantee.

13.6 This Option Agreement and any P&S Agreement shall enure to the benefit of and bind the successors and permitted assigns of the Parties.

14. Miscellaneous

14.1 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.

14.2 This Option Agreement is deemed to include all provisions that the Project Agreement requires Project Co to include in its Subcontracts, and included in the Vehicle Supply Agreement, including all those that Project Co is required to insert into its Subcontract in order to be in a position to perform specific obligations under the Project Agreement, and which have been included in the Vehicle Supply Agreement.

14.3 No amendment to this Option Agreement will be effective unless agreed to in writing by all Parties hereto, provided that the Construction Contractor's agreement will not be required after the end of CC Option Term and the assignment or novation of all P&S Agreements to which it is a party to the Maintenance Contractor, and any amendment not in accordance with the foregoing shall be null and void. As between the Construction Contractor and the Maintenance Contractor, the Construction Contractor will not amend any P&S Agreement without the consent of Maintenance Contractor.

14.4 Subcontractor agrees that any dispute arising out of this Option Agreement will be subject to the Dispute Resolution Procedure under the Vehicle 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.

14.5 Each party shall do all things, from time to time, and execute all further documents necessary to give full effect to this Option Agreement.

14.6 Except as otherwise provided in this Project Agreement, termination of this Project Agreement shall be without prejudice to, and shall not affect:

(a) all representations, warranties and indemnities under this Option Agreement;

(b) Sections 6, 7, 8, 12.1, 12.3 and 12.13 and any other provisions of this Option Agreement 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 Section 8.1 of each Attachment 35 that is incorporated by reference into this Option Agreement,

all of which shall survive the termination of this Option Agreement.

14.7 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 sent in PDF form by e-mail provided that any party providing its signature in PDF form shall promptly forward to the other party an original signed copy of this Option Agreement which was so e-mailed.

In witness whereof, the authorized representatives of the Parties have set their signatures below:

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

EXHIBIT A

CC ATTACHMENT 35

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

ATTACHMENT 35

CC ADDITIONAL VEHICLES

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PART 8 TERMINATION OF PROJECT AGREEMENT OR CONSTRUCTION CONTRACT 14

PART 1
DEFINITIONS

1.1 Definitions

Any words or phrases defined in Schedule 35 to the Project Agreement shall bear the same meaning in this Attachment 35 - CC Additional Vehicles, unless such words or phrases are otherwise defined in this Attachment 35 - CC Additional Vehicles.

In this Attachment 35, the following definitions shall have the following meanings:

(a) "**Additional Maintenance Spare Vehicles**" has the same meaning given to it in Section 2.2(a).

(b) "**Additional Vehicles**" means any additional light rail transit vehicles purchased by the City following Financial Close pursuant to Schedule 35 to the Project Agreement (and by Project Co pursuant to this Attachment 35), including all electromechanical and other equipment therein. For clarity, this includes any additional light rail transit vehicles beyond the initial fleet of Vehicles to be provided by the Construction Contractor at the Revenue Service Availability Date, whether or not such additional light rail transit vehicles are purchased from the Construction Contractor or any other third party.

(c) "**Additional Vehicles Termination Date**" has the meaning given to it in Section 8.1(b) of this Attachment 35.

(d) "**Cancelled Vehicles**" has the meaning given to it in Section 2.7(b)(i) of this Attachment 35.

(e) "**CC Additional Vehicles Agreement**" has the meaning given to it in Section 8.1(a) of this Attachment 35.

(f) **"CC Option Term**" means the period beginning at Financial Close and, subject to compliance by the Construction Contractor with the assignment obligations in Section 2.1(d) of this Attachment 35, ending on the earlier of (i) the second anniversary of the Revenue Service Availability Date and (ii) the end of the Option Term under Schedule 35 to the Project Agreement.

(g) "**Construction Contractor Additional Vehicles**" means the Additional Vehicles which are purchased by Project Co from the Construction Contractor pursuant to this Attachment 35.

(h) "**Default Event**" has the meaning given to it in Section 2.1(c)(vi) of this Attachment 35.

(i) "**Default Notice**" has the meaning given to it in Section 2.1(c)(vi) of this Attachment 35.

(j) "**Deliver**" or "**Delivery**" means that the Construction Contractor delivers the Additional Vehicles purchased by Project Co pursuant to and in accordance with this Attachment 35 to the Designated Site on the Delivery Date in a manner as requested by Project Co.

(k) "**Delivery Date**" means the later of:

(i) 30 months following the date when an Option Notice (as defined under Schedule 35 to the Project Agreement) is given by the City to Project Co in accordance with section 2.1(c) of Schedule 35 to the Project Agreement, upon which date the Construction Contractor shall be required to deliver the Additional Vehicles to a Designated Site; and

(ii) the Required Revenue Service Availability Date.

(l) "**Designated Site**" means a site in the City of Ottawa as designated by Project Co to which the Construction Contractor is required to deliver the Additional Vehicles.

(m) "**Included Upgrade**" has the meaning given to it in Section 2.3(b) of this Attachment 35.

(n) "**Maximum Order**" means the maximum number of the Additional Vehicles that Project Co shall be entitled to by way of the Option to Purchase in each year during the CC Option Term pursuant to Section 2.2(c) of this Attachment 35.

(o) "**Minimum Order**" means the minimum number of the Additional Vehicles that Project Co shall be entitled to by way of the Option to Purchase in each year during the CC Option Term pursuant to Section.2.2(b) of this Attachment 35.

(p) "**Non-Construction Contractor Additional Vehicles**" means the Additional Vehicles which are purchased by the City or Project Co from a third party other than the Construction Contractor pursuant to Schedule 35 to the Project Agreement or this Attachment 35.

(q) "**Option Notice**" has the meaning given to it in Section 2.1(c)(i) of this Attachment 35.

(r) "**Option to Purchase**" has the meaning given to it in Section 2.1(a) of this Attachment 35.

(s) "**Prime Rate**" means on any day, the annual rate of interest announced by the Royal Bank of Canada (or its successor), or any Canadian chartered bank agreed by the City and Project Co under the terms of the Project Agreement, from time to time as its reference rate then in effect for determining interest rates on Canadian dollar commercial loans made by it in Canada.

(t) "**Required Upgrade**" has the meaning given to it in Section 2.3(b) of this Attachment 35.

(u) "**Service Level Increase Additional Vehicle Delivery Delay**" has the meaning given in Section 2.7(c) of this Attachment 35.

(v) "**Vehicle Long Stop Date**" means 6 months following the Delivery Date.

(w) "**Vehicle Option Suppliers**" has the meaning given in Section 2.1(d) of this Attachment 35.

(x) "**Vehicle Unit Price**" means the price per Additional Vehicle, as follows:

(i) $[redacted] per Vehicle, subject to Section 2.4 of this Attachment 35 and subparagraph (ii) below;

(ii) $[redacted] per Vehicle (the "Reduced Price"), rather than as set out in subparagraph (i) above; provided that:

(A) the Option to Purchase is exercised on or before the expiry of 18 months following Financial Close;

(B) the Reduced Price shall be applicable to a maximum of 8 Vehicles with respect to which the City requires delivery on or prior to the expiry of 59 months following Financial Close; and

(C) the Reduced Price shall be applicable to a maximum of 20 Vehicles with respect to which the City requires delivery on or prior to the expiry of 68 months following Financial Close.

PART 2
OPTION TO PURCHASE

2.1 Project Co's Option to Purchase

(a) The Construction Contractor acknowledges the provisions of section 2.1 of Schedule 35 to the Project Agreement and agrees that, if the City exercises its option under that section during the CC Option Term, then Project Co shall be entitled to purchase from the Construction Contractor Additional Vehicles (the **"Option to Purchase"**) and require such Additional Vehicles be delivered by the Construction Contractor to the Designated Site on the Delivery Date.

(b) The Additional Vehicles that are purchased by Project Co pursuant to Section 2.1(a) of this Attachment 35 may, at Project Co's option, be used for the System and any System Extension.

(c) Option to Purchase:

(i) The Option to Purchase shall be exercised by written notice (an "**Option Notice**") given by Project Co to the Construction Contractor at any time during the CC Option Term in accordance with Part 2 Section 61.

(ii) An Option Notice shall specify the number of the Additional Vehicles that Project Co wishes to purchase from the Construction Contractor, the Designated Site, additional storage area, maintenance requirements, upgrades to Train Control System (if any), Traction Power and other issues relating to integration of Additional Vehicles into the System.

(iii) Upon delivery of a relevant Option Notice in accordance with the foregoing provision there shall be deemed to be a binding agreement of purchase and sale between Project Co (or, if Project Co directs, the City) as purchaser and the Construction Contractor as vendor in respect of the Additional Vehicles. The terms and conditions of the agreement of purchase and sale of such Additional Vehicles shall be in accordance with this Attachment 35 or the terms otherwise provided in this Agreement not in conflict with this Attachment 35.

(iv) The purchase of the Additional Vehicles resulting from the exercise of the Option to Purchase shall be completed upon the Closing Date.

(v) On the Closing Date, Part 2 Section 29.5 shall apply, *mutatis mutandis*, to the Construction Contractor and the Additional Vehicles.

(vi) The Construction Contractor acknowledges the provisions of section 2.1(c)(vi) of Schedule 35 to the Project Agreement. If the Additional Vehicles are encumbered by any encumbrances contrary to Part 2 Section 29.5 or the Construction Contractor fails to perform any covenant on its part herein contained, Project Co may in its Discretion, without derogation from its right respecting any Construction Contractor Event of Default as provided for in this Agreement, on

prior written notice to the Construction Contractor (the "**Default Notice**"), perform any such covenant capable of being performed by Project Co or arrange for the encumbrance to be discharged (any such event, a "**Default Event**") and if the Default Event requires the payment or expenditure of money, Project Co may make such payment or expenditure and all sums so expended (including amounts expended by Project Co to the City pursuant to section 2.1(c)(vi) of Schedule 35 to the Project Agreement as a result of the City exercising its rights under such section due to a failure by the Construction Contractor under this Section) shall be forthwith payable by the Construction Contractor to Project Co with the Default Interest Rate thereon until paid and Project Co may deduct and set-off any such amount against the purchase price payable on the Closing Date The Parties agree that the Closing Date shall be extended by such period of time as Project Co (or the City pursuant to section 2.1(c)(vi) of Schedule 35 to the Project Agreement) determines is necessary for the purposes of Project Co or the City curing such Default Event prior to the Closing Date.

(vii) Each of the parties shall execute and deliver all such other further documents and do such other things as the other party may reasonably request to give full effect to this Section 2.1.

(d) The Construction Contractor represents that it has agreed with Thales Canada Inc., and Alstom Power & Transport Canada Inc. (collectively the **"Vehicle Option Suppliers"**) on the terms that are sufficient to give effect to the Option to Purchase as provided for in Schedule 35 and for the entirety of the Option Term (as defined in Schedule 35 to the Project Agreement) notwithstanding that the Construction Contractor shall be assigning its rights as described below. The Construction Contractor shall not vary, amend, change or waive such terms without the prior written consent of Project Co. Upon receipt of the Option Notice, the Construction Contractor shall exercise its rights and perform all necessary acts under its agreement with the Vehicle Option Suppliers to give full effect to Project Co's Option to Purchase under this Section 2.1. At the end of the CC Option Term, the Construction Contractor shall assign to Project Co (or the Maintenance Contractor, as Project Co may direct), and Project Co (or the Maintenance Contractor, as Project Co may direct), shall assume all of its rights to exercise the Option to Purchase and its obligations vis-à-vis the Vehicle Option Suppliers. The assignment referred to in the foregoing sentence shall, subject to any adjustment to the Vehicle Handover Date (as defined in the Interface Agreement) pursuant to the Interface Agreement with respect to any Additional Vehicles, include any supply contracts, performance security and other agreements with respect to the purchase of Additional Vehicles for which any Option to Purchase has already been exercised, each of which supply contracts, performance security and other agreements shall be assigned concurrently.

2.2 The Number of the Additional Vehicles

(a) The number of the Additional Vehicles with respect to which the Option to Purchase is exercised pursuant to Section 2.1 of this Attachment 35 for each year of the CC Option Term shall take into account the spare vehicles required to provide the necessary spare vehicle capacity to allow Project Co to conduct Maintenance Services in accordance with

Schedule 15-3 to the Project Agreement (the "**Additional Maintenance Spare Vehicles**"). For the purpose of this Section 2.2, where the calculation for the required Additional Maintenance Spare Vehicles pursuant to Project Co's Response produces a fraction, such fraction shall not be taken into account in determining the number of required Additional Maintenance Spare Vehicles.

(b) The Minimum Order that Project Co shall have the right to place by way of the Option to Purchase from the Construction Contractor pursuant to Section 2.1 of this Attachment 35 for each year of the CC Option Term shall be equal to one (1) train consist (provided that the City exercises it corresponding Minimum Order pursuant to Schedule 35 to the Project Agreement).

(c) The Maximum Order that Project Co shall have the right to place by way of the Option to Purchase from the Construction Contractor pursuant to Section 2.1 of this Attachment 35 for each year of the CC Option Term shall be equal to three (3) train consists (provided that, for greater certainty, Project Co shall not place orders for more Additional Vehicles than the City orders pursuant to Schedule 35 to the Project Agreement). Notwithstanding the Maximum Order permitted in an annual period, Project Co shall also be entitled to order Additional Maintenance Spare Vehicles required in accordance with Section 2.2(a) of this Attachment 35 in such year.

2.3 Output Specifications of Additional Vehicles

(a) Subject to Section 2.3(b) of this Attachment 35 and Section 2.3(c) of this Attachment 35, the Additional Vehicles purchased by Project Co pursuant to Section 2.1(a) of this Attachment 35 shall be manufactured in accordance with the Output Specifications provided for in Schedule 15-2 of the Project Agreement.

(b) In the event that there are any improvements or upgrades required for the System in accordance with Schedule 15 to the Project Agreement which do not result in a Variation (a "**Required Upgrade**"), or there are any improvements or upgrades included in the basic model of the Vehicles (an "**Included Upgrade**"), the Construction Contractor shall ensure that the Additional Vehicles are upgraded to conform to any Required Upgrade or Included Upgrade, and that all associated equipment and interfaces are tested to accommodate such upgrades, without further costs to Project Co or the City.

(c) The Construction Contractor acknowledges the provisions of section 2.3(c) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 related to Equivalent Project Relief shall apply. In the event that the Variation Procedure applies pursuant to section 2.3(c) of Schedule 35 to the Project Agreement, the Construction Contractor shall provide Project Co with any information requested by Project Co in order to fulfil its obligations to the City under such section.

2.4 Price of Additional Vehicles

(a) Subject to the provisions of this Section 2.4 of this Attachment 35 and section 2.3(c) of Schedule 35 to the Project Agreement providing otherwise, the price of each of the

Additional Vehicles to be purchased by Project Co pursuant to Section 2.1(a) of this Attachment 35 shall be the Vehicle Unit Price.

(b) The Construction Contractor acknowledges the provisions of section 2.4(b) of Schedule 35 to the Project Agreement and agrees that there shall be no price escalation or reduction for the CC Option Term except to the extent that price escalation or reduction is permitted pursuant to such section.

2.5 Payment of Price of Additional Vehicles

(a) In respect of each of the Additional Vehicles purchased by Project Co on behalf of the City pursuant to and in accordance with Part 2 of this Attachment 35, Project Co shall make the payments referred to in section 2.5(a) of Schedule 35 to the Project Agreement to the Construction Contractor within 5 Business Days of receipt of same from the City.

2.6 Commissioning of Additional Vehicles

(a) The Additional Vehicles purchased pursuant to Part 2 of this Attachment 35 that are delivered during the Option Period shall be tested and commissioned by the Construction Contractor in accordance with Schedule 14 to the Project Agreement.

2.7 Construction Contractor's Failure to Deliver

(a) Subject to Section 2.7(c) of this Attachment 35, if the Construction Contractor shall fail to Deliver the Additional Vehicles on the Delivery Date (where the Delivery Date is during the CC Option Term) or shall cause a failure to Deliver the Additional Vehicles on the Delivery Date (where the Delivery Date is after the CC Option Term) and liquidated damages are levied by the City pursuant to section 2.7(c) of Schedule 35 to the Project Agreement, the Construction Contractor shall pay such liquidated damages to Project Co immediately upon demand. Such amount of liquidated damages shall constitute Project Co's sole entitlement to damages from the Construction Contractor in respect of a failure to deliver the Additional Vehicles on the Delivery Date.

(b) If the Construction Contractor shall fail to Deliver the Additional Vehicles by the Vehicle Long Stop Date, Project Co shall have the right to:

(i) cancel the exercised Option to Purchase the undelivered Additional Vehicles by written notice to the Construction Contractor (the "**Cancelled Vehicles**"), in which event, without derogation from Project Co's right under Section 2.7(a) of this Attachment 35 or Section 2.7(c) of this Attachment 35, as the case may be, Project Co shall be entitled to a refund of the payments that Project Co has made up until the Vehicle Long Stop Date in respect of such Cancelled Vehicles, together with the Default Interest Rate thereon.

or,

(ii) without derogation from Project Co's right under Section 2.7(a) of this Attachment 35 or Section 2.7(c) of this Attachment 35, as the case may be,

proceed with the exercised Option to Purchase by written notice to the Construction Contractor in accordance with the terms and conditions set out herein.

(c) Notwithstanding Section 2.7(a) of this Attachment 35, where Project Co has caused the Construction Contractor to acquire Additional Vehicles under the provisions of this Attachment 35 in order to implement a Service Level Increase, and the Construction Contractor has failed or has determined that it will fail to achieve the delivery, commissioning, and assimilation into the vehicle fleet of the Additional Vehicles by the Service Level Increase Date so as to effect the required Service Level Increase (where the Delivery Date is during the CC Option Term) or shall cause a failure to achieve the delivery, commissioning, and assimilation into the vehicle fleet of the Additional Vehicles by the Service Level Increase Date so as to effect the required Service Level Increase (where the Delivery Date is after the CC Option Term) ("**Service Level Increase Additional Vehicle Delivery Delay**"),

(i) if liquidated damages are levied by the City pursuant to section 2.7(c) and (d) of Schedule 35 to the Project Agreement, pay such liquidated damages to Project Co immediately upon demand; or

(ii) with Project Co's consent, not to be unreasonably withheld, confirm that Project Co will, at the Construction Contractor's cost, provide the required Service Level Increase using Project Co's existing vehicle fleet, on a temporary basis, during the period of Service Level Increase Additional Vehicle Delivery Delay, in which case the Construction Contractor shall be responsible for any costs incurred by Project Co as a result of such performance, including without limitation any applicable penalties under the Project Agreement for failure to do so, including Schedule 20 to the Project Agreement;

or

(iii) with Project Co's consent, not to be unreasonably withheld, where Project Co can partially provide the required Service Level Increase using Project Co's existing vehicle fleet on a temporary basis during the period of Service Level Increase Additional Vehicle Delivery Delay, a combination of the foregoing subparagraphs (i) and (ii) will apply.

For greater certainty, the amount of the Liquated Damages for Service Level Increase Additional Vehicle Delivery Delay as provided for in section 2.7(c) and 2.7(d) of Schedule 35 to the Project Agreement together with any amount payable to Project Co under Section 2.7(c)(ii) of this Attachment 35 shall constitute Project Co's sole entitlement to damages in respect of a failure of the Construction Contractor to deliver the Additional Vehicles on the Service Level Increase Date as required in this Section 2.7(c)

(d) The Construction Contractor acknowledges the provisions of section 2.7(d) of Schedule 35 to the Project Agreement.

(e) In the event that Project Co shall cancel the exercised Option to Purchase with respect to the undelivered Additional Vehicles pursuant to Section 2.7(b)(i) of this Attachment 35, Project Co shall have the right to exercise an Option to Purchase in respect of such Cancelled Vehicles in the next option period.

(f) [Not used]

2.8 Canadian Content

(a) For clarification, except as provided in Section 2.8(b), there shall be no obligation on the Construction Contractor to comply with the Canadian Content Requirements with respect to Additional Vehicles delivered to Project Co (or the City) pursuant to the exercise of the Option to Purchase.

(b) Notwithstanding Section 2.8(a), if the City requires compliance with the Canadian Content Requirements pursuant to section 2.8 of Schedule 35 to the Project Agreement, Project Co shall require compliance with the Canadian Content Requirements (a **"CC Request"**), with respect to any Additional Vehicles purchased pursuant to the Option to Purchase in this Attachment 35 by including the CC Request with the Option Notice. In such event the Canadian Content Requirements shall be deemed to be a CC Variation and the provisions respecting CC Variations in this Agreement and Attachment 22 – CC Variation Procedure shall be applicable to the Additional Vehicles that are the subject matter of the CC Request.

PART 3
NEGOTIATED PURCHASE OF ADDITIONAL VEHICLES

3.1 Negotiated Purchase

(a) Up to and including the Revenue Service Availability Date, Project Co shall have the right to negotiate with the Construction Contractor to purchase Additional Vehicles in accordance with Part 3 of this Attachment 35.

(b) The Additional Vehicles that are purchased by Project Co pursuant to Section 3.1(a) of this Attachment 35 may, at Project Co's option, be used for the System and any System Extension.

3.2 Output Specifications of Additional Vehicles

(a) Subject to Section 3.2(c) of this Attachment 35, the Additional Vehicles purchased pursuant to Section 3.1(a) of this Attachment 35 shall be manufactured in accordance with the Output Specifications provided for in Schedule 15-2 to the Project Agreement, or as otherwise agreed upon by Project Co and the Construction Contractor during the negotiation.

(b) In the event that there are any Required Upgrades or Included Upgrades, the Construction Contractor shall ensure that the Additional Vehicles are upgraded to conform to such Required Upgrades or Included Upgrades, and that all associated equipment and

interfaces are tested to accommodate such upgrades, without further costs to Project Co or the City.

(c) The Construction Contractor acknowledges the provisions of section 2.3(c) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 related to Equivalent Project Relief shall apply. In the event that the Variation Procedure applies pursuant to section 3.2(c) of Schedule 35 to the Project Agreement, the Construction Contractor shall provide Project Co with any information requested by Project Co in order to fulfil its obligations to the City under such section.

3.3 Price of Additional Vehicles

(a) The price of each of the Additional Vehicles purchased by Project Co pursuant to Section 3.1(a) of this Attachment 35 shall be negotiated by Project Co (and, if Project Co directs, the City) and the Construction Contractor.

3.4 Commissioning of Additional Vehicles

(a) The Additional Vehicles as purchased by Project Co pursuant to Part 3 of this Attachment 35 that are delivered up to and including the Revenue Service Availability Date shall be tested and commissioned by the Construction Contractor in accordance with Schedule 14 to the Project Agreement.

PART 4
VEHICLE PROCUREMENT

4.1 City's Right to Procure

(a) The Construction Contractor acknowledges that the City shall have the right to procure any Additional Vehicles from a provider other than Project Co and that the City may use any form of competitive procurement, sole-source contract, or other procurement methodology or transaction structure. At its option, the City may bundle the Option to Purchase in respect of the Additional Vehicles with other procurement processes.

4.2 Consulting Service

(a) The Construction Contractor acknowledges that the City shall have the right to retain either a third party or Project Co as consultant in procuring the Additional Vehicles procured pursuant to section 4.1(a) of Schedule 35 to the Project Agreement. If the City retains Project Co as a consultant up to and including the Revenue Service Availability Date, Project Co may retain the Construction Contractor to perform certain of Project Co's obligations as consultant to the City pursuant to this Section 4.2. For greater certainty, Project Co shall also be permitted to retain the Maintenance Contractor to perform certain of Project Co's obligations as consultant to the City either before or after the Revenue Service Availability Date.

(b) In the event that Project Co shall desire to consider retaining the Construction Contractor as consultant in procuring the Additional Vehicles pursuant to Section 4.1(a) of this

Attachment 35, Project Co shall provide the Construction Contractor with a written notice which shall include the following information:

(i) a description of the Additional Vehicles the City wishes to procure including the number, model, preliminary output specifications and other significant features of the Additional Vehicles; and

(ii) a preliminary plan and anticipated timelines for procurement of the Additional Vehicles.

(c) Within a period of 12 days after the date of receipt of the notice provided for in Section 4.2(b) of this Attachment 35, the Construction Contractor shall deliver to Project Co its written response advising Project Co of an estimate of the consulting fee it will charge for the consulting services to be provided in respect of such Additional Vehicles, with reasonable details to support such estimate.

(d) Project Co shall within a period of 20 days after the date of receipt of the Construction Contractor's response as provided for in Section 4.2(c) of this Attachment 35, deliver a written notice notifying the Construction Contractor whether or not Project Co shall wish to retain the Construction Contractor for providing consulting services respecting such Additional Vehicles.

(e) In the event that Project Co shall wish to retain the Construction Contractor for providing consulting services respecting such Additional Vehicles by giving the notice as provided for in Section 4.2(d) of this Attachment 35, then upon delivery and receipt of such notice, Project Co and the Construction Contractor shall, in good faith and acting reasonably, negotiate the terms of a binding agreement for the performance of the consulting services in respect of procuring the Additional Vehicles pursuant to and in accordance with Section 4.2 of this Attachment 35 provided that such agreement shall not be binding unless the City also accepts Project Co's proposal for consulting services pursuant to Schedule 35 to the Project Agreement.

4.3 Construction Contractor's Obligation to Assist

(a) In the event that the City shall retain a third-party consultant in procuring the Additional Vehicles pursuant to Section 4.2(a) of this Attachment 35, subject to the provisions in Attachment 41 - CC Intellectual Property, the Construction Contractor shall provide assistance to Project Co (or, at Project Co's direction, the City) as reasonably required by Project Co and, subject to the provisions of Part 1 relating to Equivalent Project Relief, at the City's cost, which assistance shall include without limitation:

(i) providing all necessary information and access to Fixed Facilities, E&M, MSF, and Vehicles supplied by the Construction Contractor in order to allow the City to develop appropriate technical specifications for the Additional Vehicles; and

(ii) other assistance reasonably requested by Project Co.

(b) In the event that Project Co shall retain the Construction Contractor as consultant in procuring the Additional Vehicles pursuant to Section 4.2(a) of this Attachment 35 and the City retains Project Co as consultant pursuant to section 4.2(a) of Schedule 35 to the Project Agreement, subject to payment by Project Co (upon receipt of same from the City) of the consulting fees as agreed upon by Project Co and the Construction Contractor pursuant to Section 4.2(b) of this Attachment 35, and the provisions in Attachment 41 – CC Intellectual Property, the Construction Contractor shall provide assistance to Project Co (or at Project Co's direction, the City) as reasonably required by Project Co, which assistance shall include without limitation:

(i) assistance in development of vehicle specifications and evaluation of vehicle designs to ensure compatibility with existing Fixed Facilities, E&M, MSF supplied by the Construction Contractor;

(ii) providing all necessary information and access to Fixed Facilities, E&M, MSF, and Vehicles supplied by the Construction Contractor in order to allow Project Co and the City to develop appropriate technical specifications for the Additional Vehicles;

(iii) [Not used]

(iv) [Not used]

(v) participation in testing, commissioning, acceptance process and Configuration Management with respect to Additional Vehicles delivered up to and including the Revenue Service Availability Date; and

(vi) other assistance reasonably requested by Project Co including liaising with the Maintenance Contractor, as required.

4.4 Commissioning of Non-Construction Contractor Additional Vehicles

(a) In the event that Project Co shall retain the Construction Contractor as consultant in procuring the Additional Vehicles pursuant to Section 4.2(a) of this Attachment 35 and the City retains Project Co as consultant pursuant to section 4.2(a) of Schedule 35 to the Project Agreement, at Project Co's option, the Non-Construction Contractor Additional Vehicles as procured by Project Co pursuant to Part 4 of this Attachment 35 shall, if such Non-Construction Contractor Additional Vehicles are delivered up to and including the Revenue Service Availability Date be tested and commissioned by the Construction Contractor in accordance with Schedule 14 to the Project Agreement.

4.5 Liquidated Damages

(a) The provisions respecting liquidated damages in Section 2.7 of this Attachment 35 shall apply to Non-Construction Contractor Additional Vehicles if, and only if, the delivery delay as provided for Section 2.7 of this Attachment 35 results from the Construction Contractor's failure to carry out commissioning activities in accordance with Schedule 14 to the Project Agreement.

PART 5
[NOT USED]

PART 6
[NOT USED]

PART 7
[NOT USED]

PART 8
TERMINATION OF PROJECT AGREEMENT OR CONSTRUCTION CONTRACT

8.1 Termination of Project Agreement or Construction Contract

(a) In the event that this Agreement is terminated pursuant to and in accordance with the provisions thereof (whether or not as a result of termination of the Project Agreement), and at that time Project Co has exercised its Option to Purchase pursuant Section 2.1 of this Attachment 35 or otherwise there shall have been a binding agreement between Project Co and the Construction Contractor for Project Co to purchase Additional Vehicles from the Construction Contractor in accordance with this Attachment 35, (collectively, the "**CC Additional Vehicles Agreement**"), the provisions of this Section 8.1 shall apply.

(b) If the Project Agreement is terminated as a result of a City Event of Default or the exercise of the City's right to terminate for convenience pursuant to section 47.3 of the Project Agreement, and this Agreement is correspondingly terminated pursuant to Part 2 Section 47.4(a):

(i) Project Co shall agree with the Construction Contractor, each acting reasonably, prior to exercising its right under section 8.1(b) of Schedule 35 either to continue to carry out the Additional Vehicles Agreement or terminate the Additional Vehicles Agreement by giving the City a written notice within thirty (30) days following the termination of the Project Agreement effective immediately (the "**Additional Vehicles Termination Date**");

(ii) in the event that Project Co shall elect to carry out the Additional Vehicles Agreement pursuant to section 8.1(b) of Schedule 35 to the Project Agreement, Project Co shall notify the City accordingly, and the Construction Contractor shall continue to carry out the corresponding CC Additional Vehicles Agreement, and the provisions of this Attachment 35 and the CC Additional Vehicles Agreement shall apply; and

(iii) in the event that Project Co shall elect to terminate the Additional Vehicles Agreement pursuant to section 8.1(b) of Schedule 35 to the Project Agreement, Project Co shall notify the Construction Contractor accordingly and the corresponding CC Additional Vehicles Agreement shall terminate, and Project Co

shall be entitled to a refund of the payments that Project Co has made in respect of the CC Additional Vehicles on the Additional Vehicles Termination Date.

(c) If the Project Agreement is terminated as a result of neither a City Event of Default nor the exercise of the City's right to terminate for convenience pursuant to section 47.3 of the Project Agreement, and this Agreement is correspondingly terminated pursuant to Part 2 Section 47.4(a):

(i) the Construction Contractor acknowledges that the City, pursuant to section 8.1(c) of Schedule 35 to the Project Agreement, has the right either to continue to carry out the Additional Vehicles Agreement or terminate the Additional Vehicles Agreement by giving Project Co a written notice within thirty (30) days following the termination of the Project Agreement effective immediately;

(ii) in the event that the City elects to carry out the Additional Vehicles Agreement in accordance with section 8.1(c)(i) of Schedule 35 to the Project Agreement, Project Co shall promptly notify the Construction Contractor, and the Construction Contractor agrees that the provisions of this Attachment 35 and the corresponding CC Additional Vehicles Agreement shall apply; and

(iii) in the event that the City elects to terminate the Additional Vehicles Agreement in accordance with in accordance with section 8.1(c)(i) of Schedule 35 to the Project Agreement, the Construction Contractor agrees that the corresponding CC Additional Vehicles Agreement shall terminate, and to the extent that the City is entitled to a refund under section 8.1(c) of Schedule 35 to the Project Agreement, Project Co shall be entitled to a refund of the payments that Project Co has made in respect of the Additional Vehicles, together with the Default Interest Rate thereon up until the date of repayment by the Construction Contractor.

(d) The Construction Contractor acknowledges the provisions of section 8.1(d) of Schedule 35 to the Project Agreement, and agrees that if the Additional Vehicles Agreement is deemed terminated pursuant to that section, the corresponding CC Additional Vehicles Agreement shall also be deemed to be terminated.

(e) If the Project Agreement is not terminated, but this Agreement is terminated for any reason other than a Project Co CC Event of Default, Project Co may elect, at its option: (a) to continue to carry out the CC Additional Vehicles Agreement in which case the Construction Contractor shall continue to perform the CC Additional Vehicles Agreement; (b) take an assignment of the CC Additional Vehicles Agreement in which case the Construction Contractor shall assign to Project Co all of its rights and interest in the CC Additional Vehicles Agreement; or (c) to termination the CC Additional Vehicles Agreement in which case the CC Additional Vehicles Agreement shall terminate with immediate effect and Project Co shall be entitled to refund of the payments that Project Co has made in respect of the Additional Vehicles together with interest thereon up until the date of repayment by the Construction Contractor.

(f) If the Project Agreement is not terminated, but this Agreement is terminated by reason of a Project Co CC Event of Default, any CC Additional Vehicles Agreement will also automatically terminate.

EXHIBIT B

MC ATTACHMENT 35

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

ATTACHMENT 35

MC ADDITIONAL VEHICLES

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PART 1
DEFINITIONS

1.1 Definitions

Any words or phrases defined in Schedule 35 to the Project Agreement shall bear the same meaning in this Attachment 35 - MC Additional Vehicles, unless such words or phrases are otherwise defined in this Attachment 35 - MC Additional Vehicles.

In this Attachment 35, the following definitions shall have the following meanings:

(a) "**Additional Maintenance Spare Vehicles**" has the same meaning given to it in Section 2.2(a).

(b) "**Additional Vehicles**" means any additional light rail transit vehicles purchased by the City following Financial Close pursuant to Schedule 35 to the Project Agreement, including all electromechanical and other equipment therein. For clarity, this includes any additional light rail transit vehicles beyond the initial fleet of Vehicles to be provided by Project Co from and after the Revenue Service Availability Date, whether or not such additional light rail transit vehicles are purchased from the Maintenance Contractor or any other third party.

(c) "**Additional Vehicles Termination Date**" has the meaning given to it in Section 8.1(b) of this Attachment 35.

(d) "**Bill of Sale**" has the meaning given to it in Section 2.1(c)(iv)(A) of this Attachment 35.

(e) "**Cancelled Vehicles**" has the meaning given to it in Section 2.7(b)(i) of this Attachment 35.

(f) "**Default Event**" has the meaning given to it in Section 2.1(c)(iv)(A) of this Attachment 35.

(g) "**Default Notice**" has the meaning given to it in Section 2.1(c)(iv)(A) of this Attachment 35.

(h) "**Deliver**" or "**Delivery**" means that the Maintenance Contractor delivers the Additional Vehicles purchased by Project Co pursuant to and in accordance with this Attachment 35 to the Designated Site on the Delivery Date in a manner as requested by Project Co.

(i) "**Delivery Date**" 30 months following the date when an Option Notice (as defined under Schedule 35 to the Project Agreement) is given by the City to Project Co in accordance with section 2.1(c) of Schedule 35 to the Project Agreement, upon which date the Maintenance Contractor shall be required to deliver the Additional Vehicles to a Designated Site.

(j) "**Designated Site**" means a site in the City of Ottawa as designated by Project Co to which the Maintenance Contractor is required to deliver the Additional Vehicles.

(k) "**Included Upgrade**" has the meaning given to it in Section 2.3(b) of this Attachment 35.

(l) "**Maintenance Contractor Additional Vehicles**" means the Additional Vehicles which are purchased by Project Co from the Maintenance Contractor pursuant to this Attachment 35.

(m) "**Maximum Order**" means the maximum number of the Additional Vehicles that Project Co shall be entitled to by way of the Option to Purchase in each year during the MC Option Term pursuant to Section 2.2(c) of this Attachment 35.

(n) "**MC Additional Vehicles Agreement**" has the meaning given to it in Section 8.1(a) of this Attachment 35.

(o) "**MC Option Term**" means the period beginning on the second anniversary of the Revenue Service Availability Date and ending, if later, seven (7) years following Financial Close. For greater certainty, if seven (7) years following Financial Close falls earlier than the second anniversary of the Revenue Service Availability Date, there will be no MC Option Term.

(p) "**MC Request**" has the meaning given to it in Section 2.8(b) of this Attachment 35.

(q) "**Minimum Order**" means the minimum number of the Additional Vehicles that Project Co shall be entitled to by way of the Option to Purchase in each year during the MC Option Term pursuant to Section.2.2(b) of this Attachment 35.

(r) "**Non-Maintenance Contractor Additional Vehicles**" means the Additional Vehicles which are purchased by the City or Project Co from a third party other than the Maintenance Contractor pursuant to Schedule 35 to the Project Agreement or this Attachment 35.

(s) "**Option Notice**" has the meaning given to it in Section 2.1(c)(i) of this Attachment 35.

(t) "**Option to Purchase**" refers to the option described in Section 2.1(a) of this Attachment 35

(u) "**Prime Rate**" means on any day, the annual rate of interest announced by the Royal Bank of Canada (or its successor), or any Canadian chartered bank agreed by the City and Project Co under the terms of the Project Agreement, from time to time as its reference rate then in effect for determining interest rates on Canadian dollar commercial loans made by it in Canada.

(v) "**Required Upgrade**" has the meaning given to it in Section 2.3(b) of this Attachment 35.

(w) "**Service Level Increase Additional Vehicle Delivery Delay**" has the meaning given in Section 2.7(c) of this Attachment 35.

(x) "**Vehicle Long Stop Date**" means 6 months following the Delivery Date.

(y) "**Vehicle Option Supplier**" means Thales Canada Inc. and Alstom Power & Transport Canada Inc.

(z) "**Vehicle Unit Price**" means the price per Additional Vehicle, as follows:

[Redacted]

PART 2
OPTION TO PURCHASE

2.1 Project Co's Option to Purchase

(a) The Maintenance Contractor acknowledges the provisions of section 2.1 of Schedule 35 to the Project Agreement and agrees that, if the City exercises its option under that section during the MC Option Term, then Project Co shall be entitled to purchase from the Maintenance Contractor Additional Vehicles and require such Additional Vehicles be delivered by the Maintenance Contractor to the Designated Site on the Delivery Date.

(b) The Additional Vehicles that are purchased by Project Co pursuant to Section 2.1(a) of this Attachment 35 may, at Project Co's option, be used for the System and any System Extension.

(c) Option to Purchase:

(i) The Option to Purchase shall be exercised by written notice (an "**Option Notice**") given by Project Co to the Maintenance Contractor at any time during the MC Option Term in accordance with Part 2 Section 61.

(ii) An Option Notice shall specify the number of the Additional Vehicles that Project Co wishes to purchase from the Maintenance Contractor, the Designated Site, additional storage area, maintenance requirements, upgrades to Train Control System (if any), Traction Power and other issues relating to integration of Additional Vehicles into the System.

(iii) Upon delivery of a relevant Option Notice in accordance with the foregoing provision there shall be deemed to be a binding agreement of purchase and sale between Project Co (or, if Project Co directs, the City) as purchaser and the Maintenance Contractor as vendor in respect of the Additional Vehicles. The terms and conditions of the agreement of purchase and sale of such Additional Vehicles shall be in accordance with this Attachment 35 or the terms otherwise provided in this Agreement not in conflict with this Attachment 35.

(iv) The purchase of the Additional Vehicles resulting from the exercise of the Option to Purchase shall be completed upon the Closing Date.

(A) The Maintenance Contractor shall execute and deliver to Project Co (or, if Project Co so directs, to the City) a bill of sale for the Additional Vehicles, in form and content satisfactory to Project Co (acting reasonably) and the City (the "**Bill of Sale**") on the Closing Date, in which the Maintenance Contractor:

(1) represents and warrants that:

(I) the Maintenance Contractor is at the time of the delivery of such Bill of Sale rightfully and absolutely entitled to the Additional Vehicles;

(II) the Maintenance Contractor at such time has good right, title and authority to grant, bargain, sell, assign, transfer, convey and set over to Project Co (or, if Project Co directs, the City) the Additional Vehicles; and

(III) Project Co (or, if Project Co directs, the City) shall immediately on the execution and delivery of such Bill of Sale have possession of and peaceably and quietly have, hold, possess and enjoy the Additional Vehicles to and for its own use and benefit without any manner of hindrance, interruption, molestation, claim or demand whatsoever of, from or by the Maintenance Contractor or any person whomsoever and with good title thereto, free and clear and absolutely released and discharged from and against all former and other bargains, sales, gifts, grants, mortgages, pledges, security interests, adverse claims, liens, charges and encumbrances of any nature or kind whatsoever;

(2) grants, bargains, sells, assigns, transfers, conveys and sets over to Project Co (or, if Project Co directs, the City) absolutely, all of the Maintenance Contractor's right, title and interest in and to the Additional Vehicles, subject to the provisions of Attachment 41 – MC Intellectual Property; and

(3) covenants and agrees with Project Co that it will from time to time and at all times at the Maintenance Contractor's expense, on every reasonable request of Project Co make, do and execute or cause and procure to be made, done and executed all further acts, deeds or assurances as may be reasonably required by Project Co, whether for more effectually and completely vesting in Project Co (or, if Project Co directs, in the City) the Additional Vehicles in accordance with the terms of such Bill of Sale or for the purpose of registration or otherwise.

(B) On the Closing Date, the Maintenance Contractor shall provide Project Co and the City with access to and copies of the Additional Vehicle manuals, certificates, log books and other applicable records relating to the relevant Additional Vehicles in the possession or control of the Maintenance Contractor. All such manuals, certificates, log books and records will be maintained by the Maintenance Contractor at the MSF administration building.

(C) On the Closing Date, the Maintenance Contractor shall obtain the warranties with respect to the relevant Additional Vehicles contained in Schedule 34 to the Project Agreement.

(v) The Maintenance Contractor acknowledges the provisions of section 2.1(c)(vi) of Schedule 35 to the Project Agreement. If the Additional Vehicles are encumbered by any encumbrances contrary to Part 2 Section 29.5 or the Maintenance Contractor fails to perform any covenant on its part herein contained, Project Co may in its Discretion, without derogation from its right respecting any Maintenance Contractor Event of Default as provided for in this Agreement, on prior written notice to the Maintenance Contractor (the "**Default Notice**"), perform any such covenant capable of being performed by Project Co or arrange for the encumbrance to be discharged (any such event, a "**Default Event**") and if the Default Event requires the payment or expenditure of money, Project Co may make such payment or expenditure and all sums so expended (including amounts expended by Project Co to the City pursuant to section 2.1(c)(vi) of Schedule 35 to the Project Agreement as a result of the City exercising its rights under such section due to a failure by the Maintenance Contractor under this Section) shall be forthwith payable by the Maintenance Contractor to Project Co with the Default Interest Rate thereon until paid and Project Co may deduct and set-off any such amount against the purchase price payable on the Closing Date The Parties agree that the Closing Date shall be extended by such period of time as Project Co (or the City pursuant to section 2.1(c)(vi) of Schedule 35 to the Project Agreement) determines is necessary for the purposes of Project Co or the City curing such Default Event prior to the Closing Date.

(vi) Each of the parties shall execute and deliver all such other further documents and do such other things as the other party may reasonably request to give full effect to this Section 2.1.

(d) Upon the commencement of the MC Option Term, Project Co shall assign, or direct the Construction Contractor to assign, and the Maintenance Contractor shall accept the assignment of, all of the Construction Contractor's rights to exercise the Option to Purchase and its obligations vis-à-vis the Vehicle Option Supplier. The assignment referred to in the foregoing sentence shall, subject to any adjustment of the Vehicle Handover Date (as defined in the Interface Agreement) pursuant to the Interface Agreement with respect to any Additional Vehicles, include any supply contracts, performance security and other agreements with respect to the purchase of Additional Vehicles for which any Option to Purchase has already been exercised, each of which supply contracts, performances security and other agreements shall be assigned concurrently to the Maintenance Contractor Project Co shall not, prior to the commencement of the MC Option Term, permit the Construction Contractor to vary, amend, change or waive the agreements with the Vehicle Option Suppliers without the prior written consent of the Maintenance Contractor, not to be unreasonably withheld or delayed. The Maintenance Contractor shall not vary, amend, change or waive the

agreements with the Vehicle Option Suppliers without the prior written consent of Project Co and shall keep such agreements in good standing for the entirety of the MC Option Term. Upon receipt of the Option Notice, the Maintenance Contractor shall exercise its rights and perform all necessary acts under its agreement with the Vehicle Option Suppliers to give full effect to Project Co's Option to Purchase under this Section 2.1.

2.2 The Number of the Additional Vehicles

(a) The number of the Additional Vehicles with respect to which the Option to Purchase is exercised pursuant to Section 2.1 of this Attachment 35 for each year of the MC Option Term shall take into account of the spare vehicles required to provide the necessary spare vehicle capacity to allow the Maintenance Contractor to conduct MC Maintenance Services in accordance with Schedule 15-3 to the Project Agreement (the "**Additional Maintenance Spare Vehicles**"). For the purpose of this Section 2.2, where the calculation for the required Additional Maintenance Spare Vehicles pursuant to Project Co's Response produces a fraction, such fraction shall not be taken into account in determining the number of required Additional Maintenance Spare Vehicles.

(b) The Minimum Order that Project Co shall have the right to place by way of the Option to Purchase from the Maintenance Contractor pursuant to Sections 2.1 of this Attachment 35 for each year of the MC Option Term shall be equal to one (1) train consists (provided that the City exercises it corresponding Minimum Order pursuant to Schedule 35 to the Project Agreement).

(c) The Maximum Order that Project Co shall have the right to place by way of the Option to Purchase from the Maintenance Contractor pursuant to Section 2.1 of this Attachment 35 for each year of the MC Option Term shall be equal to three (3) train consists (provided that, for greater certainty, Project Co shall not place orders for more Additional Vehicles than the /City orders pursuant to Schedule 35 to the Project Agreement). Notwithstanding the Maximum Order permitted in an annual period, Project Co shall also be entitled to order Additional Maintenance Spare Vehicles required in accordance with Section 2.2(a) of this Attachment 35 in such year.

2.3 Output Specifications of Additional Vehicles

(a) Subject to Section 2.3(b) of this Attachment 35 and Section 2.3(c) of this Attachment 35, the Additional Vehicles purchased by Project Co pursuant to Section 2.1(a) of this Attachment 35 shall be manufactured in accordance with the Output Specifications provided for in Schedule 15-2 of the Project Agreement.

(b) In the event that there are any improvements or upgrades required for the System in accordance with Schedule 15 to the Project Agreement which do not result in a Variation (a "**Required Upgrade**"), or there are any improvements or upgrades included in the basic model of the Vehicles (an "**Included Upgrade**"), the Maintenance Contractor shall ensure that the Additional Vehicles are upgraded to conform to any Required Upgrade or

Included Upgrade, and that all associated equipment and interfaces are tested to accommodate such upgrades, without further costs to Project Co or the City.

(c) The Maintenance Contractor acknowledges the provisions of section 2.3(c) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 related to Equivalent Project Relief shall apply. In the event that the Variation Procedure applies pursuant to section 2.3(c) of Schedule 35 to the Project Agreement, the Maintenance Contractor shall provide Project Co with any information requested by Project Co in order to fulfil its obligations to the City under such section.

2.4 Price of Additional Vehicles

(a) Subject to the provisions of this Section 2.4 of this Attachment 35 and section 2.3(c) of Schedule 35 to the Project Agreement providing otherwise, the price of each of the Additional Vehicles to be purchased by Project Co pursuant to Section 2.1(a) of this Attachment 35 shall be the Vehicle Unit Price.

(b) The Maintenance Contractor acknowledges the provisions of section 2.4(b) of Schedule 35 to the Project Agreement and agrees that there shall be no price escalation or reduction for the MC Option Term except to the extent that price escalation or reduction is permitted pursuant to such section.

2.5 Payment of Price of Additional Vehicles

(a) In respect of each of the Additional Vehicles purchased by Project Co on behalf of the City pursuant to and in accordance with Part 2 of this Attachment 35, Project Co shall make the payments referred to in section 2.5(a) of Schedule 35 to the Project Agreement to the Maintenance Contractor within 5 Business Days of receipt of same from the City.

2.6 Commissioning of Additional Vehicles

(a) The Maintenance Contractor acknowledges and agrees that the Additional Vehicles as purchased by the City pursuant to Part 2 of Schedule 35 to the Project Agreement or by Project Co pursuant to Part 2 of this Attachment 35 that are delivered following the second anniversary of the Revenue Service Availability Date shall be tested and commissioned by the Maintenance Contractor in accordance with Schedule 14 to the Project Agreement.

2.7 Maintenance Contractor's Failure to Deliver

(a) Subject to Section 2.7(c) of this Attachment 35, if the Maintenance Contractor shall fail to Deliver the Additional Vehicles on the Delivery Date or shall cause a failure to Deliver the Additional Vehicles on the Delivery Date and liquidated damages are levied by the City pursuant to section 2.7(c) of Schedule 35 to the Project Agreement, the Maintenance Contractor shall pay such liquidated damages to Project Co immediately upon demand. Such amount of liquidated damages shall constitute Project Co's sole entitlement to

damages from the Maintenance Contractor in respect of a failure to deliver the Additional Vehicles on the Delivery Date.

(b) If the Maintenance Contractor shall fail to Deliver the Additional Vehicles by the Vehicle Long Stop Date, Project Co shall have the right to:

(i) cancel the exercised Option to Purchase the undelivered Additional Vehicles by written notice to the Maintenance Contractor (the "**Cancelled Vehicles**"), in which event, without derogation from Project Co's right under Section 2.7(a) of this Attachment 35 or Section 2.7(c) of this Attachment 35, as the case may be, Project Co shall be entitled to a refund of the payments that Project Co has made up until the Vehicle Long Stop Date in respect of such Cancelled Vehicles, together with the Default Interest Rate thereon.

or,

(ii) without derogation from Project Co's right under Section 2.7(a) of this Attachment 35 or Section 2.7(c) of this Attachment 35, as the case may be, proceed with the exercised Option to Purchase by written notice to the Maintenance Contractor in accordance with the terms and conditions set out herein.

(c) Notwithstanding Section 2.7(a) of this Attachment 35, where Project Co has caused the Maintenance Contractor to acquire Additional Vehicles under the provisions of this Attachment 35 in order to implement a Service Level Increase, and the Maintenance Contractor has failed or has determined that it will fail to achieve the delivery, commissioning, and assimilation into the vehicle fleet of the Additional Vehicles by the Service Level Increase Date so as to effect the required Service Level Increase or shall cause a failure to achieve the delivery, commissioning, and assimilation into the vehicle fleet of the Additional Vehicles by the Service Level Increase Date so as to effect the required Service Level Increase ("**Service Level Increase Additional Vehicle Delivery Delay**"),

(i) if liquidated damages are levied by the City pursuant to section 2.7(c) and (d) of Schedule 35 to the Project Agreement, pay such liquidated damages to Project Co immediately upon demand; or

(ii) with Project Co's consent, not to be unreasonably withheld, confirm that Project Co will, at the Maintenance Contractor's cost, provide the required Service Level Increase using Project Co's existing vehicle fleet, on a temporary basis, during the period of Service Level Increase Additional Vehicle Delivery Delay, in which case the Maintenance Contractor shall be responsible for any costs incurred by Project Co as a result of such performance, including without limitation any applicable penalties under the Project Agreement for failure to do so, including Schedule 20 to the Project Agreement;

or

(iii) with Project Co's consent, not to be unreasonably withheld, where Project Co can partially provide the required Service Level Increase using Project Co's existing vehicle fleet on a temporary basis during the period of Service Level Increase Additional Vehicle Delivery Delay, a combination of the foregoing subparagraphs (i) and (ii) will apply.

For greater certainty, the Maintenance Contractor acknowledges that the amount of the Liquated Damages for Service Level Increase Additional Vehicle Delivery Delay as provided for in section 2.7(c) and 2.7(d) of Schedule 35 to the Project Agreement together with any amount payable to Project Co under Section 2.7(c)(ii) of this Attachment 35 shall constitute Project Co's sole entitlement to damages in respect of a failure of the Maintenance Contractor to deliver the Additional Vehicles on the Service Level Increase Date as required in this Section 2.7(c)

(d) The Maintenance Contractor acknowledges the provisions of section 2.7(d) of Schedule 35 to the Project Agreement.

(e) In the event that Project Co shall cancel the exercised Option to Purchase with respect to the undelivered Additional Vehicles pursuant to Section 2.7(b)(i) of this Attachment 35, Project Co shall have the right to exercise an Option to Purchase in respect of such Cancelled Vehicles in the next option period.

(f) Part 2 Section 2.7 does not derogate from any of the Maintenance Contractor's obligations as set out in Part 5 of this Attachment 35.

2.8 Canadian Content

(a) For clarification, except as provided in Section 2.8(b), there shall be no obligation on the Maintenance Contractor to comply with the Canadian Content Requirements with respect to Additional Vehicles delivered to Project Co (or the City) pursuant to the exercise of the Option to Purchase.

(b) Notwithstanding Section 2.8(a), if the City requires compliance with the Canadian Content Requirements pursuant to section 2.8 of Schedule 35 to the Project Agreement, Project Co shall require compliance with the Canadian Content Requirements (a "**MC Request**"), with respect to any Additional Vehicles purchased pursuant to the Option to Purchase in this Attachment 35 by including the MC Request with the Option Notice. In such event the Canadian Content Requirements shall be deemed to be a MC Variation and the provisions respecting MC Variations in this Agreement and Attachment 22 – MC Variation Procedure shall be applicable to the Additional Vehicles that are the subject matter of the MC Request.

PART 3
NEGOTIATED PURCHASE OF ADDITIONAL VEHICLES

3.1 Negotiated Purchase

(a) During and after the MC Option Term, Project Co shall have the right to negotiate with the Maintenance Contractor to purchase Additional Vehicles in accordance with Part 3 of this Attachment 35.

(b) The Additional Vehicles that are purchased by Project Co pursuant to Section 3.1(a) of this Attachment 35 may, at Project Co's option, be used for the System and any System Extension.

3.2 Output Specifications of Additional Vehicles

(a) Subject to Section 3.2(c) of this Attachment 35, the Additional Vehicles purchased pursuant to Section 3.1(a) of this Attachment 35 shall be manufactured in accordance with the Output Specifications provided for in Schedule 15-2 to the Project Agreement, or as otherwise agreed upon by Project Co and the Maintenance Contractor during the negotiation.

(b) In the event that there are any Required Upgrades or Included Upgrades, the Maintenance Contractor shall ensure that the Additional Vehicles are upgraded to conform to such Required Upgrades or Included Upgrades, and that all associated equipment and interfaces are tested to accommodate such upgrades, without further costs to Project Co or the City.

(c) The Maintenance Contractor acknowledges the provisions of section 2.3(c) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 related to Equivalent Project Relief shall apply. In the event that the Variation Procedure applies pursuant to section 3.2(c) of Schedule 35 to the Project Agreement, the Maintenance Contractor shall provide Project Co with any information requested by Project Co in order to fulfil its obligations to the City under such section.

3.3 Price of Additional Vehicles

(a) The price of each of the Additional Vehicles purchased by Project Co pursuant to Section 3.1(a) of this Attachment 35 shall be negotiated by Project Co (and, if Project Co directs, the City) and the Maintenance Contractor.

3.4 Commissioning of Additional Vehicles

(a) The Maintenance Contractor acknowledges and agrees that the Additional Vehicles as purchased by the City pursuant to Part 3 of Schedule 35 to the Project Agreement or by Project Co pursuant to Part 3 of this Attachment 35 that are delivered from and after the

Revenue Service Availability Date shall be tested and commissioned by the Maintenance Contractor in accordance with Schedule 14 to the Project Agreement.

PART 4
VEHICLE PROCUREMENT

4.1 City's Right to Procure

(a) The Maintenance Contractor acknowledges that, during and after the MC Option Term, the City shall have the right to procure any Additional Vehicles from a provider other than Project Co and that the City may use any form of competitive procurement, sole-source contract, or other procurement methodology or transaction structure. At its option, the City may bundle the Option to Purchase in respect of the Additional Vehicles with other procurement processes.

4.2 Consulting Service

(a) The Maintenance Contractor acknowledges the provisions of section 4.2(a) of Schedule 35 to the Project Agreement. If the City exercises its right under such section to retain Project Co as consultant in procuring the Additional Vehicles procured pursuant to section 4.1(a) of Schedule 35 to the Project Agreement, Project Co may retain the Maintenance Contractor to perform certain of Project Co's obligations as consultant to the City pursuant to this Section 4.2.

(b) In the event that Project Co shall desire to consider retaining the Maintenance Contractor as consultant in procuring the Additional Vehicles pursuant to Section 4.1(a) of this Attachment 35, Project Co shall provide the Maintenance Contractor with a written notice which shall include the following information:

(i) a description of the Additional Vehicles the City wishes to procure including the number, model, preliminary output specifications and other significant features of the Additional Vehicles; and

(ii) a preliminary plan and anticipated timelines for procurement of the Additional Vehicles.

(c) Within a period of 12 days after the date of receipt of the notice provided for in Section 4.2(b) of this Attachment 35, the Maintenance Contractor shall deliver to Project Co its written response advising Project Co an estimate of the consulting fee it will charge for the consulting services to be provided in respect of such Additional Vehicles, with reasonable details to support such estimate.

(d) Project Co shall within a period of 20 days after the date of receipt of the Maintenance Contractor's response as provided for in Section 4.2(c) of this Attachment 35, deliver a written notice notifying the Maintenance Contractor whether or not Project Co shall wish

to retain the Maintenance Contractor for providing the consulting service respecting such Additional Vehicles.

(e) In the event that Project Co shall wish to retain the Maintenance Contractor for providing the consulting service respecting such Additional Vehicles by giving the notice as provided for in Section 4.2(d) of this Attachment 35, then upon delivery and receipt of such notice, Project Co and the Maintenance Contractor shall, in good faith and acting reasonably, negotiate the terms of a binding agreement for the performance of the consulting services in respect of procuring the Additional Vehicles pursuant to and in accordance with Section 4.2 of this Attachment 35 provided that such agreement shall not be binding unless the City also accepts Project Co's proposal for consulting services pursuant to Schedule 35 to the Project Agreement.

4.3 Maintenance Contractor's Obligation to Assist

(a) In the event that the City shall retain a third-party consultant in procuring the Additional Vehicles pursuant to Section 4.2(a) of this Attachment 35, subject to the provisions in Attachment 41 - MC Intellectual Property, the Maintenance Contractor shall provide assistance to Project Co (or, at Project Co's direction, the City) as reasonably required by Project Co and, subject to the provisions of Part 1 relating to Equivalent Project Relief, at the City's cost, which assistance shall include without limitation:

(i) providing all necessary information and access to Fixed Facilities, E&M, MSF, and Vehicles in order to allow the City to develop appropriate technical specifications for the Additional Vehicles; and

(ii) other assistance reasonably requested by Project Co.

(b) In the event that Project Co shall retain the Maintenance Contractor as consultant in procuring the Additional Vehicles pursuant to Section 4.2(a) of this Attachment 35 and the City retains Project Co as consultant pursuant to section 4.2(d) of Schedule 35 to the Project Agreement, subject to payment by Project Co (upon receipt of same from the City) of the consulting fees as agreed upon by Project Co and the Maintenance Contractor pursuant to Section 4.2(b) of this Attachment 35, and the provisions in Attachment 41 – MC Intellectual Property, the Maintenance Contractor shall provide assistance to Project Co (or at Project Co's direction, the City) as reasonably required by Project Co, which assistance shall include without limitation:

(i) assistance in development of vehicle specifications and evaluation of vehicle designs to ensure compatibility with existing Fixed Facilities, E&M, MSF and maintenance practices of the Maintenance Contractor;

(ii) providing all necessary information and access to Fixed Facilities, E&M, MSF, and Vehicles in order to allow Project Co and the City to develop appropriate technical specifications for the Additional Vehicles;

(iii) advising Project Co, and at Project Co's request, the City, on development of a Lifecycle Maintenance Plan, to be developed in conjunction with other supplier(s) that will include a schedule of lifecycle maintenance and major component replacement and a budget for carrying out such work;

(iv) advising Project Co, and at Project Co's request, the City, on potential modifications that will result in maintenance cost savings guaranteed by the Maintenance Contractor, which savings shall be shared by the City and Project Co equally pursuant to section 4.3(b)(iv) of the Project Agreement. Project Co's share of any such savings shall, pursuant to the provisions of Part 1 related to Equivalent Project Relief, be provided by Project Co to the Maintenance Contractor;

(v) participation in testing, commissioning, acceptance process and Configuration Management for all Additional Vehicles delivered from and after the Revenue Service Availability Date; and

(vi) other assistance reasonably requested by Project Co including liaising with the Construction Contractor, as required.

4.4 Commissioning of Non- Maintenance Contractor Additional Vehicles

(a) In the event that Project Co shall retain the Maintenance Contractor as consultant in procuring the Additional Vehicles pursuant to Section 4.2(a) of this Attachment 35 and the City retains Project Co as consultant pursuant to section 4.2(a) of Schedule 35 to the Project Agreement, at Project Co's option, the Non-Maintenance Contractor Additional Vehicles as procured by Project Co pursuant to Part 4 of this Attachment 35 shall, if such Non-Maintenance Contractor Additional Vehicles are delivered from and after the Revenue Service Availability Date, be tested and commissioned by the Maintenance Contractor in accordance with Schedule 14 to the Project Agreement.

4.5 Liquidated Damages

(a) The provisions respecting liquidated damages in Section 2.7 of this Attachment 35 shall apply to Non- Maintenance Contractor Additional Vehicles if, and only if, the delivery delay as provided for Section 2.7 of this Attachment 35 results from the Maintenance Contractor's failure to carry out commissioning activities in accordance with Schedule 14 to the Project Agreement.

PART 5
MAINTENANCE SERVICES OF ADDITIONAL VEHICLES

5.1 Obligation of the Maintenance Contractor to Maintain

(a) Project Co may at its option require the Maintenance Contractor to be fully responsible for providing MC Maintenance Services for the Additional Vehicles purchased during the

MC Maintenance Term pursuant to this Attachment 35, including without limitation, the Non-Maintenance Contractor Additional Vehicles.

(b) In the event that the City shall require Project Co to provide Maintenance Services for the Additional Vehicles pursuant to Section 5.1(a) of this Attachment 25, provisions in Schedule 15-3 to the Project Agreement shall apply in respect of the Additional Vehicles, including without limitation, the provisions relating to maintenance reporting on the status and details of completion of various maintenance activities in respect of the Additional Vehicles.

5.2 Service Level Increase

(a) The Maintenance Contractor acknowledges that, where the Maintenance Contractor is required to provide MC Maintenance Services for any Additional Vehicles pursuant to Section 5.1 of this Attachment 35, due to a Major Service Change in accordance with Article 3 of Schedule 15-3 to the Project Agreement, Project Co's Annual Service Payment and Volume Payment shall be adjusted in accordance with Article 3 of Schedule 15-3 to the Project Agreement, in which case, subject to the provisions of Part 1 related to Equivalent Project Relief, there shall be a corresponding adjustment to the Maintenance Contractor Annual Service Payment and the Volume Payment under Attachment 20 - MC Payment Mechanism.

(b) Subject to Section 5.3(a) of this Attachment 35, the Maintenance Contractor shall have no other entitlement for any additional payment in respect of MC Maintenance Services provided to the Additional Vehicles pursuant to Section 5.1 of this Attachment 35 due to a Major Service Change, save and except for that provided for in Section 5.2(a) of this Attachment 35.

5.3 Additional Payments to the Maintenance Contractor

(a) The Maintenance Contractor acknowledges the provisions of section 5.3(a) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 related to Equivalent Project Relief shall apply. In the event that the Variation Procedure applies pursuant to section 5.3(a) of Schedule 35 to the Project Agreement, the Maintenance Contractor shall provide Project Co with any information requested by Project Co in order to fulfil its obligations to the City under such section.

PART 6
ADJUSTMENT OF LIFECYCLE PAYMENTS

6.1 Lifecycle Maintenance Services

(a) In the event that Project Co shall require the Maintenance Contractor to be fully responsible for providing MC Maintenance Services for any Additional Vehicles pursuant to Section 5.1 of this Attachment 35, the provisions in respect of lifecycle

maintenance services in Schedule 15-3 to the Project Agreement shall apply to such Additional Vehicles.

6.2 Option to Purchase

(a) Where, prior to the second anniversary of the Revenue Service Availability Date, the City purchases any Additional Vehicles by way of exercising its option pursuant to section 2.1(a) of Schedule 35 to the Project Agreement (in which case, Project Co shall promptly notify the Maintenance Contractor of the same), or, following the second anniversary of the Revenue Service Availability Date, Project Co purchases any Additional Vehicles by way of exercising its option pursuant to Section 2.1(a) of this Attachment 35, in either case subject to Section 6.2(b) of this Attachment 35, the Maintenance Contractor shall propose, and the Parties shall agree, on appropriate amendments to the schedule of Lifecycle Payments set out in Schedule 20 to the Project Agreement and the corresponding schedule of MC Lifecycle Payments set out in Attachment 20 - MC Payment Mechanism, taking into account of lifecycle costs for the Additional Vehicles that occur within the Maintenance Term.

(b) The Maintenance Contractor acknowledges the provisions of section 6.2(b) of Schedule 35 to the Project Agreement, and agrees that the Maintenance Contractor's proposed amendments to the Lifecycle Payments schedule to Schedule 20 to the Project Agreement and to the MC Lifecycle Payments as provided for in Section 6.2(a) of this Attachment 35 shall be based on a lifecycle cost curve identical in real dollar terms to the lifecycle cost curve for Vehicles contained in Project Co's financial model (PA Schedule 35 Lifecycle Info, columns D and E) at Financial Close, as amended from time to time.

(c) The Maintenance Contractor acknowledges the provisions of section 6.2(c) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 related to Equivalent Project Relief shall apply, and for greater certainty, subject to the provisions of Part 1 related to Equivalent Project Relief, any adjustment of the Lifecycle Payment pursuant to section 6.2(c) of Schedule 35 to the Project Agreement shall result in a corresponding adjustment in the MC Lifecycle Payments.

6.3 Negotiated Purchase of Additional Vehicles

(a) Where, prior to the Revenue Service Availability Date, the City purchases any Additional Vehicles by way of negotiating a purchase pursuant to section 3.1(a) of Schedule 35 to the Project Agreement (in which case, Project Co shall promptly notify the Maintenance Contractor of the same), or, following the Revenue Service Availability Date, Project Co purchases any Additional Vehicles by way of negotiating purchase pursuant to Section 3.1(a) of this Attachment 35, in either case subject to Section 6.3(b) of this Attachment 35, the Maintenance Contractor shall propose, and the Parties shall agree, amendments to the schedule of Lifecycle Payments set out in Schedule 20 to the Project Agreement and the corresponding schedule of MC Lifecycle Payments set out in Attachment 20 - MC Payment Mechanism, taking into account of lifecycle costs for the Additional Vehicles that occur within the Maintenance Term, any such agreement being subject to agreement

by the City (as relates to the of Lifecycle Payment set out in Schedule 20 to the Project Agreement) pursuant to section 6.3(a) of Schedule 35 to the Project Agreement. Project Co shall seek to agree any such agreed amendments to the schedule of Lifecycle Payments set out in Schedule 20 to the Project Agreement with the City pursuant to section 6.3(a) of Schedule 35 to the Project Agreement.

(b) The Maintenance Contractor acknowledges the provisions of section 6.3(b) of Schedule 35 to the Project Agreement, and agrees that the Maintenance Contractor's proposed amendments to the Lifecycle Payments schedule to Schedule 20 to the Project Agreement and to the MC Lifecycle Payments schedule as provided for in Section 6.3(a) of this Attachment 35 shall be presumptively based on a lifecycle cost curve identical in real dollar terms to the lifecycle cost curve for the Vehicles contained in Project Co's financial model at Financial Close, as amended from time to time. Any variations must be demonstrated by the Maintenance Contractor, to the reasonable satisfaction of Project Co and the City, with specific references to unique features of the Additional Vehicles which require a different lifecycle maintenance approach.

(c) The Maintenance Contractor acknowledges the provisions of section 6.3(c) of Schedule 35 to the Project Agreement, in respect of which the provisions of Part 1 relating to Equivalent Project Relief shall apply, and for greater certainty, subject to the provisions of Part 1 related to Equivalent Project Relief, any adjustment of the Lifecycle Payment pursuant to section 6.3(c) of Schedule 35 to the Project Agreement shall result in a corresponding adjustment in the MC Lifecycle Payments.

6.4 Procurement of Non-Maintenance Contractor Additional Vehicles

(a) Where the City exercises its option to procure any Non-Project Co Additional Vehicles pursuant to section 4.1(a) of Schedule 35 to the Project Agreement (which, for greater certainty, may occur prior to the Revenue Service Availability Date), Project Co shall promptly notify the Maintenance Contractor, and the Maintenance Contractor shall propose, and the Parties shall agree on a Lifecycle Maintenance Plan in respect of such Non-Project Co Additional Vehicles, any such agreement being subject to agreement by the City pursuant to section 6.4(a) of Schedule 35 to the Project Agreement. Project Co shall seek to agree any such agreed Lifecycle Maintenance Plan with the City pursuant to section 6.4(a) of the Project Agreement, which, if agreed with the City, will result in a Variation in accordance with the Project Agreement and Schedule 22 to the Project Agreement, and shall result in an MC Variation in accordance with this Agreement and Attachment 22 - MC Variation Procedure.

(b) The Maintenance Contractor and Project Co shall agree on appropriate amendments to the schedule of Lifecycle Payments set out in Schedule 20 to the Project Agreement and corresponding amendments to the schedule of MC Lifecycle Payments set out in Attachment 20 - MC Payment Mechanism, taking into account:

(i) the lifecycle costs for the Non-Project Co Additional Vehicles that occur within the Maintenance Term, as budgeted for in the Lifecycle Maintenance Plan and agreed to by the City; and

(ii) subject to the provisions of Part 2 relating to Equivalent Project Relief, the City shall be responsible for lifecycle costs for the Additional Vehicles that occur beyond the Maintenance Term,

any such agreement being subject to agreement by the City pursuant to section 6.4(b) of Schedule 35 to the Project Agreement.

Project Co shall, pursuant to section 6.4(b) of Schedule 35 to the Project Agreement, seek to agree on any such agreed amendments to the schedule of Lifecycle Payments set out in Schedule 20 to the Project Agreement pursuant to section 6.4(b) of Schedule 35 to the Project Agreement as have been agreed between the Maintenance Contractor and Project Co pursuant to this Section 6.4(b).

PART 7
HANDOVER MAINTENANCE OF ADDITIONAL VEHICLES

7.1 Handover Maintenance Services

(a) In the event that Project Co shall require the Maintenance Contractor to be fully responsible for providing MC Maintenance Services for any Additional Vehicles pursuant to Section 5.1 of this Attachment 35, the provisions in respect of Handover Maintenance services in Schedule 15-3 to the Project Agreement shall apply to such Additional Vehicles, including without limitation, the provisions relating to the Handover Maintenance Period, subject to reasonable adjustment based upon the proportionate age and usage of the Additional Vehicles in relation to the Vehicles, as determined by Project Co and the City, acting reasonably.

PART 8
TERMINATION OF PROJECT AGREEMENT OR MAINTENANCE CONTRACT

8.1 Termination of Project Agreement or Maintenance Contract

(a) In the event that this Agreement is terminated pursuant to and in accordance with the provisions thereof (whether or not as a result of termination of the Project Agreement), and at that time Project Co has exercised its Option to Purchase pursuant Section 2.1 of this Attachment 35 or otherwise there shall have been a binding agreement between Project Co and the Maintenance Contractor for Project Co to purchase Additional Vehicles from the Maintenance Contractor in accordance with this Attachment 35, (collectively, the "**MC Additional Vehicles Agreement**"), the provisions of this Section 8.1 shall apply.

(b) If the Project Agreement is terminated as a result of a City Event of Default or the exercise of the City's right to terminate for convenience pursuant to section 47.3 of the Project Agreement, and this Agreement is correspondingly terminated pursuant to Part 2 Section 47.4(a):

(i) Project Co shall agree with the Maintenance Contractor, each acting reasonably, prior to exercising its right under section 8.1(b) of Schedule 35 to the Project Agreement either to continue to carry out the Additional Vehicles Agreement or terminate the Additional Vehicles Agreement by giving the City a written notice within thirty (30) days following the termination of the Project Agreement effective immediately (the "**Additional Vehicles Termination Date**");

(ii) in the event that Project Co shall elect to carry out the Additional Vehicles Agreement pursuant to section 8.1(b) of Schedule 35 to the Project Agreement, Project Co shall notify the City accordingly, and the Maintenance Contractor shall continue to carry out the corresponding MC Additional Vehicles Agreement, and the provisions of this Attachment 35 and the MC Additional Vehicles Agreement shall apply; and

(iii) in the event that Project Co shall elect to terminate the Additional Vehicles Agreement pursuant to section 8.1(b) of Schedule 35 to the Project Agreement, Project Co shall notify the Maintenance Contractor accordingly and the corresponding MC Additional Vehicles Agreement shall terminate, and Project Co shall be entitled to refund of the payments that Project Co has made in respect of the MC Additional Vehicles on the Additional Vehicles Termination Date.

(c) If the Project Agreement is terminated as a result of neither a City Event of Default nor the exercise of the City's right to terminate for convenience pursuant to section 47.3 of the Project Agreement, and this Agreement is correspondingly terminated pursuant to Part 2 Section 47.4(a):

(i) the Maintenance Contractor acknowledges that the City, pursuant to section 8.1(c) of Schedule 35 to the Project Agreement, has the right either to continue to carry out the Additional Vehicles Agreement or terminate the Additional Vehicles Agreement by giving Project Co a written notice within thirty (30) days following the termination of the Project Agreement effective immediately;

(ii) in the event that the City elects to carry out the Additional Vehicles Agreement in accordance with section 8.1(c)(i) of Schedule 35 to the Project Agreement, Project Co shall promptly notify the Maintenance Contractor, and the Maintenance Contractor agrees that the provisions of this Attachment 35 and the corresponding MC Additional Vehicles Agreement shall apply; and

(iii) in the event that the City elects to terminate the Additional Vehicles Agreement in accordance with in accordance with section 8.1(c)(i) of Schedule 35 to the Project Agreement, the Maintenance Contractor agrees that the corresponding MC

Additional Vehicles Agreement shall terminate, and to the extent that the City is entitled to a refund under section 8.1(c) of Schedule 35 to the Project Agreement, Project Co shall be entitled to refund of the payments that Project Co has made in respect of the Additional Vehicles, together with the Default Interest Rate thereon up until the date of repayment by the Maintenance Contractor.

(d) The Maintenance Contractor acknowledges the provisions of section 8.1(d) of Schedule 35 to the Project Agreement, and agrees that if the Additional Vehicles Agreement is deemed terminated pursuant to that section, the corresponding MC Additional Vehicles Agreement shall also be deemed to be terminated.

(e) If the Project Agreement is not terminated, but this Agreement is terminated for any reason other than a Project Co MC Event of Default, Project Co may elect, at its option: (a) to continue to carry out the MC Additional Vehicles Agreement in which case the Maintenance Contractor shall continue to perform the MC Additional Vehicles Agreement; (b) take an assignment of the MC Additional Vehicles Agreement in which case the Maintenance Contractor shall assign to Project Co all of its rights and interest in the MC Additional Vehicles Agreement; or (c) to termination the MC Additional Vehicles Agreement in which case the MC Additional Vehicles Agreement shall terminate with immediate effect and Project Co shall be entitled to refund of the payments that Project Co has made in respect of the Additional Vehicles together with interest thereon up until the date of repayment by the Maintenance Contractor.

(f) If the Project Agreement is not terminated, but this Agreement is terminated by reason of a Project Co MC Event of Default, any MC Additional Vehicles Agreement will also automatically terminate.

EXHIBIT C

SCHEDULE 35

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

SCHEDULE 35

ADDITIONAL VEHICLES

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PART 1
DEFINITIONS

1.1 Definitions

The following definitions shall have the following meanings:

(a) **"Additional Maintenance Spare Vehicles"** has the same meaning given to it in Section 2.2(a).

(b) **"Additional Payments for Non-Project Co Additional Vehicles"** has the same meaning given to it in Section 5.3(a).

(c) "**Additional Vehicles**" means any additional light rail transit vehicles purchased by the City following Financial Close pursuant to this Schedule 35, including all electromechanical and other equipment therein. For clarity, this includes any additional light rail transit vehicles beyond the initial fleet of Vehicles to be provided by Project Co at the Revenue Service Availability Date, whether or not such additional light rail transit vehicles are purchased from the Project Co or any other third party.

(d) "**Additional Vehicles Agreement**" has the meaning given to it in Section 8.1(a).

(e) "**Additional Vehicles Termination Date**" has the meaning given to it in Section 8.1(b).

(f) "**Annual Service Payment**" has the meaning given to it in Schedule 20 - Payment Mechanism.

(g) **"Capacity Factor"** means 1.25.

(h) "**Closing Date**" means the date upon which resolution of all punch list items have been achieved, as certified by the Independent Certifier**;**

(i) "**Configuration Management**" means a process to establish and maintain the integrity of all identified project outputs and make them available to all concerned stakeholders.

(j) "**Cost of Work**" has the same meaning given to it in Schedule 3 of RFP, Part 2 - Financial Submission Requirements.

(k) "**Corrective Maintenance Plan**" has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(l) "**Custodial Maintenance Plan**" has the same meaning given to it in Appendix A of Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements.

(m) **"Daily Bus In Service Costs"** means $935, Adjusted for Inflation.

(n) "**Default Interest Rate**" means 5% over the Prime Rate.

(o) "**Designated Site**" means a site in the City of Ottawa as designated by the City to which Project Co is required to deliver the Additional Vehicles.

(p) "**Deliver**" or "**Delivery**" means that Project Co delivers the Additional Vehicles purchased by the City pursuant to and in accordance with this Schedule 35 to the Designated Site on the Delivery Date in a manner as requested by the City.

(q) "**Delivery Date**" means the later of:

(i) 30 months following the date when an Option Notice is given by the City to Project Co in accordance with Section 2.1(c), upon which date Project Co shall be required to deliver the Additional Vehicles to a Designated Site; and

(ii) the Required Revenue Service Availability Date.

(r) "**Escalation Factor**" has the meaning given to it in Schedule 20 - Payment Mechanism.

(s) "**Handover Maintenance Plan**" has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(t) "**Lifecycle Maintenance Plan**" means the plan as contemplated by Section 6.4(a).

(u) "**Liquidated Damages for Service Level Increase Additional Vehicle Delivery Delay**" means the liquated damages that are payable by Project Co to the City pursuant to and in accordance with Section 2.7(c) and Section 2.7(d).

(v) "**Maintenance Plan**" means collectively, the Custodial Maintenance Plan, the Corrective Maintenance Plan, and the Preventive Maintenance Plan.

(w) **"Major Service Change**" has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(x) "**Marginal PPHPD**" means, for any day, the difference in minimum service capacity (PPHPD) for the Morning Peak Period between:

(i) the Service Level requested by the City for that day via a Major Service Change request in accordance with Section 3.5 of Appendix 1 of Schedule 15-3 - Output Specifications – Maintenance and Rehabilitation Requirements, and

(ii) the Service Level being provided by Project Co on that day;

and by way of example only, Marginal PPHPD for a Service Level Increase from Service Level 1 to Service Level 2 is derived by reference to Schedule 10 of the RFP - Preliminary Service Plan, by taking the minimum service capacity (PPHPD) for the Morning Peak Period (Monday-Thursday) for Service Level 2 (Cell Reference H20, Sheet "Service Level 2 2020-2021"), and subtracting the minimum service capacity (PPHPD) for the Morning Peak Period (Monday-Thursday) for Service Level 1 (Cell

Reference H20, Sheet "Service Level 1 2018-2019"), which yields 11,360-10,700 = 660. For clarity, during the Maintenance Term, the relevant reference document will be the Operations Service Plan, as amended from time to time in accordance with the Project Agreement.

(y) "**Maximum Order**" means the maximum number of the Additional Vehicles that the City shall be entitled to by way of the Option to Purchase in each year during the Option Term pursuant to Section 2.2(c).

(z) "**Minimum Order**" means the minimum number of the Additional Vehicles that the City shall be entitled to by way of the Option to Purchase in each year during the Option Term pursuant to Section.2.2(b).

(aa) "**Non-Project Co Additional Vehicles**" means the Additional Vehicles which are purchased by the City from a third party other than Project Co pursuant to this Schedule 35.

(bb) "**Option Term**" means seven (7) years following Financial Close.

(cc) "**Option Notice**" has the meaning given to it in Section 2.1(c)(i).

(dd) "**Option to Purchase**" refers to the option described in Section 2.1(a).

(ee) "**Preventive Maintenance Plan**" has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(ff) "**Price Change Formula**" means the Escalation Factor set out in Section 4.1 of Part B of Schedule 20 – Payment Mechanism.

(gg) "**Prime Rate**" means on any day, the annual rate of interest announced by the Royal Bank of Canada (or its successor), or any Canadian chartered bank agreed by the City and Project Co, from time to time as its reference rate then in effect for determining interest rates on Canadian dollar commercial loans made by it in Canada.

(hh) "**Project Co Additional Vehicles**" means the Additional Vehicles which are purchased by the City from Project Co pursuant to this Schedule 35.

(ii) "**Service Level Increase"** has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(jj) "**Service Level Increase Date**" means the date upon which the Additional Vehicles are brought into revenue service. For greater certainty, for the purpose of this Schedule 35, the Service Level Increase Date shall not be earlier than the Delivery Date.

(kk) "**Service Level Increase Additional Vehicle Delivery Delay**" has the meaning given to it in Section 2.7(c).

(ll) "**System Extension**" has the meaning given to it in Schedule 38 – Extension and Additional Phases.

(mm) "**Traction Power**" has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(nn) "**Train Control System**" has the meaning given to it in Schedule 15-1 – Output Specifications - Technical Definitions and Reference Documents.

(oo) "**Vehicle Availability Standard**" has the same meaning given to it in Appendix A of Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements.

(pp) "**Vehicle Long Stop Date**" means 6 months following the Delivery Date.

(qq) "**Vehicle Supplier**" means Alstom Power and Transport Canada Inc.

(rr) "**Vehicle Unit Price**" means the price per Additional Vehicle, as follows:

(i) $[redacted] per Vehicle, subject to Section 2.4 and subparagraph (ii) below;

(ii) $[redacted] per Vehicle (the "Reduced Price"), rather than as set out in subparagraph (i) above; provided that:

(A) the Option to Purchase is exercised on or before the expiry of 18 months following Financial Close;

(B) the Reduced Price shall be applicable to a maximum of 8 Vehicles with respect to which the City requires delivery on or prior to the expiry of 59 months following Financial Close; and

(C) the Reduced Price shall be applicable to a maximum of 20 Vehicles with respect to which the City requires delivery on or prior to the expiry of 68 months following Financial Close.

(ss) "**Volume Payment**" has the meaning given to it in Schedule 20 - Payment Mechanism.

(tt) "**Weekday**" means Monday, Tuesday, Wednesday, Thursday, or Friday that is not a statuary holiday in the Province of Ontario.

PART 2
OPTION TO PURCHASE

2.1 City's Option to Purchase

(a) At its option, the City shall have the right within the Option Term to purchase from Project Co Additional Vehicles and require such Additional Vehicles be delivered by Project Co to the Designated Site on the Delivery Date.

(b) The Additional Vehicles that are purchased by the City pursuant to Section 2.1(a) may, at the City's option, be used for the System and any System Extension.

(c) Option to Purchase:

(i) The Option to Purchase shall be exercised by written notice (an "**Option Notice**") given by the City to Project Co at any time during the Option Term in accordance with Section 61 of the Project Agreement.

(ii) An Option Notice shall specify the number of the Additional Vehicles that the City wishes to purchase from Project Co, the Designated Site, additional storage area, maintenance requirements, upgrades to Train Control System (if any), Traction Power and other issues relating to integration of Additional Vehicles into the System.

(iii) Upon delivery of a relevant Option Notice in accordance with the foregoing provision there shall be deemed to be a binding agreement of purchase and sale between the City as purchaser and Project Co as vendor in respect of the Additional Vehicles. The terms and conditions of the agreement of purchase and sale of such Additional Vehicles shall be in accordance with this Schedule 35 or the terms otherwise provided in the Project Agreement not in conflict with this Schedule 35.

(iv) The purchase of the Additional Vehicles resulting from the exercise of the Option to Purchase shall be completed upon the Closing Date.

(v) On the Closing Date, Section 29.5 of the Project Agreement shall apply, *mutatis mutandis*, to Project Co and the Additional Vehicles.

(vi) If the Additional Vehicles are encumbered by any encumbrances contrary to Section 29.5 of the Project Agreement or Project Co fails to perform any covenant on its part herein contained, the City may in its Discretion, without derogation from its right respecting any Project Co Event of Default as provided for in the Project Agreement, on prior written notice to Project Co (the "**Default Notice**"), perform any such covenant capable of being performed by the City or arrange for the encumbrance to be discharged (any such event, a "**Default Event**") and if the Default Event requires the payment or expenditure of money, the City may make

such payment or expenditure and all sums so expended shall be forthwith payable by Project Co to the City with the Default Interest Rate thereon until paid and the City may deduct and set-off any such amount against the purchase price payable on the Closing Date. The parties agree that the Closing Date shall be extended by such period of time as the City determines is necessary for the purposes of it curing such Default Event prior to the Closing Date.

(vii) Each of the parties shall execute and deliver all such other further documents and do such other things as the other party may reasonably request to give full effect to this Section 2.1.

(d) Project Co represents that it has agreed with its Vehicle Supplier on the terms that are sufficient to give effect to the Option to Purchase as provided for in this Schedule 35. Upon receipt of the Option Notice, Project Co shall exercise its rights and perform all necessary acts under its agreement with its Vehicle Supplier to give full effect to City's Option to Purchase under this Section 2.1

2.2 The Number of the Additional Vehicles

(a) The number of the Additional Vehicles with respect to which the Option to Purchase is exercised pursuant to Section 2.1 for each year of the Option Term shall take into account the spare vehicles required to provide the necessary spare vehicle capacity to allow Project Co to conduct Maintenance Services in accordance with Schedule 15-3 - Output Specifications – Maintenance and Rehabilitation Requirements (the "**Additional Maintenance Spare Vehicles**"). For the purpose of this Section 2.2, where the calculation for the required Additional Maintenance Spare Vehicles pursuant to Project Co's Response produces a fraction, such fraction shall not be taken into account in determining the number of required Additional Maintenance Spare Vehicles.

(b) The Minimum Order that the City shall have the right to place by way of the Option to Purchase from Project Co pursuant to Section 2.1 for each year of the Option Term shall be equal to one (1) train consist.

(c) The Maximum Order that the City shall have the right to place by way of the Option to Purchase from Project Co pursuant to Section 2.1 for each year of the Option Term shall be equal to three (3) train consists. Notwithstanding the Maximum Order permitted in an annual period, the City shall also be entitled to order Additional Maintenance Spare Vehicles required in accordance with Section 2.2(a) in such year.

2.3 Output Specifications of Additional Vehicles

(a) Subject to Section 2.3(b) and Section 2.3(c), the Additional Vehicles purchased by the City pursuant to Section 2.1(a) shall be manufactured in accordance with the Output Specifications provided for in Schedule 15-2 – Output Specifications - Design and Construction Specifications.

(b) In the event that there are any improvements or upgrades required for the System in accordance with Schedule 15 – Output Specifications which do not result in a Variation (a "**Required Upgrade**"), or there are any improvements or upgrades included in the basic model of the Vehicles (an "**Included Upgrade**"), the Project Co shall ensure that the Additional Vehicles are upgraded to conform to any Required Upgrade or Included Upgrade, and that all associated equipment and interfaces are tested to accommodate such upgrades, without further costs to the City.

(c) Notwithstanding Section 2.3(a), the City may amend the Output Specifications provided for in Schedule 15 – Output Specifications in respect of the Additional Vehicles including any improvements or upgrades thereof. Unless the amendments to the Output Specifications in respect of the Additional Vehicles result from required improvements or upgrades to the System as provided for in Section 2.3(b), such amendments shall result in a Variation in accordance with the Project Agreement and Schedule 22 - Variation Procedure. In the event that the Variation Procedure shall apply pursuant to this Section 2.3(c), Project Co shall, at the City's request, provide the City with necessary information determining the Variation before the City shall decide whether any amendment is required.

2.4 Price of Additional Vehicles

(a) Subject to the provisions of this Section 2.4 and Section 2.3(c) providing otherwise, the price of each of the Additional Vehicles to be purchased by the City pursuant to Section 2.1(a) shall be the Vehicle Unit Price.

(b) The price of each of the Additional Vehicles as provided for in this Section 2.4(a) shall be subject to price escalation or reduction as follows:

(i) there shall be no price escalation or reduction for the initial three (3) years of the Option Term; and

(ii) for the remainder of the Option Term, the Vehicle Unit Price in respect of the Additional Vehicles may increase or decrease in accordance with the Price Change Formula. The Vehicle Unit Price for each of the Additional Vehicles shall be increased or decreased by applying the Price Change Formula to 100% of the Vehicle Unit Price.

2.5 Payment of Price of Additional Vehicles

(a) The City shall make the following milestone payments to Project Co in respect of each of the Additional Vehicles as purchased by the City pursuant to and in accordance with Part 2 of this Schedule 35:

(i) ten percent (10%) of the Vehicle Unit Price upon notice to proceed;

(ii) twenty percent (20%) of the Vehicle Unit Price upon sourcing orders of doors, HVAC, brake, gangway and pantograph;

(iii) twenty-five percent (25%) of the Vehicle Unit Price upon completion of the carbody shell;

(iv) ten percent (10%) of the Vehicle Unit Price upon completion of the subassembly;

(v) ten percent (10%) of the Vehicle Unit Price upon completion of fitting;

(vi) ten percent (10%) of the Vehicle Unit Price upon completion of the serial test; and

(vii) fifteen percent (15%) of the Vehicle Unit Price on Closing Date.

2.6 Commissioning of Additional Vehicles

(a) The Additional Vehicles purchased pursuant to Part 2 of this Schedule 35 shall be tested and commissioned by Project Co in accordance with Schedule 14 - Commissioning.

2.7 Project Co's Failure to Deliver

(a) Subject to Section 2.7(c), if Project Co shall fail to Deliver the Additional Vehicles on the Delivery Date, the City shall be entitled to an amount equal to $1,500 per Additional Vehicle each day, subject to the Escalation Factor, on account of liquidated damages. Such amount of liquidated damages shall constitute the City's sole entitlement to damages in respect of a failure of Project Co to deliver the Additional Vehicles on the Delivery Date.

(b) If Project Co shall fail to Deliver the Additional Vehicles by the Vehicle Long Stop Date, the City shall have the right to:

(i) cancel the exercised Option to Purchase the undelivered Additional Vehicles by written notice to Project Co (the "**Cancelled Vehicles**"), in which event, without derogation from the City's right under Section 2.7(a) or Section 2.7(c), as the case may be, the City shall be entitled to a refund of the payments that the City has made up until the Vehicle Long Stop Date in respect of such Cancelled Vehicles, together with the Default Interest Rate thereon.

or,

(ii) without derogation from the City's right under Section 2.7(a) or Section 2.7(c), as the case may be, proceed with the exercised Option to Purchase by written notice to Project Co in accordance with the terms and conditions set out herein.

(c) Notwithstanding Section 2.7(a), where the City has caused Project Co to acquire Additional Vehicles under the provisions of this Schedule 35 in order to implement a Service Level Increase, and Project Co has failed or has determined that it will fail to

achieve the delivery, commissioning, and assimilation into the vehicle fleet of the Additional Vehicles by the Service Level Increase Date so as to effect the required Service Level Increase ("**Service Level Increase Additional Vehicle Delivery Delay**"), then Project Co shall:

(i) pay to the City the Liquidated Damages for Service Level Increase Additional Vehicle Delivery Delay in accordance with Section 2.7(d), below, for each Weekday of Service Level Increase Additional Vehicle Delivery Delay; or

(ii) with the City's consent, not to be unreasonably withheld, confirm that it will provide the required Service Level Increase using Project Co's existing vehicle fleet, on a temporary basis, during the period of Service Level Increase Additional Vehicle Delivery Delay, in which case Project Co shall be responsible to provide the relevant Service Level and shall be subject to all applicable penalties under the Project Agreement for failure to do so, including Schedule 20- the Payment Mechanism;

or

(iii) where Project Co can partially provide the required Service Level Increase using Project Co's existing vehicle fleet on a temporary basis during the period of Service Level Increase Additional Vehicle Delivery Delay, a combination of the foregoing subparagraphs (i) and (ii).

For greater certainty, the amount of the Liquated Damages for Service Level Increase Additional Vehicle Delivery Delay as provided for in this Section 2.7(c) and 2.7(d) shall constitute the City's sole entitlement to damages in respect of a failure of Project Co to deliver the Additional Vehicles on the Service Level Increase Date as required in this Section 2.7(c)

(d) For the purpose of this Section 2.7(c):

(i) The Liquated Damages for Service Level Increase Additional Vehicle Delivery Delay shall be calculated for each Weekday of Service Level Increase Additional Vehicle Delivery Delay, based on the formula below:

$$PWAVDLD_{Wk} = \left(\frac{Marginal\ PPHPD}{70}\right) * Capacity\ Factor * Daily\ Bus\ In\ Service\ Cost$$

Where:

"PWAVDLDWk" means the amount, in dollars, of Liquidated Damages for Service Level Increase Additional Vehicle Delivery Delay calculated for any given Weekday during a period of Service Level Increase Additional Vehicle Delivery Delay.

(ii) The Liquidated Damages for Service Level Increase Additional Vehicle Delivery Delay shall be applicable to each Weekday during a period of Service Level Increase Additional Vehicle Delivery Delay, up to a maximum period of six (6) months following the Delivery Date.

(e) In the event that the City shall cancel the exercised Option to Purchase with respect to the undelivered Additional Vehicles pursuant to Section 2.7(b)(i), the City shall have the right to exercise an Option to Purchase in respect of such Cancelled Vehicles in the next option period.

(f) Section 2.7 does not derogate from any of Project Co's obligations as set out in Part 5 of this Schedule 35.

2.8 Canadian Content

(a) For clarification, except as provided in Section 2.8(b), there shall be no obligation on Project Co to comply with the Canadian Content Requirements with respect to Additional Vehicles delivered to the City pursuant to the exercise of the Option to Purchase.

(b) Notwithstanding Section 2.8(a), the City may, in its Discretion, require compliance with the Canadian Content Requirements (a "CC Request"), with respect to any Additional Vehicles purchased pursuant to the Option to Purchase by including the CC Request with the Option Notice. In such event the Canadian Content Requirements shall be deemed to be a Variation and the provisions respecting Variations in the Project Agreement and Schedule 22 – Variation Procedure shall be applicable to the Additional Vehicles that are the subject matter of the CC Request.

PART 3
NEGOTIATED PURCHASE OF ADDITIONAL VEHICLES

3.1 Negotiated Purchase

(a) During and after the Option Term, the City shall have the right to negotiate with Project Co to purchase Additional Vehicles in accordance with Part 3 of this Schedule 35.

(b) The Additional Vehicles that are purchased by the City pursuant to Section 3.1(a) may, at the City's option, be used for the System and any System Extension.

3.2 Output Specifications of Additional Vehicles

(a) Subject to Section 3.2(c), the Additional Vehicles purchased pursuant to Section 3.1(a) shall be manufactured in accordance with the Output Specifications provided for in Schedule 15-2 – Output Specifications - Design and Construction Specifications, or as otherwise agreed upon by the City and Project Co during the negotiation.

(b) In the event that there are any Required Upgrades or Included Upgrades, Project Co shall ensure that the Additional Vehicles are upgraded to conform to such Required Upgrades or Included Upgrades, and that all associated equipment and interfaces are tested to accommodate such upgrades, without further costs to the City.

(c) Notwithstanding Section 3.2(a), the City may amend the Output Specifications provided for in Schedule 15-2 – Output Specifications - Design and Construction Specifications in respect of the Additional Vehicles including any improvements or upgrades thereof. Unless the amendments to the Output Specifications in respect of the Additional Vehicles result from required improvements or upgrades to the System as provided for in Section 3.2(b), such amendments shall result in a Variation in accordance with the Project Agreement and Schedule 22 - Variation Procedure. In the event that the Variation Procedure shall apply pursuant to this Section 3.2(c), Project Co shall, at the City's request, provide the City with necessary information determining the Variation before the City shall decide whether any amendment is required.

3.3 Price of Additional Vehicles

(a) The price of each of the Additional Vehicles purchased by the City pursuant to Section 3.1(a) shall be negotiated by Project Co and the City.

3.4 Commissioning of Additional Vehicles

(a) The Additional Vehicles as purchased by the City pursuant to Part 3 of this Schedule 35 shall be tested and commissioned by Project Co in accordance with Schedule 14 - Commissioning.

PART 4
VEHICLE PROCUREMENT

4.1 City's Right to Procure

(a) During and after the Option Term, the City shall have the right to procure any Additional Vehicles from a provider other than Project Co. The City may use any form of competitive procurement, sole-source contract, or other procurement methodology or transaction structure. At its option, the City may bundle the Option to Purchase in respect of the Additional Vehicles with other procurement processes.

4.2 Consulting Service

(a) The City shall have the right to retain either a third party or Project Co as consultant in procuring the Additional Vehicles procured pursuant to Section 4.1(a).

(b) In the event that the City shall desire to consider retaining Project Co as consultant in procuring the Additional Vehicles pursuant to Section 4.1(a), the City shall provide Project Co with a written notice which shall include the following information:

(i) a description of the Additional Vehicles the City wishes to procure including the number, model, preliminary output specifications and other significant features of the Additional Vehicles; and

(ii) a preliminary plan and anticipated timelines for procurement of the Additional Vehicles.

(c) Within a period of 15 days after the date of receipt of the notice provided for in Section 4.2(b), Project Co shall deliver to the City its written response advising the City of an estimate of the consulting fee it will charge for the consulting services to be provided in respect of such Additional Vehicles, with reasonable details to support such estimate.

(d) the City shall within a period of 15 days after the date of receipt of Project Co's response as provided for in Section 4.2(c), deliver a written notice notifying Project Co whether or not the City shall wish to retain Project Co for providing the consulting service respecting such Additional Vehicles.

(e) In the event that the City shall wish to retain Project Co for providing the consulting service respecting such Additional Vehicles by giving the notice as provided for in Section 4.2(d), then upon delivery and receipt of such notice, the City and Project Co shall, in good faith and acting reasonably, negotiate the terms of a binding agreement for the performance of the consulting services in respect of procuring the Additional Vehicles pursuant to and in accordance with Section 4.2.

4.3 Project Co's Obligation to Assist

(a) In the event that the City shall retain a third-party consultant in procuring the Additional Vehicles pursuant to Section 4.2(a), subject to the provisions in Schedule 41 – Intellectual Property, Project Co shall provide assistance to the City as reasonably required by the City and at the City's cost, which assistance shall include without limitation:

(i) providing all necessary information and access to Fixed Facilities, E&M, MSF, and Vehicles supplied by Project Co in order to allow the City to develop appropriate technical specifications for the Additional Vehicles; and

(ii) other assistance reasonably requested by the City.

(b) In the event that the City shall retain Project Co as consultant in procuring the Additional Vehicles pursuant to Section 4.2(a), subject to payment by the City of the consulting fees as agreed upon by the City and Project Co pursuant to Section 4.2(d), and the provisions in Schedule 41 – Intellectual Property, Project Co shall provide assistance to the City as reasonably required by the City, which assistance shall include without limitation:

(i) assistance in development of vehicle specifications and evaluation of vehicle designs to ensure compatibility with existing Fixed Facilities, E&M, MSF supplied by Project Co and maintenance practices of Project Co;

(ii) providing all necessary information and access to Fixed Facilities, E&M, MSF, and Vehicles supplied by Project Co in order to allow the City to develop appropriate technical specifications for the Additional Vehicles;

(iii) advising the City on development of a Lifecycle Maintenance Plan, to be developed in conjunction with other supplier(s) that will include a schedule of lifecycle maintenance and major component replacement and a budget for carrying out such work;

(iv) advising the City on potential modifications that will result in maintenance cost savings guaranteed by Project Co, which savings shall be shared by the City and Project Co equally;

(v) participation in testing, commissioning, acceptance process and Configuration Management; and

(vi) other assistance reasonably requested by the City.

4.4 Commissioning of Non-Project Co Additional Vehicles

(a) In the event that the City shall retain Project Co as consultant in procuring the Additional Vehicles pursuant to Section 4.2(a), at the City's option, the Non-Project Co Additional Vehicles as procured by the City pursuant to Part 4 of this Schedule 35 shall be tested and commissioned by Project Co in accordance with Schedule 14 – Commissioning.

4.5 Liquidated Damages

(a) The provisions respecting liquidated damages in Section 2.7 shall apply to Non-Project Co Additional Vehicles if, and only if, the delivery delay as provided for Section 2.7 results from Project Co's failure to carry out commissioning activities in accordance with Schedule 14 – Commissioning.

PART 5
MAINTENANCE SERVICES OF ADDITIONAL VEHICLES

5.1 Obligation of Project Co to Maintain

(a) The City may at its option require Project Co to be fully responsible for providing Maintenance Services for the Additional Vehicles purchased during the Maintenance Term pursuant to this Schedule 35, including without limitation, the Non-Project Co Additional Vehicles.

(b) In the event that the City shall require Project Co to provide Maintenance Services for the Additional Vehicles pursuant to Section 5.1(a), provisions in Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements shall apply in respect of the Additional Vehicles, including without limitation, the provisions relating to maintenance reporting on the status and details of completion of various maintenance activities in respect of the Additional Vehicles.

5.2 Service Level Increase

(a) Where Project Co is required to provide Maintenance Services for any Additional Vehicles pursuant to Section 5.1, due to a Major Service Change in accordance with Article 3 of Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements, Project Co's Annual Service Payment and Volume Payment shall be adjusted in accordance with Article 3 of Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements.

(b) Subject to Section 5.3(a), Project Co shall have no other entitlement for any additional payment in respect of Maintenance Services provided to the Additional Vehicles pursuant to Section 5.1 due to a Major Service Change, save and except for that provided for in Section 5.2(a).

5.3 Additional Payments to Project Co

(a) In addition to the payments as provided for in Section 5.2(a) but without duplication thereof, Project Co shall be entitled to additional payments in respect of providing Maintenance Services for the Non-Project Co Additional Vehicles pursuant to and in accordance with the provisions respecting Variations in the Project Agreement and Schedule 22 – Variation Procedure with respect to any addition or changes to the System required by the inclusion of the Non-Project Co Additional Vehicles as Approved by the City ("**Additional Payments for Non-Project Co Additional Vehicles**"), in which event, Project Co shall, at the City's request, provide the City with necessary information determining the Variation before the City shall decide whether such addition or changes are required.

PART 6
ADJUSTMENTOF LIFECYCLE PAYMENTS

6.1 Lifecycle Maintenance Services

(a) In the event that the City shall require Project Co to be fully responsible for providing Maintenance Services for any Additional Vehicles pursuant to Section 5.1, the provisions in respect of lifecycle maintenance services in Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements shall apply to such Additional Vehicles.

6.2 Option to Purchase

(a) Where the City shall purchase any Additional Vehicles by way of exercising the Option to Purchase pursuant to Section 2.1(a), subject to Section 6.2(b), Project Co shall be entitled to amend its schedule of Lifecycle Payments set out in Schedule 20 - Payment Mechanism, taking into account lifecycle costs for the Additional Vehicles that occur within the Maintenance Term.

(b) Project Co's amendment of the Lifecycle Payments schedule as provided for in Section 6.2(a) shall be based on a lifecycle cost curve identical in real dollar terms to the lifecycle cost curve for Vehicles contained in Project Co's financial model (PA Schedule 35 Lifecycle Info, columns D and E) at Financial Close, as amended from time to time.

(c) For greater certainty, the amendment of the Lifecycle Payments as provided for hereunder shall take into account that:

(i) any amendment in the Output Specifications requested by the City pursuant to Section 2.3(c) or Section 3.2(c) shall result in an adjustment in the Lifecycle Payments; and

(ii) the City shall be responsible for lifecycle costs for the Additional Vehicles that occur beyond the Maintenance Term.

6.3 Negotiated Purchase of Additional Vehicles

(a) Where the City shall purchase any Additional Vehicles by way of negotiating a purchase pursuant to Section 3.1(a), subject to Section 6.3(b), the City and Project Co shall agree on appropriate amendments to the schedule of Lifecycle Payments set out in Schedule 20 - Payment Mechanism, taking into account lifecycle costs for the Additional Vehicles that occur within the Maintenance Term.

(b) The amendments of the Lifecycle Payments schedule as provided for in Section 6.3(a) shall be presumptively based on a lifecycle cost curve identical in real dollar terms to the lifecycle cost curve for the Vehicles contained in Project Co's financial model at Financial Close, as amended from time to time. Any variations must be demonstrated by Project Co with specific references to unique features of the Additional Vehicles which require a different lifecycle maintenance approach.

(c) For greater certainty, the amendment of the Lifecycle Payments as provided for hereunder shall take into account that:

(i) any amendment in the Output Specifications requested by the City pursuant to Section 2.3(c) or Section 3.2(c) shall result in an adjustment in the Lifecycle Payments; and

(ii) the City shall be responsible for lifecycle costs for the Additional Vehicles that occur beyond the Maintenance Term.

6.4 Procurement of Non-Project Co Additional Vehicles

(a) Where the City shall procure any Non-Project Co Additional Vehicles pursuant to Section 4.1(a), Project Co and the City shall agree on a Lifecycle Maintenance Plan in respect of such Non-Project Co Additional Vehicles, which Lifecycle Maintenance Plan shall result in a Variation in accordance with Project Agreement and Schedule 22 - Variation Procedure.

(b) The City and Project Co shall agree on appropriate amendments to the schedule of Lifecycle Payments set out in Schedule 20 - Payment Mechanism, taking into account:

(i) the lifecycle costs for the Non-Project Co Additional Vehicles that occur within the Maintenance Term, as budgeted for in the Lifecycle Maintenance Plan; and

(ii) the City shall be responsible for lifecycle costs for the Additional Vehicles that occur beyond the Maintenance Term.

PART 7 HANDOVER MAINTENANCE OF ADDITIONAL VEHICLES

7.1 Handover Maintenance Services

(a) In the event that the City shall require Project Co to be fully responsible for providing Maintenance Services for any Additional Vehicles pursuant to Section 5.1, the provisions in respect of Handover Maintenance services in Schedule 15-3 – Output Specifications – Maintenance and Rehabilitation Requirements shall apply to such Additional Vehicles, including without limitation, the provisions relating to the Handover Maintenance Period, subject to reasonable adjustment based upon the proportionate age and usage of the Additional Vehicles in relation to the Vehicles, as determined by the City, acting reasonably.

PART 8 TERMINATION OF PROJECT AGREEMENT

8.1 Termination of Project Agreement

(a) In the event that the Project Agreement shall be terminated pursuant to and in accordance with the provisions thereof and at that time the City shall have exercised the Option to Purchase pursuant to Section 2.1 hereof or otherwise there shall have been a binding agreement between the City and Project Co for the City to purchase Additional Vehicles from Project Co in accordance with this Schedule 35 (collectively, the "**Additional Vehicles Agreement**"), the provisions of this Section 8.1 shall apply.

(b) If the Project Agreement shall be terminated as a result of a City Event of Default or the exercise of the City's right to terminate for convenience pursuant to Section 47.3 of the Project Agreement:

(i) Project Co shall have the right either to continue to carry out the Additional Vehicles Agreement or terminate the Additional Vehicles Agreement by giving the City a written notice within thirty (30) days following the termination of the Project Agreement effective immediately (the "**Additional Vehicles Termination Date**");

(ii) in the event that Project Co shall elect to carry out the Additional Vehicles Agreement in accordance with subparagraph (i) above, the provisions of this Schedule 35 and the Additional Vehicles Agreement shall apply; and

(iii) in the event that Project Co shall elect to terminate the Additional Vehicles Agreement in accordance with subparagraph (i) above, the City shall be entitled to a refund of the payments that the City shall have made in respect of the Additional Vehicles on the Additional Vehicles Termination Date.

(c) If the Project Agreement shall be terminated as a result of neither a City Event of Default nor the exercise of the City's right to terminate for convenience pursuant to Section 47.3 of the Project Agreement:

(i) the City shall have the right either to continue to carry out the Additional Vehicles Agreement or terminate the Additional Vehicles Agreement by giving Project Co a written notice within thirty (30) days following the termination of the Project Agreement effective immediately;

(ii) in the event that the City shall elect to carry out the Additional Vehicles Agreement in accordance with subparagraph (i) above, the provisions of this Schedule 35 and the Additional Vehicles Agreement shall apply; and

(iii) in the event that the City shall elect to terminate the Additional Vehicles Agreement in accordance with subparagraph (i) above, the City shall be entitled to a refund of the payments that the City shall have made in respect of the Additional Vehicles, together with the Default Interest Rate thereon up until the date of repayment by Project Co.

(d) In the event that Project Co or the City, as the case may be, fails to deliver a written notice within thirty (30) days following the termination of the Project Agreement as provided for in Section 8.1(b) or Section 8.1(c), it shall be deemed that Project Co or the City, as the case may be, elects to terminate the Additional Vehicles Agreement.

EXHIBIT D

CAPITAL SPARES WITH OPTIONS

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

Capital Spares

Item N°	Reference	DESIGNATION	QTY 48m	TCP	Appendix A Proposed Selling price in CAD	Fixed Selling Price (no cpa)	Increase when 48 extended to 59 metre	Increase after 3 additional LRV's 4 trains
1	PBE-01-00030782M	Complete Motor Bogie BM1	3	714,294	1,425,520	1,624,347	1	0
3	PBE-01-00030782T	Complete Trailer Bogie	2	350,435	699,365	796,910	0	0
5	6224000	Complete air sanding compressor	2	28,141	37,669	42,923	0	1
6		Cab Booster unit	2	11,527	15,430	17,582	0	1
7	ESP1544	Compartment air conditioning complete unit	4	128,920	172,570	196,639	0	2
8	VFW3110030010	Automatic coupler	3	140,684	205,893	234,610	0	1
9	TRACS25871010	Master controller – dead man	2	3,573	4,783	5,450	0	1
10	1-7020.5710	Complete pantograph	1	13,133	17,579	20,031	0	1
12	DTR0000174972	High Speed circuit breaker	1	4,448	8,876	10,114	0	1
16	DTR0000174972	Complete braking rheostat	3	27,382	54,646	62,268	0	1
17	UF-1586-060201	Static converter	3	137,914	184,610	210,359	0	1
19	B61382	Battery box	1	13,650	18,271	20,819	0	1
TOTAL				1,574,101	**2,845,212**	**3,242,052**		

EXHIBIT E

ADDITIONAL VEHICLES RESPONSIBILITY MATRIX

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

ADDITIONAL OPTION PURCHASE VEHICLE - RESPONSIBILITY MATRIX – ALSTOM SUPPLY (1)

Appendix E1 to Option Agreement – MSF Assembly			
Activity	Alstom RS	Contractor (CC or MC)	Comment
Assembly of additional vehicles assembly of additional vehicles			
Access to the MSF for components delivery		X	Alstom MSC to facilitate
MSF surface allocation for storage and construction		X	Alstom MSC to facilitate
Various Duty (cleaning, guarding, telecom…)		X	
Energy Costs (Painshare)	X		Supply by CC/MC
Means of Lifting (crane, forklift…)		X	Alstom MSC to facilitate
Specific tooling	X		
Subassembly and supplied component	X		
Signalling and communication equipments		X	Alstom coordination and collaboration with Thales
Workforce for assembly and control	X		
Quality record	X		
Vehicles serial static testing			
MSF track allocation for static testing		X	Alstom MSC to facilitate
Energy supply (Costs)	X		
Vehicle towing inside MSF	X		
Specific tooling	X		
Workforce for test and control	X		
Quality record	X		
Vehicles dynamic testing			
Slot allocation on actual Ottawa track for dynamic testing		X	To be provided by the City and subject to Operating Rules and Procedures Permit to City to be applied for by Alstom through CC/MC.
Energy supply (Costs)		X	
Specific tooling	X		
Workforce for test and control	X		
Driver		X	To be provided by the City
Quality record	X		
Vehicles acceptance and warranty			
Vehicle cleaning before acceptance	X		
Customer acceptance	X (to Contractor)	X (to City)	
Vehicle Acceptance Testing	X		
Integration Testing and Commissioning		X	Alstom RS to assist
Vehicle Warranties	X		
Miscellaneous			
Additional capital spare procurement		X	
Additional capital spare supply	X		
Capital spare acceptance		X	

ADDITIONAL OPTION PURCHASE VEHICLE - RESPONSIBILITY MATRIX – ALSTOM SUPPLY (2)

Appendix E2 to Option Agreement – Off-site Assembly and Serial Testing			
Activity	Alstom RS	Contractor (CC or MC)	Comment
Assembly of additional vehicles			
Access to the MSF for components delivery		X	Alstom MSC to facilitate
Various Duty (cleaning, guarding, telecom…)		X	
Energy Costs	X		
Means of Lifting (crane, forklift…)		X	Alstom MSC to facilitate
Specific tooling	X		
Subassembly and supplied component	X		
Signalling and communication equipments		X	Alstom coordination and collaboration with Thales
Workforce for assembly and control	X		
Quality record	X		
Vehicle Verification testing for re-assembly			
MSF track allocation for static testing		X	Alstom MSC to facilitate
Energy supply (Costs)	X		
Vehicle towing inside MSF	X		
Specific tooling	X		
Workforce for test and control	X		
Quality record	X		
Vehicles dynamic testing			
Slot allocation on actual Ottawa track for dynamic testing		X	To be provided by the City and subject to Operating Rules and Procedures Permit to City to be applied for by Alstom through CC/MC.
Energy supply (Costs)		X	
Specific tooling	X		
Workforce for test and control	X		
Driver		X	To be provided by the City
Quality record	X		
Vehicles acceptance and warranty			
Vehicle cleaning before acceptance	X		
Customer acceptance	X (to Contractor)	X (to City)	
Vehicle Acceptance Testing	X		
Integration Testing and Commissioning		X	Alstom RS to assist
Vehicle Warranties	X		
Miscellaneous			
Additional capital spare procurement		X	
Additional capital spare supply	X		
Capital spare acceptance		X	

ADDITIONAL VEHICLE RESPONSIBILITY MATRIX PRIOR TO VEHICLE HANDOVER DATE (RSAD THROUGH END OF CC OPTION TERM)

Exhibit E3 to the Option Agreement			
Activity	CC	MC	Comment
Assembly of additional vehicles			
Access to the MSF for components delivery		X	
MSF surface allocation for storage and construction		X	
Various Duty (cleaning, guarding, telecom…)		X	
Energy supply (Costs)	X		
Means of Lifting (crane, forklift…)		X	
Specific tooling	X		
Subassembly and supplied component	X		
Signalling and communication equipments	X		
Workforce for assembly and control	X		
Quality record	X		
Vehicles serial static testing			
MSF track allocation for static testing		X	
Energy supply (Costs)	X		
Vehicle towing inside MSF	X		
Specific tooling	X		
Workforce for test and control	X		
Quality record	X		
Vehicles dynamic testing			
Slot allocation on actual Ottawa track for dynamic testing		X	To be provided by the City and subject to Operating Rules and Procedures
Energy supply (Costs)	X		
Specific tooling	X		
Workforce for test and control	X		
Driver (Costs)	X		To be provided by the City
Quality record	X		
Vehicles acceptance and warranty			
Vehicle cleaning before acceptance	X		
Customer acceptance		X (Post-RSAD)	
Manage Vehicle Commissioning		X (Post-RSAD)	
Vehicle Warranties	X		
Miscellaneous			
Additional capital spare procurement		X	
Additional capital spare supply	X		
Capital spare acceptance		X	

EXHIBIT F
OPTION VEHICLES GUARANTEE

THIS GUARANTEE is made as of February 12, 2013

BETWEEN:

(1) **ALSTOM TRANSPORT SA**, a corporation established under the laws of France (the "**Guarantor**"); and

(2) **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**").

(3) **RIDEAU TRANSIT MAINTENANCE GENERAL PARTNERSHIP**, a general partnership established under the laws of Ontario ("**Maintenance Contractor**", and together with the Construction Contractors, the "**Contractors**").

WHEREAS:

(A) Project Co has on the date hereof entered into an agreement (the "**Project Agreement**") with the City of Ottawa (the "**City**") (a) to design, construct, finance and maintain for a 30 year term, a new light rail transit system in Ottawa, Ontario; (b) to construct, finance and complete the widening of Highway 417, in Ontario; and (c) to construct, install, test and complete the Civic Works, as further described in the Project Agreement (the "**Project**").

(B) Under the Project Agreement, Project Co has granted the City an option to purchase additional light rail vehicles (the "**Option to Purchase**").

(C) The Construction Contractor has on the date hereof entered into a engineering, procurement and construction contract with Project Co (the "**Construction Contract**"), and the Maintenance Contractor has on the date hereof entered into a maintenance contract with Project Co (the "**Maintenance Contract**").

(D) Under the Construction Contract and Maintenance Contract, respectively, the Contractors have undertaken to fulfill Project Co's obligations in respect of the Option to Purchase.

(E) This Guarantee is made supplemental to a contract made on or about the date hereof with reference number 507528-P001A (the "**Option Agreement**") between Contractors and Alstom Power & Transport Canada Inc. (the "**Subcontractor**") which gives effect to the Option to Purchase. Under the Subcontracts, when the Option to Purchase is exercised, a binding agreement of purchase and sale for additional light rail vehicles will arise between a Contractor and the Subcontractor (each, a "**P&S Agreement**").

(F) The Subcontractor and the Guarantor are each, directly or indirectly, a wholly-owned subsidiary of ALSTOM.

(G) The Guarantor has agreed to guarantee the obligations of the Subcontractor under the the Option Agreement and any P&S Agreement (collectively, the "**Subcontracts**").

NOW IT IS HEREBY AGREED as follows:

1. In this Guarantee (including the Recitals) words and expressions shall have the same meanings as are respectively assigned to them in the Subcontracts.

2. In consideration of the Contractors entering into the Option Agreement with the Subcontractor:

(a) the Guarantor absolutely, irrevocably and unconditionally guarantees to Contractors the due and punctual payment, observance and performance by Subcontractor of each and all of the obligations, covenants, warranties, duties and undertakings of the Subcontractor under and pursuant to the Subcontracts when and if performance of such obligations, duties and undertakings shall become due according to the terms of the Subcontracts and the due payment and discharge of all such sums of money and liabilities due, owing or incurred or payable and unpaid by the Subcontractor to the Contractors pursuant to the Subcontracts (taking into account any period for payment of such sums and liabilities expressly provided for in the Subcontracts) or as a result of any breach of the terms of the Subcontracts by the Subcontractor (including all reasonable and documented expenses, including reasonable legal fees and taxes incurred by the Contractors in connection with the Contractors successfully enforcing any of the above against the Guarantor), to the extent that such amounts are recoverable under the Subcontracts, against the Subcontractor and excluding Indirect Losses (as defined in the Subcontracts). The Guarantor agrees with the Contractors that if and whenever at any time and from time to time the Subcontractor fails to perform any obligation, duty or undertaking under the Subcontracts or to make payment of any sum due and payable thereunder, the Guarantor shall promptly on receipt of a written demand from the Contractors notifying the Guarantor of such failure and in any event within 5 Business Days (as defined in the Subcontracts), pay, perform, cause to perform or discharge such obligations and liabilities, as the case may be, as if the Guarantor instead of the Subcontractor was the Subcontractor under the Subcontracts.

(b) to the extent that such amounts are due to the Contractors from the Subcontractor under the Subcontracts, the Guarantor shall indemnify the Contractors, promptly on receipt of written demand from the Contractors and in any event within 5 Business Days of receipt of such demand, in respect of any claim, demand, proceedings, liability, loss, damage, costs, charges or expenses, including, for greater certainty, third party claims and the cost of defending any third party claims (and any taxes arising thereon) arising out of any failure by the

Subcontractor to perform each and all of the obligations, warranties, duties and undertakings of the Subcontractor or to pay and discharge each and all sums of money and liabilities due, owing, incurred or payable and unpaid by the Subcontractor to the Contractors, in each case pursuant to the Subcontracts when and if such obligations, warranties, duties and undertakings become due and payable or performable according to the terms of the Subcontracts and excluding Indirect Losses (as defined in the Option Agreement).

(c) the Guarantor shall indemnify the Contractors, promptly upon receipt of written demand from the Contractors and in any event within 5 Business Days of receipt of such demand, against any loss or liability suffered by Subcontractor as a result of any obligation guaranteed by the Guarantor being or becoming unenforceable, invalid or illegal (other than as a result of an act or omission of the Contractors) as if the obligation guaranteed had not become unenforceable, invalid or illegal provided that the Guarantor's liability shall be no greater than the Subcontractor's liability would have been if the obligation guaranteed had not become unenforceable, invalid or illegal and provided further that the Guarantor shall not be obligated to perform any obligation to the extent that it would be illegal for it to do so.

3. The Guarantor agrees that this is a guarantee of performance and payment and not merely a guarantee of collection. The Contractors shall not be bound or obliged to take any action or legal proceedings against or demand payment from the Subcontractor and the liability of the Guarantor under this Guarantee shall not be conditional or contingent upon pursuit of any remedy against the Subcontractor except as provided for in the Subcontracts (although the Contractors are entitled to pursue such remedies if they choose to) or any other person or any collateral subject to any security before seeking satisfaction from the Guarantor of its obligations hereunder. The Contractors are under no obligation to marshal or appropriate in favour the Guarantor or to exercise, apply, perfect or recover any security interest or other lien or encumbrance the Contractors hold at any time or any funds or property that the Contractors may be entitled to receive or have a claim on. Each and every default by the Subcontractor under the Subcontracts shall give rise to a separate claim or cause of action hereunder, and separate claims or suits may be brought, as the case may be, hereunder as such default occurs.

4. The Guarantor shall not be exonerated by time being given to the Subcontractor by the Contractors nor by any concession or arrangement or waiver or forbearance granted or made by the Contractors to or with the Subcontractor or by anything that the Contractors may do or omit or neglect to do.

5. Without prejudice to the Contractors' rights against the Subcontractor as principal obligor, the Guarantor shall be deemed principal obligor in respect of its obligations under this Guarantee and not merely as surety; accordingly, the Guarantor shall not be discharged nor shall its liability hereunder be affected by any act or thing or means whatsoever by which its said liability would have been discharged or affected if it had not been principal obligor.

6. The Guarantor hereby authorizes (without need for further consent) the Subcontractor and the Contractors to make any amendment, addendum or variation to the Subcontracts, the due and punctual performance of which amendment, addendum or variation shall be likewise guaranteed by the Guarantor in accordance with the terms of this Guarantee. Except to the extent required to reflect such amendment, addendum or variation, the obligations of the Guarantor hereunder shall in no way be affected by any amendment, variation or addendum to the Subcontracts.

7. This Guarantee is a continuing guarantee and, accordingly, shall remain in operation and in full force and effect (notwithstanding any intermediate satisfaction by the Subcontractor or any other person) until all obligations, warranties, duties and undertakings now or hereafter to be carried out or performed and all sums of money and liabilities now or hereafter due, owing, incurred or payable by the Subcontractor under the Subcontracts shall have been satisfied or performed or as the case may be discharged in full and is not revocable and is in addition to and not in substitution for any other security which Subcontractor may at any time hold for the performance of such obligations and may be enforced against the Guarantor without first having recourse to any such security and without taking any steps or proceedings against the Subcontractor, any other guarantor or any other person. In the event that the Contractors bring formal legal proceedings against the Subcontractor related to the Subcontracts, the Guarantor will be bound by any final judgement made by the court in such proceedings. Notwithstanding anything else contained in this Guarantee, the Contractors shall not make a claim pursuant to this Guarantee unless the Subcontractor is in default pursuant to the terms of the Subcontracts and notice of such default has been given to the Subcontractor in accordance with the Subcontracts.

8. Neither the liability of the Guarantor hereunder nor the rights of the Contractors in relation to this Guarantee shall be discharged, released, reduced, impaired or affected by reason of:

(a) any limitation of status or power, disability, incapacity or other circumstance relating to the Subcontractor or any other person, including any insolvency, bankruptcy, liquidation, reorganization (voluntary or otherwise), readjustment, composition, dissolution, winding-up or other proceeding involving or affecting the Guarantor or the Subcontractor;

(b) any failure of the Subcontractor, whether or not without fault on its part, to perform or comply with any of the provisions of the Subcontracts, or to give notice thereof to the Guarantor;

(c) the taking or enforcing or exercising or the refusal or neglect to take or enforce or exercise any right or remedy against the Subcontractor or its assets, or the release or discharge of any such right or remedies;

(d) the granting of time, renewals, extensions, compromises, concessions, waivers, releases, discharges and other indulgences to the Subcontractor;

(e) any amendment, variation, modification, supplement or termination of the Subcontracts;

(f) any change in the ownership, control, name, objects, businesses, assets, capital structure or constitution of the Guarantor or the Subcontractor;

(g) any merger, amalgamation or consolidation of the Guarantor or the Subcontractor with any person or persons;

(h) the existence of any claim, set-off or other rights which the Guarantor may have at any time against the Subcontractor;

(i) any compromise, release of any security (including any other guarantee, letter of credit or bond), waiver, renewal, extension, indulgence, compromise, amendment, addition, deletion, change, release, discharge or modification of or with respect to any of the obligations guaranteed under this Guarantee;

(j) any failure, neglect or omission on the part of the Contractors, as the case may be, or any other person to give the Guarantor notice of the occurrence of any default by the Subcontractor under or with respect to the obligations hereunder, or to realize upon any obligations or liabilities of the Subcontractor;

(k) any judgment or right which the Contractors may have or exercise against the Subcontractor, the Guarantor;

(l) the Subcontracts not being duly executed and delivered by the Subcontractor to the Contractors; and

(m) the Subcontracts (and the performance by the Subcontractor of its obligations under thereunder) not being duly authorized by the Subcontractor.

9. While any amount is payable by the Subcontractor under the Subcontracts or any amount is payable by the Guarantor under this Guarantee, the Guarantor shall not claim, recover, accept or prove as creditor or otherwise in competition with the Contractors in respect of any monies owing to them by the Subcontractor, on grounds that the Guarantor performed obligations of the Subcontractor under the Subcontracts, in the event of any bankruptcy, liquidation or other insolvency proceedings relating to the Subcontractor. If any amount shall be paid by the Subcontractor to the Guarantor, on grounds that the Guarantor performed obligations of the Subcontractor under the Subcontracts, in connection with an insolvency proceeding at any time when all guaranteed obligations shall not have been fully satisfied, then such amount shall be used by the Guarantor solely towards performance of the unperformed guaranteed obligations until the guaranteed obligations are satisfied in full.

10. If any payment by the Subcontractor or the Guarantor in respect of the obligations, duties and undertakings of the Subcontractor under and pursuant to the Subcontracts is avoided or annulled or must be repaid as a result of insolvency or any similar event, the liability of the Guarantor will continue as if such payment had not occurred (and to the extent necessary, the

guarantee of the Guarantor will automatically be reinstated). For greater certainty, the Guarantor agrees that it will remain liable for the performance in full of such obligations even if the Subcontractor is discharged therefrom by applicable legislation relating to bankruptcy, insolvency or reorganization.

11. The Guarantor represents and warrants to the Contractors as follows:

(a) the Guarantor is a corporation fully organized, validly existing, authorized to do business and in good standing under the laws of France;

(b) the Guarantor has the requisite corporate power and authority to own its property and assets, transact the business in which it is engaged and to enter into this Guarantee and perform its obligations hereunder.

(c) this Guarantee has been duly authorized, executed and delivered by the Guarantor and constitutes a valid and binding agreement of the Guarantor and is enforceable against the Guarantor in accordance with the terms of this Guarantee, except to the extent limited by equitable principles and laws affecting the rights of creditors generally, and no other corporate proceedings on the part of Guarantor or its affiliates are necessary to authorize this Guarantee or the transactions contemplated hereby;

(d) no consent, authorization or approval or other action by, and no notice to or filing with, any governmental authority or other regulatory body or third party in any jurisdiction is required for the due execution, delivery and performance by the Guarantor of this Guarantee and its signatory is a duly authorized representative and has the power to bind the Guarantor by signing this Guarantee;

(e) as of the date hereof, the execution, delivery, and performance of this Guarantee does not and will not (i) conflict with or result in a default, breach or violation of any of the terms, conditions or provisions of the Guarantor's certificate or articles of incorporation, bylaws or other organizational documents of the Guarantor, as applicable, or (ii) constitute an event which would permit any person or entity to terminate rights or accelerate the performance or maturity of any indebtedness or obligation of the Guarantor or result in the creation of any lien upon any or the properties or assets of the Guarantor, or (iii) violate any order, writ, injunction decree, arbitration award, statute, rule or regulation applicable to the Guarantor or any of its properties or assets, or (iv) constitute an event which could require any consent of a third party or under any agreement to which Guarantor or its properties or assets is bound, or (vi) conflict with any agreement, instrument or arrangement to which the Guarantor is now a party or by which the Guarantor is, or may be, bound, or constitute a default thereunder,

(f) as of the date hereof, except as disclosed by the Guarantor, there is no actual, or, to the knowledge of the Guarantor having made due enquiry and investigation, pending or threatened litigation or proceeding against or affecting the Guarantor

before any court, governmental authority, commission or arbitrator which, if successful, could reasonably be expected to have a material adverse affect on the ability of the Guarantor to perform its obligations under this Guarantee;

(g) the Guarantor's payment obligations under this Guarantee are not subordinated to any of its senior unsecured debt obligations, other than obligations that are mandatorily preferred by law;

(h) the Guarantor acknowledges that it is familiar with the terms of this Guarantee and the Subcontracts entered into as of the date hereof between the Subcontractor and the Contractors.

12. The Guarantor covenants that, upon demand from the Contractors, it will perform all acts and execute all deeds and documents reasonably necessary to give full effect to the provisions hereof and to ensure that this Guarantee will be at all times enforceable against the Guarantor.

13. Any amount not paid when due hereunder shall bear interest at the interest rate set out in the Subcontracts, provided that such interest will not be in duplication of any interest payable pursuant to the Subcontracts and claimed hereunder.

14.

(a) If, for the purposes of obtaining judgment in any court, it is necessary to convert a sum due hereunder to the Contractors in one currency (the **"Original Currency"**) into another currency (the **"Judgment Currency"**), the Guarantor agrees, to the fullest extent that it may effectively do so under applicable law, that the rate of exchange used shall be that at which in accordance with normal banking procedures the Contractors could purchase the Original Currency with the Judgment Currency on the Business Day preceding that on which final judgment is paid or satisfied.

(b) The obligations of the Guarantor in respect of any sum due in the Original Currency from it to the Contractors under this Guarantee shall, notwithstanding any judgment in any Judgment Currency, be discharged only to the extent that, on the Business Day following receipt by the Contractors of any sum adjudged to be so due in such Judgment Currency, it may in accordance with normal banking procedures purchase the Original Currency with such Judgment Currency. If the amount of the Original Currency so purchased is less than the sum originally due to the Contractors in the Original Currency, the Guarantor agrees, as a separate obligation and notwithstanding any such judgment, to indemnify the Contractors against such loss and, if the amount of the Original Currency so purchased exceeds the sum originally due to the Contractors in the Original Currency, they shall remit such excess to the Guarantor.

15.

(a) All payments required to be made by the Guarantor hereunder shall be made to the Contractors, free and clear of, and without deduction or withholding for, any and all present and future Taxes. If as a result of this Guarantee the Guarantor shall be required by law to deduct any Taxes from or in respect of any sum payable hereunder (other than any amount the Subcontractor would have been required to deduct or withhold pursuant to the Subcontracts), (a) the sum payable shall be increased as much as shall be necessary so that after making all required withholdings and deductions (including withholdings and deductions applicable to additional sums payable under this Section 15) the Contractors receive an amount equal to the sum they would have received had no such withholdings or deductions been made, (b) Guarantor shall make such withholdings and deductions and (c) Guarantor shall pay the full amount withheld or deducted to the relevant taxing or other governmental authority in accordance with applicable law.

(b) In addition, the Guarantor hereby agrees to indemnify and, within ten (10) Business Days of demand therefor, pay the Contractors for the full amount of Taxes (except for Excluded Taxes imposed on any amount paid pursuant to this Section 15) paid by the Contractors, or that arise from any payment made under this Guarantee, and any penalties, interest and reasonable expenses arising from, or with respect to, those Taxes paid by the Contractors.

(c) For the purposes hereof, **"Taxes"** means any and all present or future taxes, levies, imposts, duties, deductions, charges or withholdings imposed by any governmental authority, including any and all present or future stamp or documentary taxes or any other excise or property taxes, charges or similar levies arising from any payment made under this Guarantee or from the execution, delivery or enforcement of, or otherwise with respect to, this Guarantee and **"Excluded Taxes"** means any taxes based on the net income of the Contractors (including franchise taxes imposed in lieu of net income taxes) imposed by (x) the Canadian federal government, or (y) the jurisdiction where such party is organized or has its principal office.

16. The Contractors' right under this Guarantee may be assigned by the Contractors only in conjunction with an assignment of the Contractors' rights under the Subcontracts, and only to permitted assigns of the Contractors' rights under the Subcontracts.

17. No action or proceedings for any breach of this Guarantee shall be commenced against the Guarantor after the expiry of the limitation period in respect of the underlying obligation of the Subcontractor under the Subcontracts.

18. The invalidity, illegality or unenforceability in whole or in part of any of the provisions of this Guarantee shall not affect the validity, legality and enforceability of the remaining part or provisions of this Guarantee. The obligations and liabilities of the Guarantor hereunder shall not be impaired, diminished, abated or otherwise affected by the commencement by or against the Guarantor of any proceedings under any bankruptcy or insolvency law or laws relating to the

relief of debtors, re-adjustment of indebtedness, reorganization, arrangements, compositions or extensions or other similar laws.

19. The Guarantor represents and warrants that this Guarantee is its legally binding obligation, enforceable in accordance with its terms, and that all necessary governmental, corporate and other consents and authorisations for the giving and implementation of this Guarantee have been obtained. This Guarantee and all obligations of the Guarantor hereunder shall be binding upon the respective successors and assigns of the Guarantor (including a debtor-in-possession on behalf of the Guarantor) and shall, together with the rights and remedies of the Contractors, enure to the benefit of and be enforceable by the Contractors, and their successors and permitted transferees. The Guarantor may not assign, transfer, charge, dispose of or otherwise alienate any interest in or obligation under this Guarantee without the prior written consent of the Contractors, in their sole discretion.

20. Any notice or demand ("**Communication**") hereunder shall be duly signed by or on behalf of a duly authorised officer of the person giving the Communication and sent by hand delivery, courier or registered mail to the following addresses:

(a) If to Guarantor:

ALSTOM Transport SA
48 Rue Albert Dhalenne
93000 St Ouen, France

Attention: Valérie Astier, Secretary
Fax: +33- 1-57-06-88-68
e-mail: valerie.astier@transport.alstom.com

With copy to :

ALSTOM
801 Pennsylvania Ave Suite 855
Washington, DC 20004

Attention: Isabelle Melody, VP Legal and Contract NAM
Fax: +1 202-495-4961
e-mail: isabelle.melody@transport.alstom.com

(b) 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
Email: David.Whyte@snclavalin.com
Fax: 416.231.5356

With copies to:

Dragados Canada, Inc.
150 King Street West, Suite 2103, P.O. Box 48
Toronto, Ontario M5H 1J9

Attention: Manuel Rivaya, Executive Vice President
Email: mrivaya@dragados-canada.com
Fax: +1 647-260-5002

EllisDon Corporation
800-89 Queensway Avenue
Mississauga, ON, N5B 2V2

Attention: Jamie Haldenby
Fax: 905-896-8911
Email: jhaldenby@ellisdon.com

(c) If to the Maintenance Contractor

Rideau Transit Maintenance General Partnership
1 First Canadian Place, Suite 6000
PO Box 367, 100 King Street West,
Toronto, Ontario M5X 1E2

Fax: 416-365-7886
Attention: Marc Devlin

With copies to:

ACS RT Maintenance Partner Inc.
c/o ACS Infrastructure Canada Inc.
155 University Avenue, Suite 1800, Toronto, ON, M5H 3B7
Attention : Nuria Haltiwanger

Email: nhaltiwanger@acsinfra.com
Fax: 1-786-272-7992

ProTrans RT Maintenance Partner Inc.
c/o SNC-Lavalin O&M

304 The East Mall, Suite 900, Toronto, ON, M9B 6E2
Attention : Marc Devlin - President – Protrans

Email : marc.devlin@snclavalinom.com
Copy to: presidentprotransrtmaintenancepartnerinc@snclavalinom.com
corporatesecretary@snclavalinom.com,
generalcounsel@snclavalin.com,
corporatesecretary@snclavalin.com
Fax : 416-207-8020

EllisDon RT Maintenance Partner Inc.
c/o 89 Queensway Avenue West, Suite 800
Mississauga, ON L5B 2V2.

Attn: John Bisanti
Email : jbisanti@ellisdon.com
Fax : 905 896 8911

Any party may change its address for Communication to another address by prior Communication in writing to the other party.

21. This Guarantee shall be governed by the laws of the Province of Ontario and the laws of Canada applicable therein without regard to conflicts of laws principles, and all actions or proceedings in respect of any claim arising out of or related to this Guarantee, whether in contract, tort, at law or in equity, shall be brought in the courts of the Province of Ontario.

22. This Guarantee may be executed in any number of counterparts, and this has the same effect as if the signatures on the counterparts were on a single copy of this Guarantee.

23. Notwithstanding any other provision of this Guarantee:

(a) in no event shall the aggregate liability of the Guarantor under this Guarantee, to the Contractors and the corporations and partners forming the Contractors collectively, exceed the maximum aggregate liability of the Subcontractor set out in the Option Agreement at Section 9 (Limitation of Liability) thereof, but this limit of liability:

(i) shall be subject to the same exceptions as apply to the limit of liability of the Subcontractor;

(ii) shall not apply to amounts payable by the Guarantor pursuant to Section 15 arising from the deduction of Taxes; and

(iii) shall not apply to interest and enforcement costs payable under this Guarantee;

(b) in determining the Guarantor's liability under this Guarantee other than section 2(c) above, the Guarantor shall have the benefit of all (but no greater) rights, defences and limitations that the Subcontractor would have been entitled to assert under the Subcontracts;

(c) in determining the Guarantor's liability under section 2(c) above, such liability shall be determined as if the Guarantor had the benefit of all (but no greater) rights, defences and limitations that the Subcontractor would be entitled to assert under the Subcontracts if the obligation that is unenforceable, invalid or illegal were enforceable, valid or legal;

(d) notwithstanding paragraph (c) above (but without prejudice to the Guarantor's liability for claims properly made against the Subcontractor within applicable limitation periods), where an obligation of the Subcontractor has become unenforceable due to the expiry of applicable limitation periods, the Guarantor's liability under this Guarantee shall be determined as if the Guarantor had the benefit of the same limitation periods that the Subcontractor as a member of the Subcontractor would be entitled to assert under the Subcontracts; and

(e) The corporations and partners forming the Contractors, whether alone or together, may issue a single written demand under Section 2(a) in respect of each failure of the Subcontractor to perform any obligation, duty or undertaking under the Subcontracts or to make payment of any sum due and payable thereunder.

[SIGNATURE PAGE TO FOLLOW]

EXHIBIT G – FORM OF LETTER OF CREDIT

[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 OR purchase order OR agreement]* 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 *[#]* 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 *[currency and amount in figures and letters]* 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 *[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 requiring 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").

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 Quebec and Canada applicable therein.

NAME OF BANK

*per:*_____

*Signature:*_____

*Signature:*_____

EXHIBIT "A"

T
his 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 clause *[insert clause no.]* 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)* "

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

EXHIBIT H

VEHICLE TESTING SCHEDULE

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

OTTAWA LIGHT RAILTRANSIT PROJECT

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ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

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ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

1 INTRODUCTION

The object of this section is to define the testing activity that will be performed by Alstom on the Ottawa LRT vehicles.

2 SERIAL TESTS

The vehicles serial tests are performed on each vehicle to confirm, by simplified tests, the compliance to design performances within the limit given by the manufacturing site where they are performed.

The serial tests do not cover the interface and commissioning activities with other subsystems (radio, CBTC...).

The serials tests will be performed in an Alstom facility for the two first vehicles and in Ottawa MSF for the serial vehicles (3 to 34)

2.1 Serial Test plan, configuration management

The Serial test Plan defines the scope of each test, the main test phases, the main validation infrastructure and tools.

Particular attention will be pay to the Configuration management in order to have consistent test plan, tools, vehicles hardware & software. Tools will be managed to ensure proper calibration.

2.2 Serial Tests descriptions

- tests on current return circuits and protection circuits
- dielectric strength and insulation of all 1500 V and low voltage circuits
- geometric checks
- weighing
- vehicle water tightness check
- driver's cab control devices tests
- exterior signalling and lighting circuits tests
- traction functional check
- braking functional check
- door functional tests
- ventilation, cooling and heating systems functional test
- static converter tests

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Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

- tests relative to traction – braking circuits (tram empty with no load)
- tests relative to brake system control unit and hydraulic circuits
- tests of wheel flange lubrication fittings
- Low speed traction/braking tests

3 ACCEPTANCE TESTS

The vehicles acceptance tests are the complement to the serial tests. These tests are performed on each vehicle to confirm, by simplified tests, the compliance to design performances in the actual operational environment. They are performed on a significant operational portion of the Ottawa Confederation line track (approximately 4 km) with functioning catenary system.

The acceptance tests do not cover the interface and commissioning activities with other subsystems (radio, CBTC...).

The acceptance tests will be performed on Ottawa Confederation line for all vehicles.

3.1 Acceptance testing for LRT produced in the Alstom manufacturing site

The Acceptance test Plan defines the scope of each test, the main test phases, the main validation infrastructure and instrumentation

3.2 Acceptance tests description

- LV and HV system start up
- Driver cab activation
- Door cycling tests
- Traction / Braking functional test
- Event recorder functional test

4 TYPE TESTS

Purpose of type testing is to demonstrate compliance of the vehicle with the technical specification and with the legal requirements. A type test gives the proof that the specified contractual performance and functional requirement has been achieved.

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ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

4.1 Quality Management

The Alstom Validation & Certification department has incorporated in its quality system the requirements set forth in the EN 17025 "General Requirements for the Competence of Testing and Calibration Laboratories." The Alstom test team is organize according this quality system structures to provide each project with objective and accurate testing results. This team is networked with Alstom accredited test laboratories.

4.2 Type test plan

The Type test Plan defines the scope of each test, the main test phases, the main validation infrastructure and instrumentation.
The type test plan will cover the full range of activities from component tests, to dynamic performance type tests. These tests are performed on new components, or new sub-systems, produced during the industrial process.

4.3 Test infrastructures

The two first vehicles will support the vehicle type tests. Static and low speed dynamic test will be performed in an Alstom plant. The "high" speed type testing will be performed in a specific test facility (test ring).

The car-body static compression tests will be performed in a dedicated facility.

A climatic chamber will be used to perform the climate chamber tests (see Chapter 5)

4.4 Type tests description

See appendix A

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Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

5 CLIMATIC TESTING

Climatic testing will be conducted at sub-system level and/or vehicle level. Tests conducted at vehicle level will be performed in a climatic chamber on a half vehicle. Tests conducted at sub-system could be performed by the sub-system OEM as part of the sub-system type test or mounted on the vehicle in the climatic chamber. This will be depending on relevance and convenience.

5.1 Sub-system level testing

5.1.1 Low temperature testing:

For all sub-system:

- Long term storage test at temperature of -38°C
- Performance test after storage at -38°C

For sub-systems mounted on the roof or under-frame (HVAC, traction cubicle ...):

- Performance test at -38°C

5.1.2 Testing related with ice

The performance of the following sub-system will be validated in case of ice accretion:

- Brake callipers
- Doors
- Pantograph
- Coupler

Ice impact test will be performed on equipment mounted under-frame that will not be protected from ice impact by a specific device.

5.1.3 Testing related with snow

The performance of the following sub-system will be validated in case of snow:

- Brake callipers
- Forward vision
- Lightning
- Horn
- Doors
- Pantograph
- Coupler
- Air intakes
- Roof mounted cubicles

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Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

5.1.4 Testing related with rain

The performance of the following sub-system will be validated in case of rain:

- Forward vision
- Roof mounted cubicles

5.2 Vehicle level testing

5.2.1 Functional validation

The following tests will be performed in climatic chamber on a half vehicle:

- Vehicle behaviour at -38°C
- Vehicle start-up at -25°C
- Vehicle start-up at -25°C after 5 hours storage at -38°C and application of the warm-up procedure
- Vehicle powered-on at -38°C for at least 5 hours and exposed to +20°C

5.2.2 Climatic comfort validation

The following tests will be performed in climatic chamber on a half vehicle:

- Heating test:
  - Extreme low temperature -38°C
  - Heating performance / -25°C exterior / no passenger / No sun / Door closed / train at standstill
  - Heating regulation : 3 points to be agreed with customer
  - K factor (Overall heat transfer UA)
- Cooling test:
  - Cooling performance / 30°C, 45 % RH exterior / AW2 passenger load / 700 W/m² / Door closed / train at standstill
  - Cooling regulation : 3 points to be agreed with customer
  - High temperature cut-off

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ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

6 COMMISSIONING

Alstom will support RTG in performing the system commissioning to prove that the full system is ready for the revenue service in the limit of its scope as defined by the contract between RTG and Alstom.

For example, Alstom will contribute to the following tests

- CBTC interface tests
- CBTC performance tests
- Radio System interface tests
- Radio operation Test
- Vehicle to ground communication tests
- Rear vision system tests
- Energy consumption test according to "Traction Consumption" procedure attached to the LOI

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Vehicle testing schedule

rev 1

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7 APPENDIX A: LIST OF TYPE TESTS

Dimensional & Gauge	
	Gauging - Static Gauge Test
	Lifting ability test
	Dimensional - Outside dimensions
	Dimensional - Bogie / Car & Car / Car Clearance
	Dimensional - Hose and cables length
	Dimensional - Current Collection
	Watertighness tests
Electromagnetic Compatibility	
	Inspection of cabling by EMC expert
	EMC preliminary tests
	Compatibility with track/vehicle signalling systems (ATC/ATP)
	Compatibility with telecommunication circuits (psophometric current)
	Human exposure to EMI (DC & AC magnetic field inside and oustide RS)
Acoustics / Noise	
	Vibroacoustic measurements of equipment installed in the vehicle
	External noise at V=0
	Internal noise at V=0
	External noise at Vmax on test track
	Internal noise at Vmax on test track
	Internal noise measurement at 65km/h in tunnel
Railway Dynamics	
	Gauging - Coefficient of flexibility
	Safety of running
	Ride comfort tests
Weight management & allocation	
	Invidual section weighing
	Vehicle wheighing

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Vehicle testing schedule

rev 1

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HVAC / Winterisation / Climatic adaptation - Half vehicle tests	
	Half vehicle Functional validation · Vehicle behaviour at -38°C · Vehicle start-up at -25°C · Vehicle start-up at -25°C after 5 hours storage at -38°C and application of the warm-up procedure · Vehicle powered-on at -38°C for at least 5 hours and exposed to +20°C
	Climatic comfort validation · Heating test: · Extreme low temperature -38°C · Heating performance / -25°C exterior / no passenger / No sun / Door closed / train at standstill · Heating regulation : 3 points to be agreed with customer · K factor (Overall heat transfer UA) · Cooling test: · Cooling performance / 30°C, 45 % RH exterior / AW2 passenger load / 700 W/m² / Door closed / train at standstill · Cooling regulation : 3 points to be agreed with customer · High temperature cut-off
Auxiliary supply	
	Electrical energy functional test
	Battery autonomy and charging tests
	Consumption and protection of electrical tri-phase auxiliaries
	Loads startup
Mechanical Brake	
	Air System - Operation of Compressed air system test & Provide pneumatic energy functional test
	Leveling system performance test
	Hydraulic system tests (tightness & functional)
	Mechnical Braking functionnal tests
	Mechanical Braking - Wheel-slide protection tests
	Mechanical Braking performance tests
	Parking brake tests
	Emergency towing-pushing
Doors	
	Passenger evacuation
	Driver evacuation
	Doors functional test in single unit
	Doors functional test in multiple unit

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Vehicle testing schedule

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Safety earthing	
	Electrical resistance of mounted wheel axles
	Vehicle earthing
Fire protection System	
	Fire / smoke detection (Perf.)
	Fire and smoke detection functional test
Horn & Headlights	
	Head-light
	Tail light
	Horns
Internal lighting	
	Lighting system performance test
	Lighting functional test
Sanding	
	Sanding system
PAPIS	
	Equipment integration
	Network performances
	Alarms
	Sonorisation
	Passagers intercom
	Passengers information displays (interior, exterior, reservation)
	Vidéo-surveillance (CCTV) functionnal test
	Public address and passenger information functional test
TCMS	
	Vehicle control network functional test
	Driver cab functional test including diagnostics
	Train control network functional tests
	Diagnostic system tests
	Data transmission tests
	Vehicle Control System tests
	Event recorder Performance test
	Multiple unit functionnal tests

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Vehicle testing schedule

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Traction	
	Traction/Vehicle interfaces validation
	HV system start up
	Auxiliary converter
	Maintenance mode - Reduced power test
	Traction aeraulics tests
	Traction/braking, emergency braking, brake blending
	Drift and direction of running
	Traction and electrical braking functional test
	Antislip tests
	Antiskid tests
	Traction performance tests
	Electrical braking performance tests
	Braking - Traction and braking thermal tests
	Current collection tests
Component type test	
	Windscreen performances
	Bogie System (trailer and motor bogies)
	Bogie frame
	Bogie fatique test
	Bogie static load test
	Main circuit breaker
	Traction converter
	Braking resistor
	Motor
	CarbodyShell
	Fire barriers
	Door test on TSS bench
	Door Panel Strength Tests
	Automatic coupler
	Seats
	Heater gard
	HVAC test on test bench
	Event recorder
	Smoke detector

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Vehicle testing schedule

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Component winterisation tests	
	Low temperature testing:
	Testing related with ice
	Testing related with snow
	Testing related with rain

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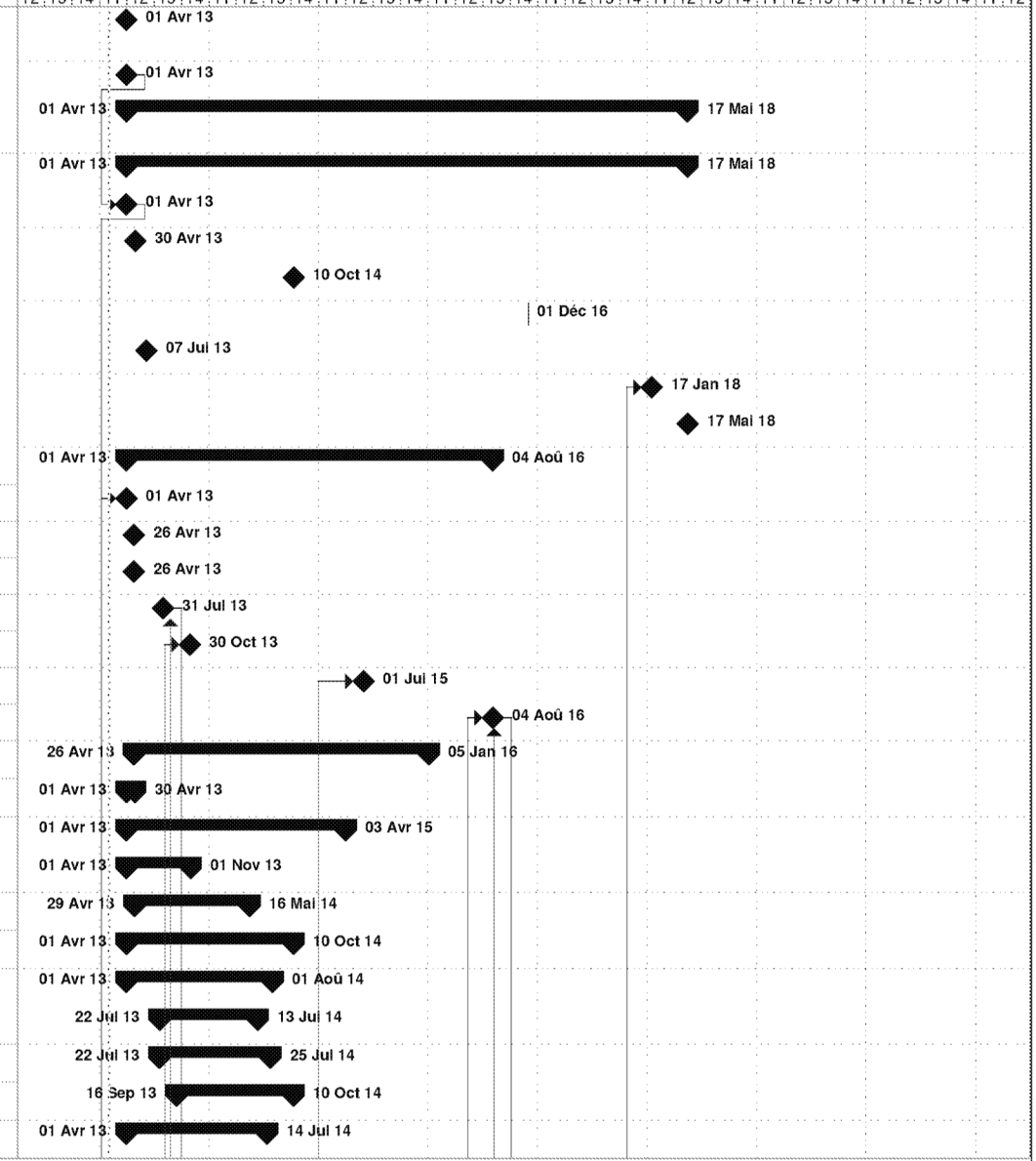
APPENDIX D
PLANNING

APPENDIX D1
VEHICLE PLANNING

OLRT Vehicle planning - 2012 Sept. 28

Milestone name updated
2013 Jan. 29

N°	Nom de la tâche	Début	Fin
1	**LRV Ottawa**	**01 Avr 13**	**01 Avr 13**
2	Notice to Proceed	01 Avr 13	01 Avr 13
3	**Design**	**01 Avr 13**	**17 Mai 18**
4	**Main Milestones**	**01 Avr 13**	**17 Mai 18**
5	M1 : Advance payment upon issuance of the NTP	01 Avr 13	01 Avr 13
6	M2 : Supply of Quality Management Plan and Preliminary Design Package	30 Avr 13	30 Avr 13
7	M3a : Pre-Final Submittal and Approval of Final Design Package	10 Oct 14	10 Oct 14
8	M3b : Final Submittal and Approval of Final Design Package	01 Déc 16	01 Déc 16
9	M4 : Sourcing orders of doors, HVAC, brake, gangway, pantograph	07 Jui 13	07 Jui 13
10	M9 : Acceptance of the Vehicles	17 Jan 18	17 Jan 18
11	M10 : Revenue service start	17 Mai 18	17 Mai 18
12	**Customer and EPC Interfaces Milestones**	**01 Avr 13**	**04 Aoû 16**
13	Final Environmental interfaces specifications (Track, gauge , MSF) freeze	01 Avr 13	01 Avr 13
14	Signaling equipement (Thales) Final interfaces specifications freeze	26 Avr 13	26 Avr 13
15	Radio and platform camera Final interface specification freeze	26 Avr 13	26 Avr 13
16	D&S Freeze meeting (shape for exterior , driver cabs and interior)	31 Jul 13	31 Jul 13
17	D&S Freeze meeting working mock-up (colors , samples	30 Oct 13	30 Oct 13
18	MSF available for manufacturing	01 Jui 15	01 Jui 15
19	Ottawa track available for vehicle dynamic testing	04 Aoû 16	04 Aoû 16
20	**Project Gate Reviews**	**26 Avr 13**	**05 Jan 16**
30	**Project Management**	**01 Avr 13**	**30 Avr 13**
32	**Design**	**01 Avr 13**	**03 Avr 15**
33	**Train System Engineering (TSE)**	**01 Avr 13**	**01 Nov 13**
38	**Expertises**	**29 Avr 13**	**16 Mai 14**
44	**Train Control & Information system (TC&IS)**	**01 Avr 13**	**10 Oct 14**
45	**Train Control Engineering (TCE)**	**01 Avr 13**	**01 Aoû 14**
51	**Train Control & Monitoring System (TCMS)**	**22 Jul 13**	**13 Jul 14**
55	**Public Address & Customer Information System (PACIS)**	**22 Jul 13**	**25 Jul 14**
59	**Electrical**	**16 Sep 13**	**10 Oct 14**
62	**Structure & Fitting**	**01 Avr 13**	**14 Jul 14**

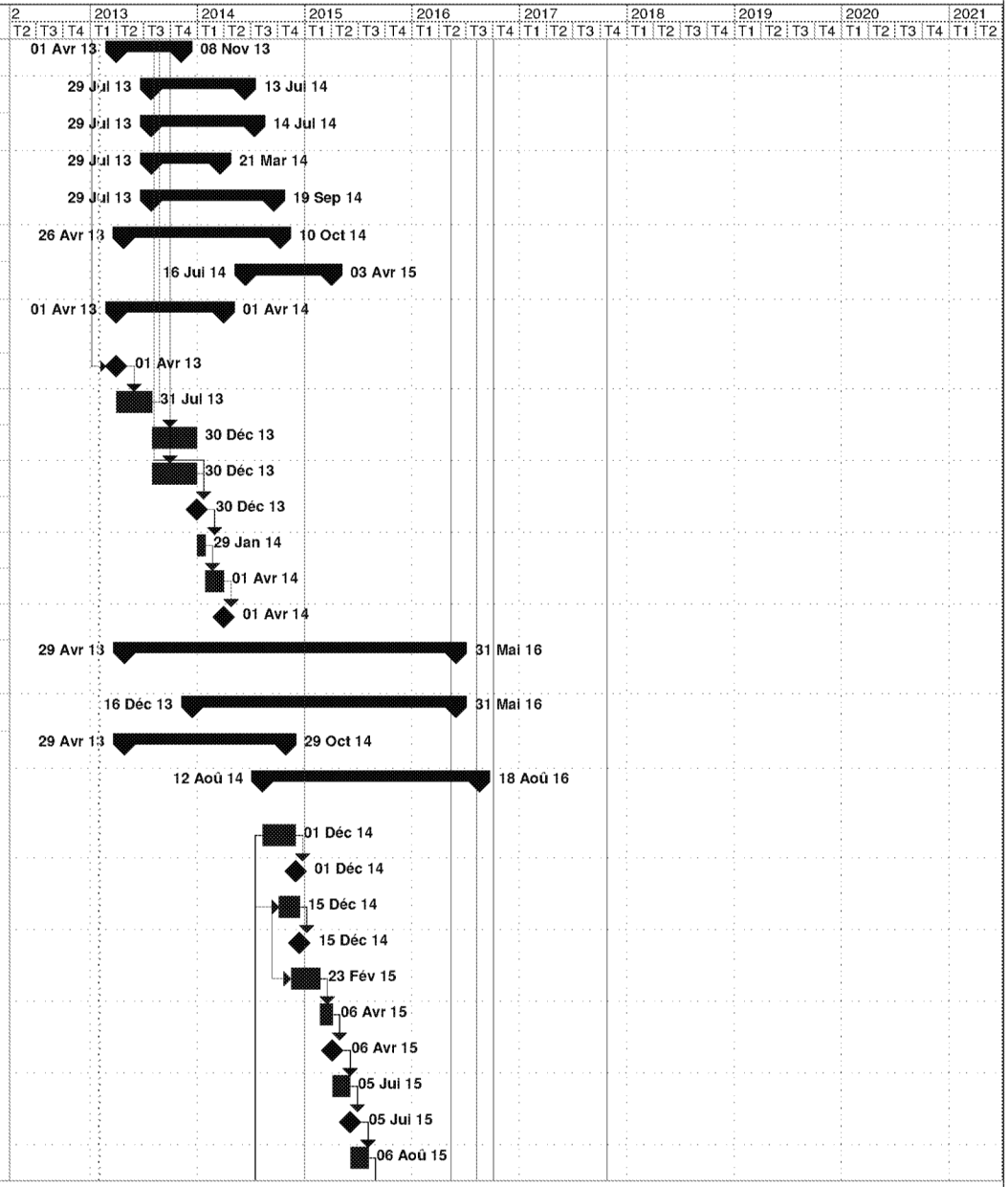


30 Jan 13

OLRT Vehicle planning - 2012 Sept. 28

Milestone name updated
2013 Jan. 29

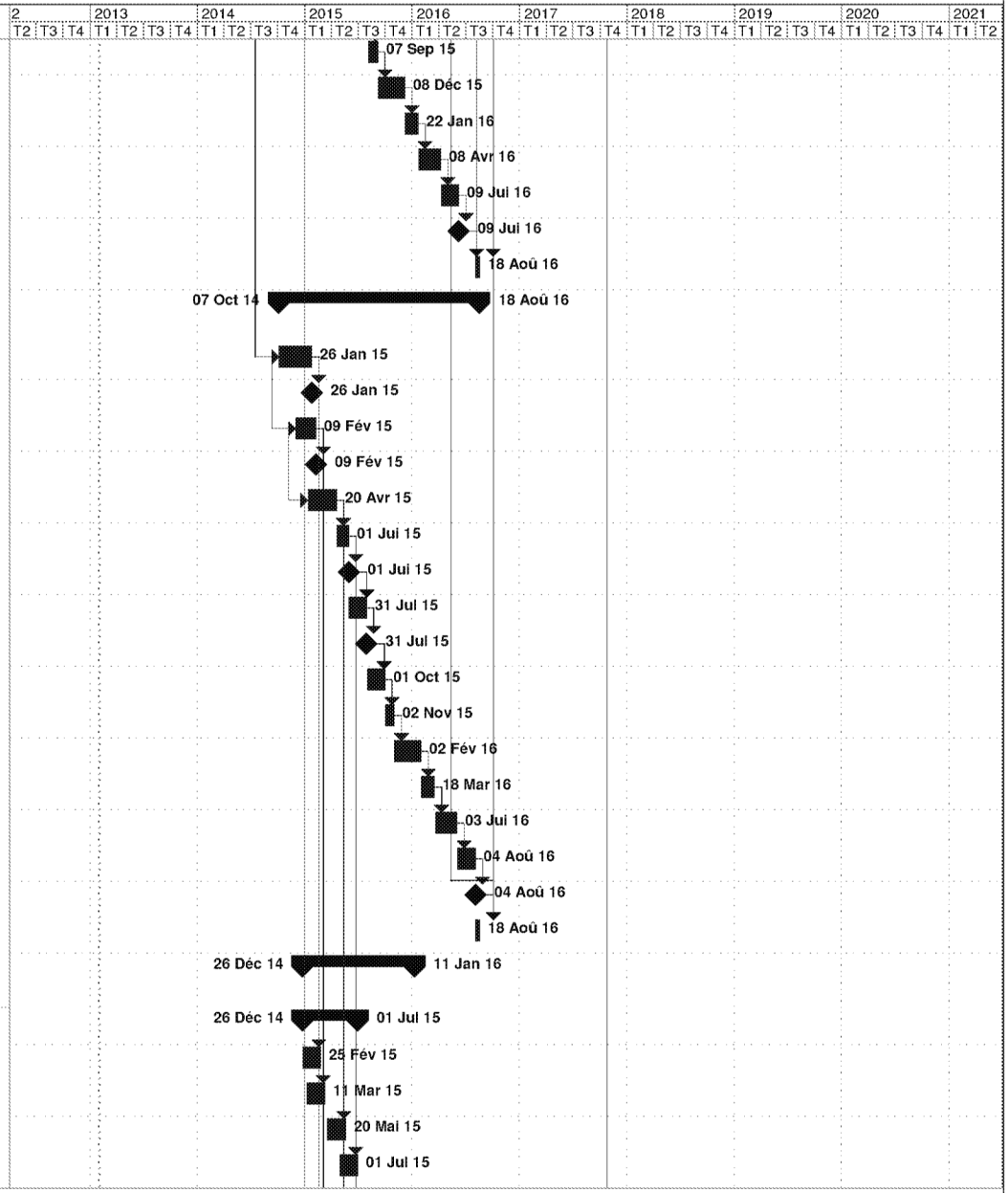
N°	Nom de la tâche	Début	Fin
63	**Train Design Engineering (TDE)**	**01 Avr 13**	**08 Nov 13**
68	**Interiors & Fitting**	**29 Jul 13**	**13 Jul 14**
71	**Carbody Shell (CBS)**	**29 Jul 13**	**14 Jul 14**
74	**Final Element Analysis (FEA) / Calcul & Crash**	**29 Jul 13**	**21 Mar 14**
80	**Bogie & Propulsion**	**29 Jul 13**	**19 Sep 14**
83	**Design Reviews**	**26 Avr 13**	**10 Oct 14**
88	**Subsystems validation**	**16 Jui 14**	**03 Avr 15**
92	**Mock-up**	**01 Avr 13**	**01 Avr 14**
93	Preliminary Customer meeting	01 Avr 13	01 Avr 13
94	Iterative meetings on Aesthetic design & updated proposa	01 Avr 13	31 Jul 13
95	Cab mock-up Manufacturing	01 Aoû 13	30 Déc 13
96	Passenger aera mock-up Manufacturing	01 Aoû 13	30 Déc 13
97	First presentation in Valenciennes	30 Déc 13	30 Déc 13
98	Potential update of the mock-u	31 Déc 13	29 Jan 14
99	Transportation	30 Jan 14	01 Avr 14
100	Delivery in OTTAWA	01 Avr 14	01 Avr 14
101	**Industrialisation & Procurement**	**29 Avr 13**	**31 Mai 16**
102	**Industrialisation**	**16 Déc 13**	**31 Mai 16**
106	**Procurement**	**29 Avr 13**	**29 Oct 14**
109	**Vehicle-1 Manufacturing**	**12 Aoû 14**	**18 Aoû 16**
110	Carbody shell Manufacturing	12 Aoû 14	01 Déc 14
111	M5 : Carbodyshell veh 1	01 Déc 14	01 Déc 14
112	Sub-assembling-fitting	07 Oct 14	15 Déc 14
113	M6 : Sub-assembly finished veh 1	15 Déc 14	15 Déc 14
114	Ext.& Int. section fitting	18 Nov 14	23 Fév 15
115	Vehicule fitting & control	24 Fév 15	06 Avr 15
116	M7 : end of fitting veh 1	06 Avr 15	06 Avr 15
117	Vehicle-1 Serial testings #1	07 Avr 15	05 Jui 15
118	M8 : end of serial testing veh 1	05 Jui 15	05 Jui 15
119	Vehicle-1 Testings #2	08 Jui 15	06 Aoû 15



OLRT Vehicle planning - 2012 Sept. 28

Milestone name updated
2013 Jan. 29

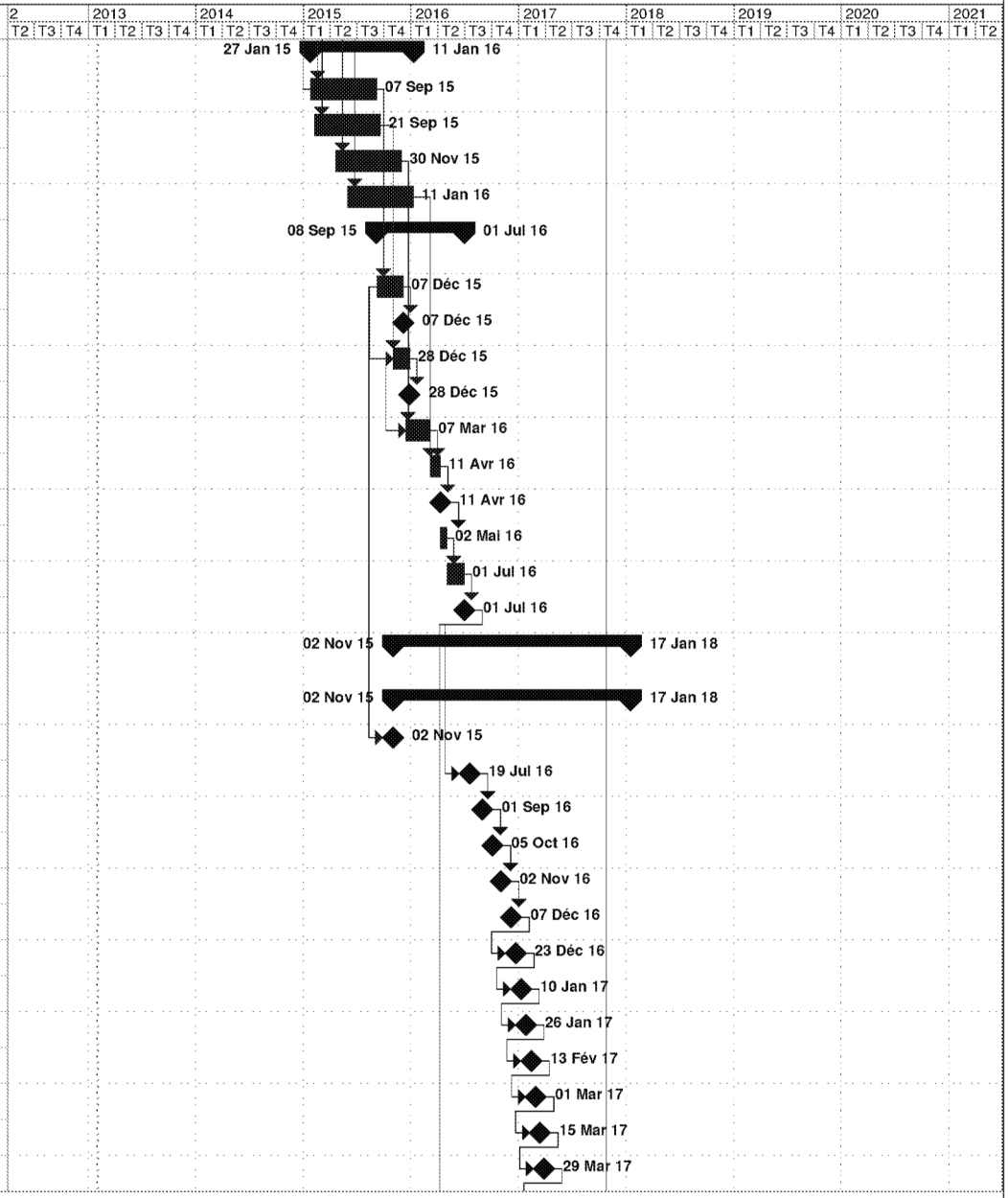
N°	Nom de la tâche	Début	Fin
120	Vehicle-1 and 2 Preliminary multiple units type test	07 Aoû 15	07 Sep 15
121	Vehicle-1 Testing #3	08 Sep 15	08 Déc 15
122	Vehicle-1 and 2 Preliminary multiple units type test	09 Déc 15	22 Jan 16
123	Vehicle-1 Type Testing #4	25 Jan 16	08 Avr 16
124	Vehicle-1 Preparation and transportation	11 Avr 16	09 Jui 16
125	Vehicle-1 Delivered on Ottawa Site	09 Jui 16	09 Jui 16
126	Vehicle-1 Routine test on Ottawa track	05 Aoû 16	18 Aoû 16
127	**Vehicle-2 Manufacturing (VPF)**	**07 Oct 14**	**18 Aoû 16**
128	Carbody shell Manufacturing	07 Oct 14	26 Jan 15
129	M5 : Carbodyshell veh 2	26 Jan 15	26 Jan 15
130	Sub-assembling-fitting	02 Déc 14	09 Fév 15
131	M6 : Sub-assembly finished veh 2	09 Fév 15	09 Fév 15
132	Ext.& Int. section fitting	13 Jan 15	20 Avr 15
133	Vehicule fitting & control	21 Avr 15	01 Jui 15
134	M7 : end of fitting veh 2	01 Jui 15	01 Jui 15
135	Vehicle-2 Serial testings #1	02 Jui 15	31 Jul 15
136	M8 : end of serial testing veh 2	31 Jul 15	31 Jul 15
137	Vehicle-2 Testings #2	03 Aoû 15	01 Oct 15
138	Vehicle-1 and 2 Preliminary multiple units type test	02 Oct 15	02 Nov 15
139	Vehicle-2 Testing #3	03 Nov 15	02 Fév 16
140	Vehicle-1 and 2 Preliminary multiple units type test	03 Fév 16	18 Mar 16
141	Vehicle-2 Type Testing #4	21 Mar 16	03 Jui 16
142	Vehicle-2 Preparation and transportation	06 Jui 16	04 Aoû 16
143	Vehicle-2 Delivered on Ottawa Site	04 Aoû 16	04 Aoû 16
144	Vehicle-2 Routine test on Ottawa track	05 Aoû 16	18 Aoû 16
145	**Transfer of Technology**	**26 Déc 14**	**11 Jan 16**
146	**Documentation transfer**	**26 Déc 14**	**01 Jul 15**
147	Structure manufacturing documentation transferd	26 Déc 14	25 Fév 15
148	Sub-assembly documentation transfer	09 Jan 15	11 Mar 15
149	Fitting documentation transfe ravailable	20 Mar 15	20 Mai 15
150	Coupling documentation transfer	01 Mai 15	01 Jul 15



OLRT Vehicle planning - 2012 Sept. 28

Milestone name updated
2013 Jan. 29

N°	Nom de la tâche	Début	Fin
151	**Tools transfer**	**27 Jan 15**	**11 Jan 16**
152	Tools dismounting and transportation frame, roof, sides, cab	27 Jan 15	07 Sep 15
153	Tools dismounting and transportation for Sub-assembly	10 Fév 15	21 Sep 15
154	Tools dismounting and transportation for Fitting	21 Avr 15	30 Nov 15
155	Tools dismounting and transportation for Coupling	02 Jui 15	11 Jan 16
156	**Vehicle-3 Manufacturing (CA)**	**08 Sep 15**	**01 Jul 16**
157	Carbody shell Manufacturing	08 Sep 15	07 Déc 15
158	M5 : Carbodyshell veh 3	07 Déc 15	07 Déc 15
159	Sub-assembling-fitting	03 Nov 15	28 Déc 15
160	M6 : Sub-assembly finished veh 3	28 Déc 15	28 Déc 15
161	Ext.& Int. section fitting	15 Déc 15	07 Mar 16
162	Vehicule fitting & control	08 Mar 16	11 Avr 16
163	M7 : end of fitting veh 3	11 Avr 16	11 Avr 16
164	Vehicle-3 Preparation and transportation	12 Avr 16	02 Mai 16
165	Vehicle-3 Serial testings and Commissioning	03 Mai 16	01 Jul 16
166	M8 : end of serial testing veh 3	01 Jul 16	01 Jul 16
167	**Serial manufacturing 4 to 34 (CA)**	**02 Nov 15**	**17 Jan 18**
168	**Vehicels 4 to 33 Commissioning on OTTAWA track**	**02 Nov 15**	**17 Jan 18**
169	serial manufacturing Start	02 Nov 15	02 Nov 15
170	M8 : end of serial testing veh 4	19 Jul 16	19 Jul 16
171	M8 : end of serial testing veh 5	01 Sep 16	01 Sep 16
172	M8 : end of serial testing veh 6	05 Oct 16	05 Oct 16
173	M8 : end of serial testing veh 7	02 Nov 16	02 Nov 16
174	M8 : end of serial testing veh 8	07 Déc 16	07 Déc 16
175	M8 : end of serial testing veh 9	23 Déc 16	23 Déc 16
176	M8 : end of serial testing veh 10	10 Jan 17	10 Jan 17
177	M8 : end of serial testing veh 11	26 Jan 17	26 Jan 17
178	M8 : end of serial testing veh 12	13 Fév 17	13 Fév 17
179	M8 : end of serial testing veh 13	01 Mar 17	01 Mar 17
180	M8 : end of serial testing veh 14	15 Mar 17	15 Mar 17
181	M8 : end of serial testing veh 15	29 Mar 17	29 Mar 17



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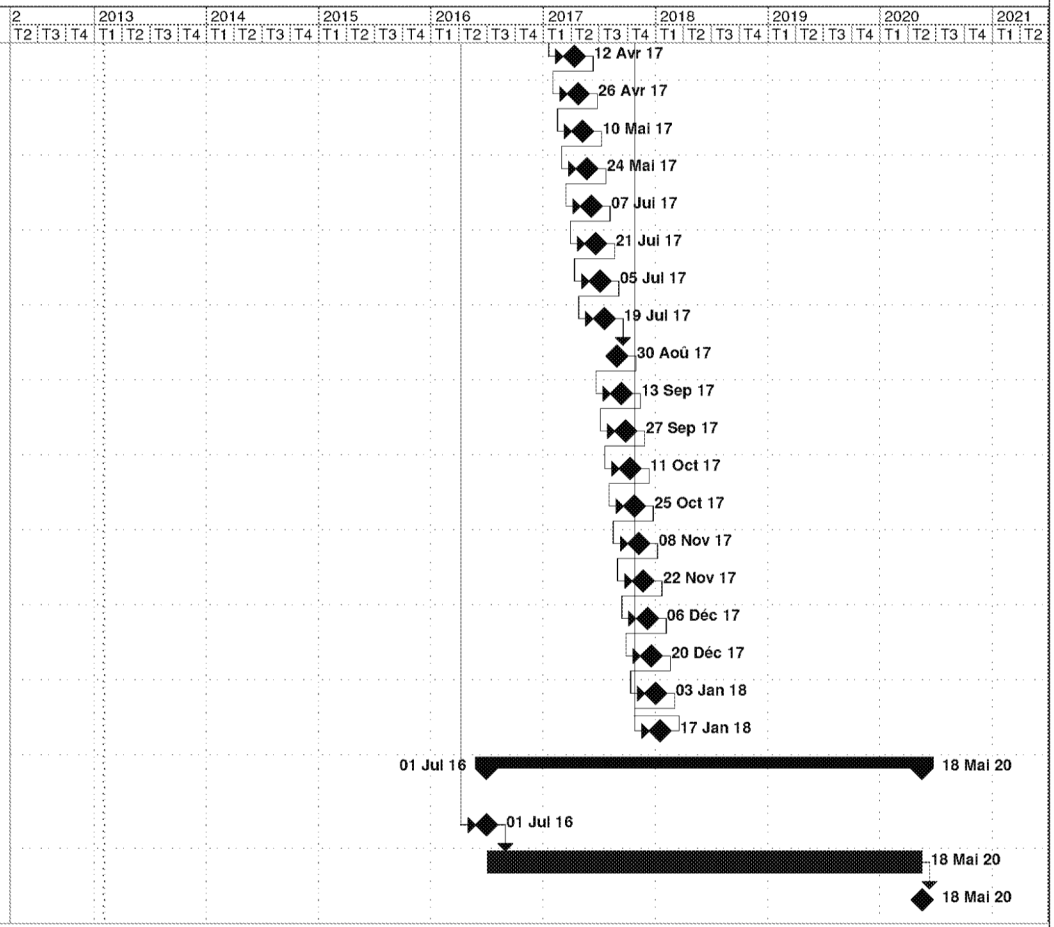
OLRT Vehicle planning - 2012 Sept. 28

Milestone name updated
2013 Jan. 29

N°	Nom de la tâche	Début	Fin
182	M8 : end of serial testing veh 16	12 Avr 17	12 Avr 17
183	M8 : end of serial testing veh 17	26 Avr 17	26 Avr 17
184	M8 : end of serial testing veh 18	10 Mai 17	10 Mai 17
185	M8 : end of serial testing veh 19	24 Mai 17	24 Mai 17
186	M8 : end of serial testing veh 20	07 Jui 17	07 Jui 17
187	M8 : end of serial testing veh 21	21 Jui 17	21 Jui 17
188	M8 : end of serial testing veh 22	05 Jul 17	05 Jul 17
189	M8 : end of serial testing veh 23	19 Jul 17	19 Jul 17
190	M8 : end of serial testing veh 24	30 Aoû 17	30 Aoû 17
191	M8 : end of serial testing veh 25	13 Sep 17	13 Sep 17
192	M8 : end of serial testing veh 26	27 Sep 17	27 Sep 17
193	M8 : end of serial testing veh 27	11 Oct 17	11 Oct 17
194	M8 : end of serial testing veh 28	25 Oct 17	25 Oct 17
195	M8 : end of serial testing veh 29	08 Nov 17	08 Nov 17
196	M8 : end of serial testing veh 30	22 Nov 17	22 Nov 17
197	M8 : end of serial testing veh 31	06 Déc 17	06 Déc 17
198	M8 : end of serial testing veh 32	20 Déc 17	20 Déc 17
199	M8 : end of serial testing veh 33	03 Jan 18	03 Jan 18
200	M8 : end of serial testing veh 34	17 Jan 18	17 Jan 18
201	**Warranty**	**01 Jul 16**	**18 Mai 20**
202	Start of General warranty	01 Jul 16	01 Jul 16
203	Warranty period	04 Jul 16	18 Mai 20
204	End of General Warranty	18 Mai 20	18 Mai 20



30 Jan 13

APPENDIX D2
CONTRACTOR EQUIPMENT SUPPLY DATES

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APPENDIX D

SCHEDULE

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1 SCHEDULE OF WORKS 3

2 SCHEDULE OF EQUIPMENT AND FREE-ISSUE MATERIAL 3

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1 SCHEDULE OF WORKS

Refer to OLRT Vehicle planning dated 2013 Jan 28, 2013 attached.
NTP assumption is February 1st 2013

2 SCHEDULE OF EQUIPMENT AND FREE-ISSUE MATERIAL

2.1 To be able to manufacture the mock up as per the planning, the Construction Contractor shall deliver to the Subcontractor the telecom CBTC and radio equipment referred to in Appendix O - Article 3.8.2 ("Free-Issue Material") no later than 16 December 2013.

2.2 The parties acknowledge that the CBTC, radio and telecom equipment provided by the Construction Contractor in accordance with the last paragraph of Article 1.1 of the Subcontract, shall be delivered to ALSTOM DDP (Incoterm 2011) no later than:

Equipment need date for CBTC/Radio/Telcom			
Vehicle 1	17-Nov-14	Vehicle 17	17-Mar-17
Vehicle 2	17-Nov-14	Vehicle 18	31-Mar-17
Vehicle 3	8-Sep-15	Vehicle 19	13-Apr-17
Vehicle 4	10-Nov-15	Vehicle 20	26-Apr-17
Vehicle 5	15-Jan-16	Vehicle 21	9-May-17
Vehicle 6	14-Mar-16	Vehicle 22	22-May-17
Vehicle 7	4-May-16	Vehicle 23	2-Jun-17
Vehicle 8	23-Jun-16	Vehicle 24	15-Jun-17
Vehicle 9	7-Sep-16	Vehicle 25	29-Jun-17
Vehicle 10	17-Oct-16	Vehicle 26	11-Jul-17
Vehicle 11	17-Nov-16	Vehicle 27	24-Jul-17
Vehicle 12	13-Dec-16	Vehicle 28	4-Aug-17
Vehicle 13	4-Jan-17	Vehicle 29	17-Aug-17
Vehicle 14	24-Jan-17	Vehicle 30	30-Aug-17
Vehicle 15	10-Feb-17	Vehicle 31	12-Sep-17
Vehicle 16	2-Mar-17	Vehicle 32	26-Sep-17
Vehicle 17	17-Mar-17	Vehicle 33	9-Oct-17
Vehicle 18	31-Mar-17	Vehicle 34	20-Oct-17

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APPENDIX E
PAYMENT SCHEDULE

APPENDIX E

TERM OF PAYMENT

FOR THE BASE CONTRACT

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1 MILESTONES & PAYMENT & SCHEDULING.....3

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1 MILESTONES & PAYMENT & SCHEDULING

N°	Milestone	Payment	Due Date	Triggering event
1	Advance payment upon issuance of the notice to proceed.	25 % of Total Subcontract Price	Refer To Appendix E	LOC 10 % LOC 15 % Parent Guarantee
2	Preliminary design elements of the vehicles: Work Breakdown Structure, vehicle layout, Surface area, vehicle Cross Section and quality management plan of the vehicle	5 % of Total Subcontract Price		Supply of the documentation for : Work breakdown Structure, Vehicle Layout, surface area, vehicle cross section, and quality management plan of the vehicle
3a	Pre-Final Submittal and Approval of Final Design Package	2,5 % of Total Subcontract Price		Approval by CC of the Documentation the deliverable list in Appendix A under "DS # 1"
3b	Final Submittal and Approval of Final Design Package	2,5 % of Total Subcontract Price		Approval by CC of the Documentation the deliverable list in Appendix A under "DS # 2"
4	Order of doors, HVAC, brake, gangway, & pantograph	15% of Total Subcontract Price		Purchase orders
5	Carbodyshell	15 % of Total Subcontract Price per vehicle according to the planning		Shipment papers showing delivery of the underframes and roofs at manufacturing site
6	Sub assembly finished	10% of Total Subcontract Price per vehicle according to the planning		Internal quality acceptance certificate of all roofs and underframes for one vehicle

All information within this document is the property of Alstom Transport.

N°	Milestone	Payment	Due Date	Triggering event
7	End of fitting	5% of Total Subcontract Price per vehicle according to the planning		Internal quality acceptance certificate for completion of the assembly of one vehicle
8	End of serial test	5% of Total Subcontract Price per vehicle according to the planning		Internal vehicle serial test report
9	Acceptance of the 34 Vehicles	5% of Total Subcontract Price		34 Vehicle acceptance test reports
10	At Revenue Service	10% of the Total Subcontract Price		At the date of the start of Revenue Service

All information within this document is the property of Alstom Transport.

APPENDIX F
LETTER OF CREDIT AND GUARANTEE FORM

APPENDIX F1 – FORM OF LETTER OF CREDIT

[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 OR purchase order OR agreement]* 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 *[#]* 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 *[currency and amount in figures and letters]* 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 *[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 requiring 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").

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 Quebec 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 clause *[insert clause no.]* 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)* "

APPENDIX F2
GUARANTEE

THIS GUARANTEE is made on _____, 2013

BETWEEN:

(1) **ALSTOM TRANSPORT SA**, a corporation established under the laws of France (the "**Guarantor**"); and

(2) **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, ("**Construction Contractor**").

WHEREAS:

(A) Project Co has on the date hereof entered into an agreement (the "**Project Agreement**") with the City of Ottawa (the "**City**") (a) to design, construct, finance and maintain for a 30 year term, a new light rail transit system in Ottawa, Ontario; (b) to construct, finance and complete the widening of Highway 417, in Ontario; and (c) to construct, install, test and complete the Civic Works, as further described in the Project Agreement (the "**Project**").

(B) Construction Contractor has on the date hereof entered into a engineering, procurement and construction contract with Project Co (the "**Construction Contract**").

(C) This Guarantee is made supplemental to a contract made on or about the date hereof with reference number 507528-P001 (hereinafter called the "**Subcontract**") between Construction Contractor and Alstom Power & Transport Canada Inc. (the "**Subcontractor**") in respect of the Subcontract Works (as defined in the Subcontract).

(D) The Subcontract and the Guarantor are each, directly or indirectly, a wholly-owned subsidiary of ALSTOM.

(E) The Guarantor has agreed to guarantee the obligations of the Subcontractor under the Subcontract.

NOW IT IS HEREBY AGREED as follows:

1. In this Guarantee (including the Recitals) words and expressions shall have the same meanings as are respectively assigned to them in the Subcontract.

2. In consideration of Construction Contractor entering into the Subcontract with the Subcontractor:

(a) the Guarantor absolutely, irrevocably and unconditionally guarantees to Construction Contractor the due and punctual payment, observance and performance by Subcontractor of each and all of the obligations, covenants, warranties, duties and undertakings of the Subcontractor under and pursuant to the Subcontract when and if performance of such obligations, duties and undertakings shall become due according to the terms of the Subcontract and the due payment and discharge of all such sums of money and liabilities due, owing or incurred or payable and unpaid by the Subcontractor to Construction Contractor pursuant to the Subcontract (taking into account any period for payment of such sums and liabilities expressly provided for in the Subcontract) or as a result of any breach of the terms of the Subcontract by the Subcontractor (including all reasonable and documented expenses, including reasonable legal fees and taxes incurred by Construction Contractor in connection with Construction Contractor successfully enforcing any of the above against the Guarantor), to the extent that such amounts are recoverable under the Subcontract, against the Subcontractor and excluding Indirect Losses (as defined in the Subcontract). The Guarantor agrees with Construction Contractor that if and whenever at any time and from time to time the Subcontractor fails to perform any obligation, duty or undertaking under the Subcontract or to make payment of any sum due and payable thereunder, the Guarantor shall promptly on receipt of a written demand from Construction Contractor notifying the Guarantor of such failure and in any event within 5 Business Days (as defined in the Subcontract), pay, perform, cause to perform or discharge such obligations and liabilities, as the case may be, as if the Guarantor instead of the Subcontractor was the Subcontractor under the Subcontract.

(b) to the extent that such amounts are due to Construction Contractor from the Subcontractor under the Subcontract, the Guarantor shall indemnify Construction Contractor, promptly on receipt of written demand from Construction Contractor and in any event within 5 Business Days of receipt of such demand, in respect of any claim, demand, proceedings, liability, loss, damage, costs, charges or expenses, including, for greater certainty, third party claims and the cost of defending any third party claims (and any taxes arising thereon) arising out of any failure by the Subcontractor to perform each and all of the obligations, warranties, duties and undertakings of the Subcontractor or to pay and discharge each and all sums of money and liabilities due, owing, incurred or payable and unpaid by the Subcontractor to Construction Contractor, in each case pursuant to the Subcontract when and if such obligations, warranties, duties and undertakings become due and payable or performable according to the terms of the Subcontract and excluding Indirect Losses (as defined in the Subcontract).

(c) the Guarantor shall indemnify Construction Contractor, promptly upon receipt of written demand from Construction Contractor and in any event within 5 Business Days of receipt of such demand, against any loss or liability suffered by Subcontractor as a result of any obligation guaranteed by the Guarantor being or becoming unenforceable, invalid or illegal (other than as a result of an act or

omission of Construction Contractor) as if the obligation guaranteed had not become unenforceable, invalid or illegal provided that the Guarantor's liability shall be no greater than the Subcontractor's liability would have been if the obligation guaranteed had not become unenforceable, invalid or illegal and provided further that the Guarantor shall not be obligated to perform any obligation to the extent that it would be illegal for it to do so.

3. The Guarantor agrees that this is a guarantee of performance and payment and not merely a guarantee of collection. Construction Contractor shall not be bound or obliged to take any action or legal proceedings against or demand payment from the Subcontractor and the liability of the Guarantor under this Guarantee shall not be conditional or contingent upon pursuit of any remedy against the Subcontractor except as provided for in the Subcontract (although Construction Contractor is entitled to pursue such remedies if it chooses to) or any other person or any collateral subject to any security before seeking satisfaction from the Guarantor of its obligations hereunder. Construction Contractor is under no obligation to marshal or appropriate in favour the Guarantor or to exercise, apply, perfect or recover any security interest or other lien or encumbrance Construction Contractor holds at any time or any funds or property that Construction Contractor may be entitled to receive or have a claim on. Each and every default by the Subcontractor under the Subcontract shall give rise to a separate claim or cause of action hereunder, and separate claims or suits may be brought, as the case may be, hereunder as such default occurs.

4. The Guarantor shall not be exonerated by time being given to the Subcontractor by Construction Contractor nor by any concession or arrangement or waiver or forbearance granted or made by Construction Contractor to or with the Subcontractor or by anything that Construction Contractor may do or omit or neglect to do.

5. Without prejudice to Construction Contractor's rights against the Subcontractor as principal obligor, the Guarantor shall be deemed principal obligor in respect of its obligations under this Guarantee and not merely as surety; accordingly, the Guarantor shall not be discharged nor shall its liability hereunder be affected by any act or thing or means whatsoever by which its said liability would have been discharged or affected if it had not been principal obligor.

6. The Guarantor hereby authorizes (without need for further consent) the Subcontractor and Construction Contractor to make any amendment, addendum or variation to the Subcontract, the due and punctual performance of which amendment, addendum or variation shall be likewise guaranteed by the Guarantor in accordance with the terms of this Guarantee. Except to the extent required to reflect such amendment, addendum or variation, the obligations of the Guarantor hereunder shall in no way be affected by any amendment, variation or addendum to the Subcontract.

7. This Guarantee is a continuing guarantee and, accordingly, shall remain in operation and in full force and effect (notwithstanding any intermediate satisfaction by the Subcontractor or any other person) until all obligations, warranties, duties and undertakings now or hereafter to be carried out or performed and all sums of money and liabilities now or hereafter due, owing,

incurred or payable by the Subcontractor under the Subcontract shall have been satisfied or performed or as the case may be discharged in full and is not revocable and is in addition to and not in substitution for any other security which Subcontractor may at any time hold for the performance of such obligations and may be enforced against the Guarantor without first having recourse to any such security and without taking any steps or proceedings against the Subcontractor, any other guarantor or any other person. In the event that Construction Contractor brings formal legal proceedings against the Subcontractor related to the Subcontract, the Guarantor will be bound by any final judgement made by the court in such proceedings. Notwithstanding anything else contained in this Guarantee, Construction Contractor shall not make a claim pursuant to this Guarantee unless the Subcontractor is in default pursuant to the terms of the Subcontract and notice of such default has been given to the Subcontractor in accordance with the Subcontract.

8. Neither the liability of the Guarantor hereunder nor the rights of Construction Contractor in relation to this Guarantee shall be discharged, released, reduced, impaired or affected by reason of:

(a) any limitation of status or power, disability, incapacity or other circumstance relating to the Subcontractor or any other person, including any insolvency, bankruptcy, liquidation, reorganization (voluntary or otherwise), readjustment, composition, dissolution, winding-up or other proceeding involving or affecting the Guarantor or the Subcontractor;

(b) any failure of the Subcontractor, whether or not without fault on its part, to perform or comply with any of the provisions of the Subcontract, or to give notice thereof to the Guarantor;

(c) the taking or enforcing or exercising or the refusal or neglect to take or enforce or exercise any right or remedy against the Subcontractor or its assets, or the release or discharge of any such right or remedies;

(d) the granting of time, renewals, extensions, compromises, concessions, waivers, releases, discharges and other indulgences to the Subcontractor;

(e) any amendment, variation, modification, supplement or termination of the Subcontract;

(f) any change in the ownership, control, name, objects, businesses, assets, capital structure or constitution of the Guarantor or the Subcontractor;

(g) any merger, amalgamation or consolidation of the Guarantor or the Subcontractor with any person or persons;

(h) the existence of any claim, set-off or other rights which the Guarantor may have at any time against the Subcontractor;

(i) any compromise, release of any security (including any other guarantee, letter of credit or bond), waiver, renewal, extension, indulgence, compromise, amendment, addition, deletion, change, release, discharge or modification of or with respect to any of the obligations guaranteed under this Guarantee;

(j) any failure, neglect or omission on the part of Construction Contractor, as the case may be, or any other person to give the Guarantor notice of the occurrence of any default by the Subcontractor under or with respect to the obligations hereunder, or to realize upon any obligations or liabilities of the Subcontractor;

(k) any judgment or right which the Construction Contractor may have or exercise against the Subcontractor, the Guarantor;

(l) the Subcontract not being duly executed and delivered by the Subcontractor to Construction Contractor; and

(m) the Subcontract (and the performance by the Subcontractor of its obligations under thereunder) not being duly authorized by the Subcontractor.

9. While any amount is payable by the Subcontractor under the Subcontract or any amount is payable by the Guarantor under this Guarantee, the Guarantor shall not claim, recover, accept or prove as creditor or otherwise in competition with Construction Contractor in respect of any monies owing to it by the Subcontractor, on grounds that the Guarantor performed obligations of the Subcontractor under the Subcontract, in the event of any bankruptcy, liquidation or other insolvency proceedings relating to the Subcontractor. If any amount shall be paid by the Subcontractor to the Guarantor, on grounds that the Guarantor performed obligations of the Subcontractor under the Subcontract, in connection with an insolvency proceeding at any time when all guaranteed obligations shall not have been fully satisfied, then such amount shall be used by the Guarantor solely towards performance of the unperformed guaranteed obligations until the guaranteed obligations are satisfied in full.

10. If any payment by the Subcontractor or the Guarantor in respect of the obligations, duties and undertakings of the Subcontractor under and pursuant to the Subcontract is avoided or annulled or must be repaid as a result of insolvency or any similar event, the liability of the Guarantor will continue as if such payment had not occurred (and to the extent necessary, the guarantee of the Guarantor will automatically be reinstated). For greater certainty, the Guarantor agrees that it will remain liable for the performance in full of such obligations even if the Subcontractor is discharged therefrom by applicable legislation relating to bankruptcy, insolvency or reorganization.

11. The Guarantor represents and warrants to Construction Contractor as follows:

(a) the Guarantor is a corporation fully organized, validly existing, authorized to do business and in good standing under the laws of France;

(b) the Guarantor has the requisite corporate power and authority to own its property and assets, transact the business in which it is engaged and to enter into this Guarantee and perform its obligations hereunder.

(c) this Guarantee has been duly authorized, executed and delivered by the Guarantor and constitutes a valid and binding agreement of the Guarantor and is enforceable against the Guarantor in accordance with the terms of this Guarantee, except to the extent limited by equitable principles and laws affecting the rights of creditors generally, and no other corporate proceedings on the part of Guarantor or its affiliates are necessary to authorize this Guarantee or the transactions contemplated hereby;

(d) no consent, authorization or approval or other action by, and no notice to or filing with, any governmental authority or other regulatory body or third party in any jurisdiction is required for the due execution, delivery and performance by the Guarantor of this Guarantee and its signatory is a duly authorized representative and has the power to bind the Guarantor by signing this Guarantee;

(e) as of the date hereof, the execution, delivery, and performance of this Guarantee does not and will not (i) conflict with or result in a default, breach or violation of any of the terms, conditions or provisions of the Guarantor's certificate or articles of incorporation, bylaws or other organizational documents of the Guarantor, as applicable, or (ii) constitute an event which would permit any person or entity to terminate rights or accelerate the performance or maturity of any indebtedness or obligation of the Guarantor or result in the creation of any lien upon any or the properties or assets of the Guarantor, or (iii) violate any order, writ, injunction decree, arbitration award, statute, rule or regulation applicable to the Guarantor or any of its properties or assets, or (iv) constitute an event which could require any consent of a third party or under any agreement to which Guarantor or its properties or assets is bound, or (vi) conflict with any agreement, instrument or arrangement to which the Guarantor is now a party or by which the Guarantor is, or may be, bound, or constitute a default thereunder,

(f) as of the date hereof, except as disclosed by the Guarantor, there is no actual, or, to the knowledge of the Guarantor having made due enquiry and investigation, pending or threatened litigation or proceeding against or affecting the Guarantor before any court, governmental authority, commission or arbitrator which, if successful, could reasonably be expected to have a material adverse affect on the ability of the Guarantor to perform its obligations under this Guarantee;

(g) the Guarantor's payment obligations under this Guarantee are not subordinated to any of its senior unsecured debt obligations, other than obligations that are mandatorily preferred by law;

(h) the Guarantor acknowledges that it is familiar with the terms of this Guarantee and the Subcontract entered into as of the date hereof between the Subcontractor and Construction Contractor.

12. The Guarantor covenants that, upon demand from Construction Contractor, it will perform all acts and execute all deeds and documents reasonably necessary to give full effect to the provisions hereof and to ensure that this Guarantee will be at all times enforceable against the Guarantor.

13. Any amount not paid when due hereunder shall bear interest at the interest rate set out in the Subcontract, provided that such interest will not be in duplication of any interest payable pursuant to the Subcontract and claimed hereunder.

14.

(a) If, for the purposes of obtaining judgment in any court, it is necessary to convert a sum due hereunder to Construction Contractor in one currency (the **"Original Currency"**) into another currency (the **"Judgment Currency"**), the Guarantor agrees, to the fullest extent that it may effectively do so under applicable law, that the rate of exchange used shall be that at which in accordance with normal banking procedures Construction Contractor could purchase the Original Currency with the Judgment Currency on the Business Day preceding that on which final judgment is paid or satisfied.

(b) The obligations of the Guarantor in respect of any sum due in the Original Currency from it to Construction Contractor under this Guarantee shall, notwithstanding any judgment in any Judgment Currency, be discharged only to the extent that, on the Business Day following receipt by Construction Contractor of any sum adjudged to be so due in such Judgment Currency, it may in accordance with normal banking procedures purchase the Original Currency with such Judgment Currency. If the amount of the Original Currency so purchased is less than the sum originally due to Construction Contractor in the Original Currency, the Guarantor agrees, as a separate obligation and notwithstanding any such judgment, to indemnify Construction Contractor against such loss and, if the amount of the Original Currency so purchased exceeds the sum originally due to Construction Contractor in the Original Currency, it shall remit such excess to the Guarantor.

15.

(a) All payments required to be made by the Guarantor hereunder shall be made to Construction Contractor, free and clear of, and without deduction or withholding for, any and all present and future Taxes. If as a result of this Guarantee the Guarantor shall be required by law to deduct any Taxes from or in respect of any sum payable hereunder (other than any amount the Subcontractor would have been required to deduct or withhold pursuant to the Subcontract), (a) the sum

payable shall be increased as much as shall be necessary so that after making all required withholdings and deductions (including withholdings and deductions applicable to additional sums payable under this Section 15) Construction Contractor receives an amount equal to the sum they would have received had no such withholdings or deductions been made, (b) Guarantor shall make such withholdings and deductions and (c) Guarantor shall pay the full amount withheld or deducted to the relevant taxing or other governmental authority in accordance with applicable law.

(b) In addition, the Guarantor hereby agrees to indemnify and, within ten (10) Business Days of demand therefor, pay Construction Contractor for the full amount of Taxes (except for Excluded Taxes imposed on any amount paid pursuant to this Section 15) paid by Construction Contractor, or that arise from any payment made under this Guarantee, and any penalties, interest and reasonable expenses arising from, or with respect to, those Taxes paid by Construction Contractor.

(c) For the purposes hereof, **"Taxes"** means any and all present or future taxes, levies, imposts, duties, deductions, charges or withholdings imposed by any governmental authority, including any and all present or future stamp or documentary taxes or any other excise or property taxes, charges or similar levies arising from any payment made under this Guarantee or from the execution, delivery or enforcement of, or otherwise with respect to, this Guarantee and **"Excluded Taxes"** means any taxes based on the net income of Construction Contractor (including franchise taxes imposed in lieu of net income taxes) imposed by (x) the Canadian federal government, or (y) the jurisdiction where such party is organized or has its principal office.

16. The Construction Contractor's right under this Guarantee may be assigned by the Construction Contractor only in conjunction with an assignment of the Construction Contractor's rights under the Subcontract, and only to permitted assigns of the Construction Contractor's rights under the Subcontract.

17. No action or proceedings for any breach of this Guarantee shall be commenced against the Guarantor after the expiry of the limitation period in respect of the underlying obligation of the Subcontractor under the Subcontract.

18. The invalidity, illegality or unenforceability in whole or in part of any of the provisions of this Guarantee shall not affect the validity, legality and enforceability of the remaining part or provisions of this Guarantee. The obligations and liabilities of the Guarantor hereunder shall not be impaired, diminished, abated or otherwise affected by the commencement by or against the Guarantor of any proceedings under any bankruptcy or insolvency law or laws relating to the relief of debtors, re-adjustment of indebtedness, reorganization, arrangements, compositions or extensions or other similar laws.

19. The Guarantor represents and warrants that this Guarantee is its legally binding obligation, enforceable in accordance with its terms, and that all necessary governmental, corporate and other consents and authorisations for the giving and implementation of this Guarantee have been obtained. This Guarantee and all obligations of the Guarantor hereunder shall be binding upon the respective successors and assigns of the Guarantor (including a debtor-in-possession on behalf of the Guarantor) and shall, together with the rights and remedies of the Construction Contractor, enure to the benefit of and be enforceable by Construction Contractor, and its successors and permitted transferees. The Guarantor may not assign, transfer, charge, dispose of or otherwise alienate any interest in or obligation under this Guarantee without the prior written consent of Construction Contractor, in its sole discretion.

20. Any notice or demand ("**Communication**") hereunder shall be duly signed by or on behalf of a duly authorised officer of the person giving the Communication and sent by hand delivery, courier or registered mail to the following addresses:

(a) If to Guarantor:

ALSTOM Transport SA
48 Rue Albert Dhalenne
93000 St Ouen, France

Attention: Valérie Astier, Secretary
Fax: +33- 1-57-06-88-68
e-mail: valerie.astier@transport.alstom.com

With copy to :

ALSTOM
801 Pennsylvania Ave Suite 855
Washington, DC 20004

Attention: Isabelle Melody, VP Legal and Contract NAM
Fax: +1 202-495-4961
e-mail: isabelle.melody@transport.alstom.com

(b) 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
Email: David.Whyte@snclavalin.com
Fax: 416.231.5356

With copies to:

Dragados Canada, Inc.
150 King Street West, Suite 2103, P.O. Box 48
Toronto, Ontario M5H 1J9

Attention: Manuel Rivaya, Executive Vice President
Email: mrivaya@dragados-canada.com
Fax: +1 647-260-5002

EllisDon Corporation
800-89 Queensway Avenue
Mississauga, ON, N5B 2V2

Attention: Jody Becker
Fax: 905-896-8911
Email: jbecker@ellisdon.com

Any party may change its address for Communication to another address by prior Communication in writing to the other party.

21. This Guarantee shall be governed by the laws of the Province of Ontario and the laws of Canada applicable therein without regard to conflicts of laws principles, and all actions or proceedings in respect of any claim arising out of or related to this Guarantee, whether in contract, tort, at law or in equity, shall be brought in the courts of the Province of Ontario.

22. This Guarantee may be executed in any number of counterparts, and this has the same effect as if the signatures on the counterparts were on a single copy of this Guarantee.

23. Notwithstanding any other provision of this Guarantee:

(a) in no event shall the aggregate liability of the Guarantor under this Guarantee, to the Construction Contractor and the corporations forming the Construction Contractor collectively, exceed the maximum aggregate liability of the Subcontractor set out in the Subcontract, which for ease of reference is the Subcontract Price as defined in the Subcontract, but this limit of liability:

(i) shall be subject to the same exceptions as apply to the limit of liability of the Subcontractor;

(ii) shall not apply to amounts payable by the Guarantor pursuant to Section 15 arising from the deduction of Taxes; and

(iii) shall not apply to interest and enforcement costs payable under this Guarantee;

(b) in determining the Guarantor's liability under this Guarantee other than section 2(c) above, the Guarantor shall have the benefit of all (but no greater) rights, defences and limitations that the Subcontractor would have been entitled to assert under the Subcontract;

(c) in determining the Guarantor's liability under section 2(c) above, such liability shall be determined as if the Guarantor had the benefit of all (but no greater) rights, defences and limitations that the Subcontractor would be entitled to assert under the Subcontract if the obligation that is unenforceable, invalid or illegal were enforceable, valid or legal;

(d) notwithstanding paragraph (c) above (but without prejudice to the Guarantor's liability for claims properly made against the Subcontractor within applicable limitation periods), where an obligation of the Subcontractor has become unenforceable due to the expiry of applicable limitation periods, the Guarantor's liability under this Guarantee shall be determined as if the Guarantor had the benefit of the same limitation periods that the Subcontractor as a member of the Subcontractor would be entitled to assert under the Subcontract; and

(e) The corporations forming the Construction Contractor, whether alone or together, may issue a single written demand under Section 2(a) in respect of each failure of the Subcontractor to perform any obligation, duty or undertaking under the Subcontract or to make payment of any sum due and payable thereunder.

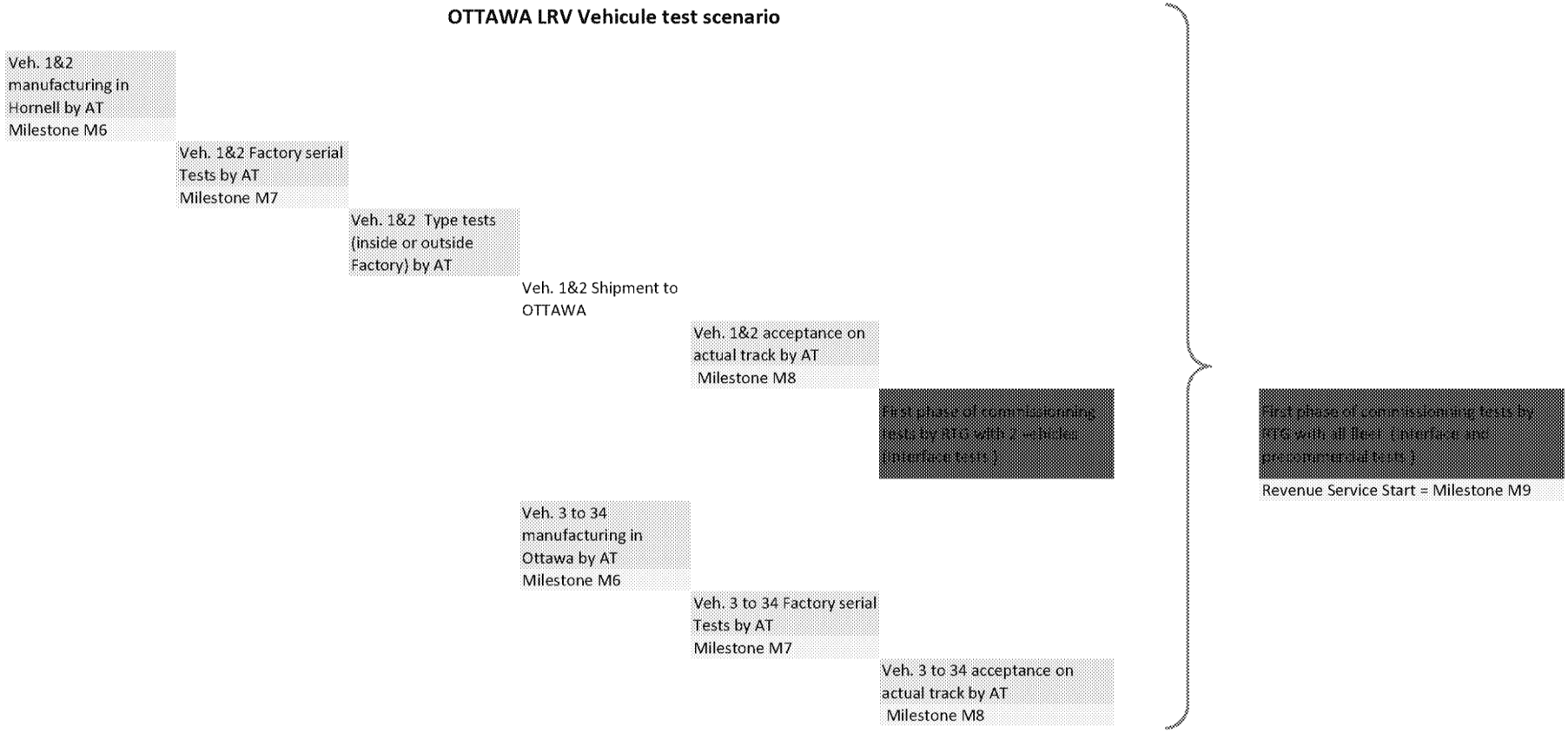
[SIGNATURE PAGE TO FOLLOW]

APPENDIX G
VEHICLE TESTING

CONFIDENTIAL AND COMMERCIALLY SENSITIVE. NOT FOR DISTRIBUTION

APPENDIX G1
VEHICLE TESTS FLOW CHART

OTTAWA LRV Vehicule test scenario



APPENDIX G2
TESTS PLANNING

ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

OTTAWA LIGHT RAILTRANSIT PROJECT

All information within this document is the property of ALSTOM Transport.

ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

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All information within this document is the property of ALSTOM Transport.

ALSTOM

Vehicle testing schedule

rev 1

Inquiry n° : 507528-P001

1 INTRODUCTION

The object of this section is to define the testing activity that will be performed by Alstom on the Ottawa LRT vehicles.

2 SERIAL TESTS

The vehicles serial tests are performed on each vehicle to confirm, by simplified tests, the compliance to design performances within the limit given by the manufacturing site where they are performed.

The serial tests do not cover the interface and commissioning activities with other subsystems (radio, CBTC...).

The serials tests will be performed in an Alstom facility for the two first vehicles and in Ottawa MSF for the serial vehicles (3 to 34)

2.1 Serial Test plan, configuration management

The Serial test Plan defines the scope of each test, the main test phases, the main validation infrastructure and tools.

Particular attention will be pay to the Configuration management in order to have consistent test plan, tools, vehicles hardware & software. Tools will be managed to ensure proper calibration.

2.2 Serial Tests descriptions

- tests on current return circuits and protection circuits
- dielectric strength and insulation of all 1500 V and low voltage circuits
- geometric checks
- weighing
- vehicle water tightness check
- driver's cab control devices tests
- exterior signalling and lighting circuits tests
- traction functional check
- braking functional check
- door functional tests
- ventilation, cooling and heating systems functional test
- static converter tests

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Vehicle testing schedule

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- tests relative to traction – braking circuits (tram empty with no load)
- tests relative to brake system control unit and hydraulic circuits
- tests of wheel flange lubrication fittings
- Low speed traction/braking tests

3 ACCEPTANCE TESTS

The vehicles acceptance tests are the complement to the serial tests. These tests are performed on each vehicle to confirm, by simplified tests, the compliance to design performances in the actual operational environment. They are performed on a significant operational portion of the Ottawa Confederation line track (approximately 4 km) with functioning catenary system.

The acceptance tests do not cover the interface and commissioning activities with other subsystems (radio, CBTC...).

The acceptance tests will be performed on Ottawa Confederation line for all vehicles.

3.1 Acceptance testing for LRT produced in the Alstom manufacturing site

The Acceptance test Plan defines the scope of each test, the main test phases, the main validation infrastructure and instrumentation

3.2 Acceptance tests description

- LV and HV system start up
- Driver cab activation
- Door cycling tests
- Traction / Braking functional test
- Event recorder functional test

4 TYPE TESTS

Purpose of type testing is to demonstrate compliance of the vehicle with the technical specification and with the legal requirements. A type test gives the proof that the specified contractual performance and functional requirement has been achieved.

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4.1 Quality Management

The Alstom Validation & Certification department has incorporated in its quality system the requirements set forth in the EN 17025 "General Requirements for the Competence of Testing and Calibration Laboratories." The Alstom test team is organize according this quality system structures to provide each project with objective and accurate testing results. This team is networked with Alstom accredited test laboratories.

4.2 Type test plan

The Type test Plan defines the scope of each test, the main test phases, the main validation infrastructure and instrumentation.
The type test plan will cover the full range of activities from component tests, to dynamic performance type tests. These tests are performed on new components, or new sub-systems, produced during the industrial process.

4.3 Test infrastructures

The two first vehicles will support the vehicle type tests. Static and low speed dynamic test will be performed in an Alstom plant. The "high" speed type testing will be performed in a specific test facility (test ring).

The car-body static compression tests will be performed in a dedicated facility.

A climatic chamber will be used to perform the climate chamber tests (see Chapter 5)

4.4 Type tests description

See appendix A

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5 CLIMATIC TESTING

Climatic testing will be conducted at sub-system level and/or vehicle level. Tests conducted at vehicle level will be performed in a climatic chamber on a half vehicle. Tests conducted at sub-system could be performed by the sub-system OEM as part of the sub-system type test or mounted on the vehicle in the climatic chamber. This will be depending on relevance and convenience.

5.1 Sub-system level testing

5.1.1 Low temperature testing:

For all sub-system:

- Long term storage test at temperature of -38°C
- Performance test after storage at -38°C

For sub-systems mounted on the roof or under-frame (HVAC, traction cubicle ...):

- Performance test at -38°C

5.1.2 Testing related with ice

The performance of the following sub-system will be validated in case of ice accretion:

- Brake callipers
- Doors
- Pantograph
- Coupler

Ice impact test will be performed on equipment mounted under-frame that will not be protected from ice impact by a specific device.

5.1.3 Testing related with snow

The performance of the following sub-system will be validated in case of snow:

- Brake callipers
- Forward vision
- Lightning
- Horn
- Doors
- Pantograph
- Coupler
- Air intakes
- Roof mounted cubicles

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5.1.4 Testing related with rain

The performance of the following sub-system will be validated in case of rain:

- Forward vision
- Roof mounted cubicles

5.2 Vehicle level testing

5.2.1 Functional validation

The following tests will be performed in climatic chamber on a half vehicle:

- Vehicle behaviour at -38°C
- Vehicle start-up at -25°C
- Vehicle start-up at -25°C after 5 hours storage at -38°C and application of the warm-up procedure
- Vehicle powered-on at -38°C for at least 5 hours and exposed to +20°C

5.2.2 Climatic comfort validation

The following tests will be performed in climatic chamber on a half vehicle:

- Heating test:
  - Extreme low temperature -38°C
  - Heating performance / -25°C exterior / no passenger / No sun / Door closed / train at standstill
  - Heating regulation : 3 points to be agreed with customer
  - K factor (Overall heat transfer UA)
- Cooling test:
  - Cooling performance / 30°C, 45 % RH exterior / AW2 passenger load / 700 W/m² / Door closed / train at standstill
  - Cooling regulation : 3 points to be agreed with customer
  - High temperature cut-off

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Vehicle testing schedule

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6 COMMISSIONING

Alstom will support RTG in performing the system commissioning to prove that the full system is ready for the revenue service in the limit of its scope as defined by the contract between RTG and Alstom.

For example, Alstom will contribute to the following tests

- CBTC interface tests
- CBTC performance tests
- Radio System interface tests
- Radio operation Test
- Vehicle to ground communication tests
- Rear vision system tests
- Energy consumption test according to "Traction Consumption" procedure attached to the LOI

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Vehicle testing schedule

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7 APPENDIX A: LIST OF TYPE TESTS

Dimensional & Gauge	
	Gauging - Static Gauge Test
	Lifting ability test
	Dimensional - Outside dimensions
	Dimensional - Bogie / Car & Car / Car Clearance
	Dimensional - Hose and cables length
	Dimensional - Current Collection
	Watertighness tests
Electromagnetic Compatibility	
	Inspection of cabling by EMC expert
	EMC preliminary tests
	Compatibility with track/vehicle signalling systems (ATC/ATP)
	Compatibility with telecommunication circuits (psophometric current)
	Human exposure to EMI (DC & AC magnetic field inside and oustide RS)
Acoustics / Noise	
	Vibroacoustic measurements of equipment installed in the vehicle
	External noise at V=0
	Internal noise at V=0
	External noise at Vmax on test track
	Internal noise at Vmax on test track
	Internal noise measurement at 65km/h in tunnel
Railway Dynamics	
	Gauging - Coefficient of flexibility
	Safety of running
	Ride comfort tests
Weight management & allocation	
	Invidual section weighing
	Vehicle wheighing

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HVAC / Winterisation / Climatic adaptation - Half vehicle tests	
	Half vehicle Functional validation · Vehicle behaviour at -38°C · Vehicle start-up at -25°C · Vehicle start-up at -25°C after 5 hours storage at -38°C and application of the warm-up procedure · Vehicle powered-on at -38°C for at least 5 hours and exposed to +20°C
	Climatic comfort validation · Heating test: · Extreme low temperature -38°C · Heating performance / -25°C exterior / no passenger / No sun / Door closed / train at standstill · Heating regulation : 3 points to be agreed with customer · K factor (Overall heat transfer UA) · Cooling test: · Cooling performance / 30°C, 45 % RH exterior / AW2 passenger load / 700 W/m² / Door closed / train at standstill · Cooling regulation : 3 points to be agreed with customer · High temperature cut-off
Auxiliary supply	
	Electrical energy functional test
	Battery autonomy and charging tests
	Consumption and protection of electrical tri-phase auxiliaries
	Loads startup
Mechanical Brake	
	Air System - Operation of Compressed air system test & Provide pneumatic energy functional test
	Leveling system performance test
	Hydraulic system tests (tightness & functional)
	Mechnical Braking functionnal tests
	Mechanical Braking - Wheel-slide protection tests
	Mechanical Braking performance tests
	Parking brake tests
	Emergency towing-pushing
Doors	
	Passenger evacuation
	Driver evacuation
	Doors functional test in single unit
	Doors functional test in multiple unit

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Safety earthing	
	Electrical resistance of mounted wheel axles
	Vehicle earthing
Fire protection System	
	Fire / smoke detection (Perf.)
	Fire and smoke detection functional test
Horn & Headlights	
	Head-light
	Tail light
	Horns
Internal lighting	
	Lighting system performance test
	Lighting functional test
Sanding	
	Sanding system
PAPIS	
	Equipment integration
	Network performances
	Alarms
	Sonorisation
	Passagers intercom
	Passengers information displays (interior, exterior, reservation)
	Vidéo-surveillance (CCTV) functionnal test
	Public address and passenger information functional test
TCMS	
	Vehicle control network functional test
	Driver cab functional test including diagnostics
	Train control network functional tests
	Diagnostic system tests
	Data transmission tests
	Vehicle Control System tests
	Event recorder Performance test
	Multiple unit functionnal tests

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Vehicle testing schedule

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Traction	
	Traction/Vehicle interfaces validation
	HV system start up
	Auxiliary converter
	Maintenance mode - Reduced power test
	Traction aeraulics tests
	Traction/braking, emergency braking, brake blending
	Drift and direction of running
	Traction and electrical braking functional test
	Antislip tests
	Antiskid tests
	Traction performance tests
	Electrical braking performance tests
	Braking - Traction and braking thermal tests
	Current collection tests
Component type test	
	Windscreen performances
	Bogie System (trailer and motor bogies)
	Bogie frame
	Bogie fatique test
	Bogie static load test
	Main circuit breaker
	Traction converter
	Braking resistor
	Motor
	CarbodyShell
	Fire barriers
	Door test on TSS bench
	Door Panel Strength Tests
	Automatic coupler
	Seats
	Heater gard
	HVAC test on test bench
	Event recorder
	Smoke detector

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Component winterisation tests	
	Low temperature testing:
	Testing related with ice
	Testing related with snow
	Testing related with rain

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APPENDIX G3
ENERGY CONSUMPTION TESTS

ALSTOM TRANSPORTATION INC.

Traction Power Consumption Test

OLRT Project

Intent of document:

This document summarizes the test conditions to validate the vehicle energy consumption related to traction only of the OTTAWA LRT.

Commitment from ALSTOM:

Simulations have shown the following figures for a round trip:

Energy consumption for traction:	169 kWh
Energy regenerated by dynamic braking:	- 70 kWh
Total Energy Consumption for traction:	99 kWh

Since the test will be performed with a single train on the line, there will be no regenerated energy. The total energy consumption for traction on the road-trip should be 169 kWh.

The simulations were performed in the following conditions:

- 5% coasting
- Half-worn wheels
- Train loaded in nominal operating conditions
- Nominal catenary voltage: 1500V
- Route profile according to "C3D-OLRT-Align_(REV5)_2012-06-18.dwg"

Test at vehicle level under ALSTOM responsibility

Test preparation:

Prior to test, measurement will have to be performed by RTG to confirm that the executed route-profile is compliant to the route profile taken in account for the simulations.

Test train:

The test train will be made of a single unit vehicle with all traction cases and braking units operational.

Traction power measurement will be done by the mean of one to three energy meter(s) with an accuracy of +/- 1%. The measurement will only take into account traction power, not auxiliary power.

The energy meters probes will be installed to ensure that only energy for traction is measured.

The train will be loaded with 21 Metric Tonnes to simulate loading associated with 300 passengers. The load will be evenly distributed along the passenger compartment. This can be achieved by using sand bags.

The test train will have new wheels which increases energy consumption. To account for this, 1% will be removed from measured energy consumption.

Test must be performed on clean dry rail with ambient temperature between 0°C and 20°C, no wind.

Catenary voltage should be at a minimum 1500 Volts.

Train will perform a round-trip prior to the test run.

Driving mode:

Driving will be done manually during the test. The driver will accelerate fully until track speed is reached and will then cut the acceleration and let the train roll on its inertia until braking is required for the next stop and/or new speed limitation. The test round trip will be performed with similar condition (end to end run time, speed profile, dwell time...) than a commercial trip in accordance with the PA requirements.

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Pass-fail criteria:

Total energy consumption for traction on the round-trip will be given by the following formula

$E_{traction} = E_{measured} \times (1 - 0.01)$

with $E_{measured}$ being the current measured by the energy meters.

$E_{traction}$ should be within 10% of 169kWh.

Commissioning test with ATO under Construction Contractor responsibility.

As part of the commissioning tests (schedule 14), the Construction Contractor will organize at its own expenses the same test in ATO mode. ALSTOM will provide assistance for measurement and data analysis.

Alstom shall not be responsible of discrepancies between the Manual driving mode results and the ATO mode results, nor will be responsible for the energy consumption results the test would provide in such driving mode.

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APPENDIX H
MSF USAGE

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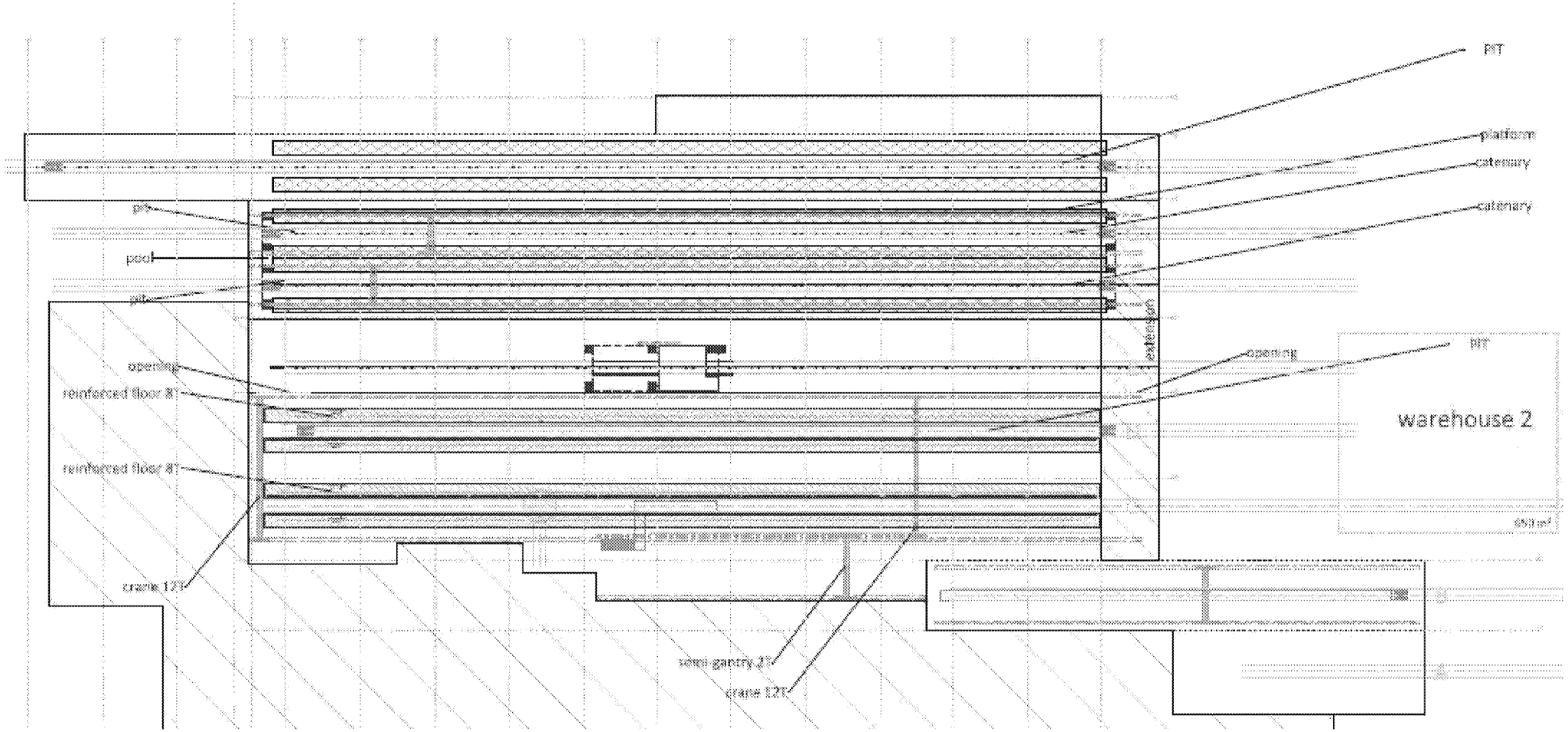
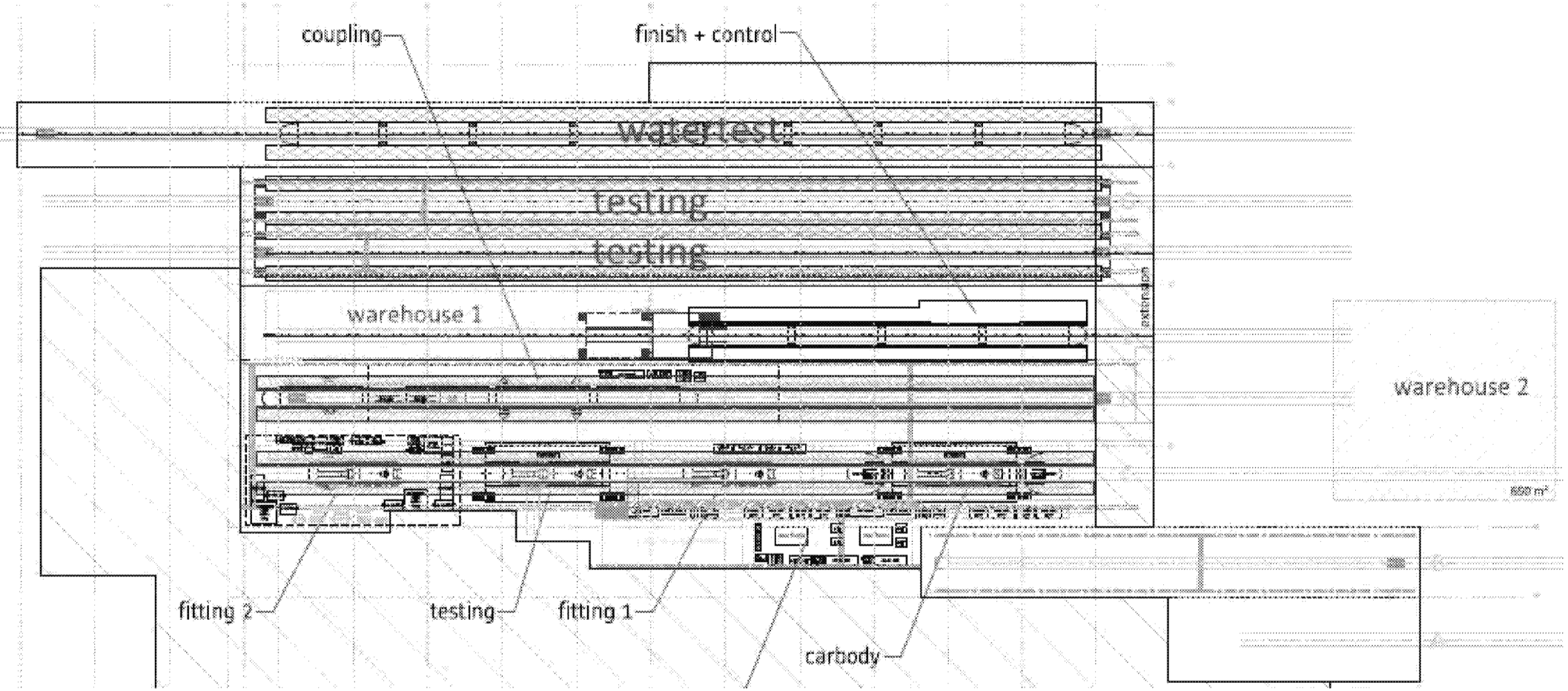
APPENDIX H1
OTTAWA VEHICLE ASSEMBLY INSIDE THE MSF – REV6

Plan building

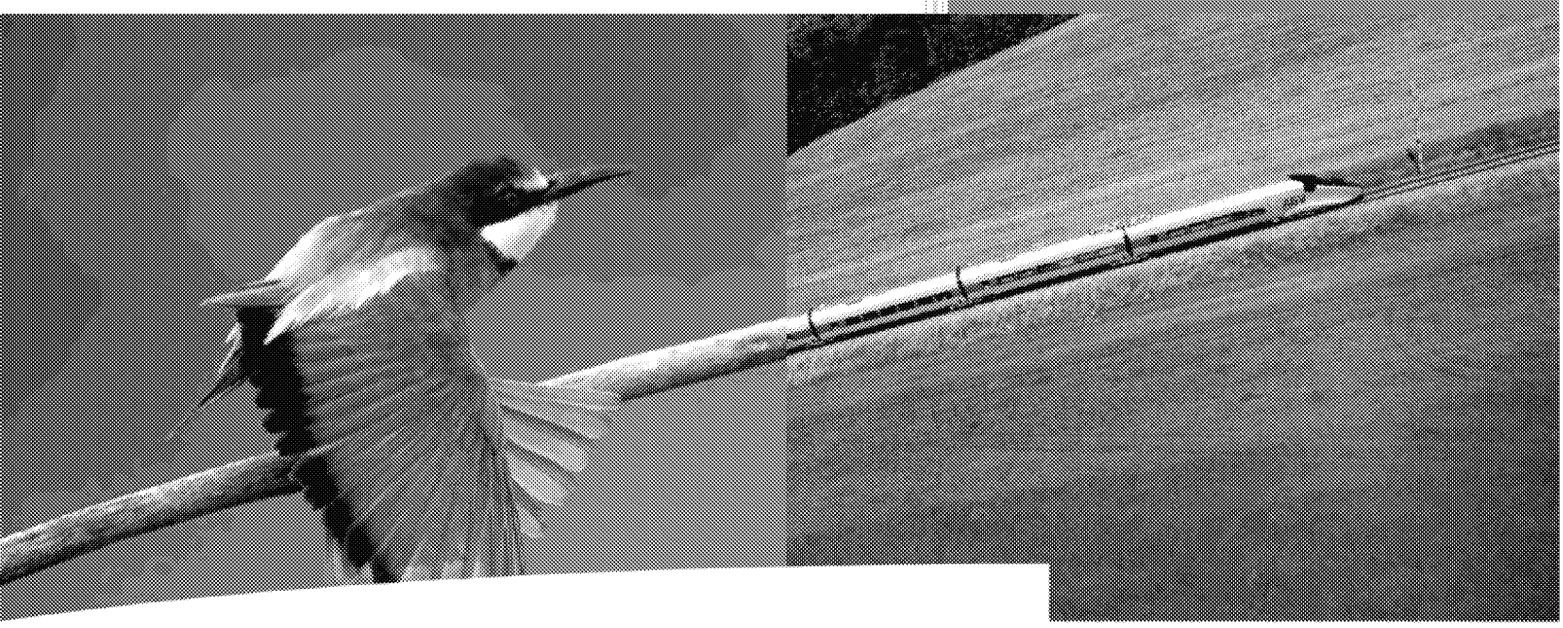


APPENDIX H2
PLAN BUILDING

assembly process Layout



APPENDIX H3
PLAN PROCESS



Ottawa Vehicle assembly inside the MSF - rev6

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Alstom

26/01/2013

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draft ☐ for consultation ☑ for application ☐ confidential ☐

	FUNCTION	NAME	DATE	SIGNATURE
WRITTEN BY	Dvpt indus	Blin Sylvain	28/01/13	
VERIFIED BY				
APPROVED BY				

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- Safety 10
G. APPENDIX 11

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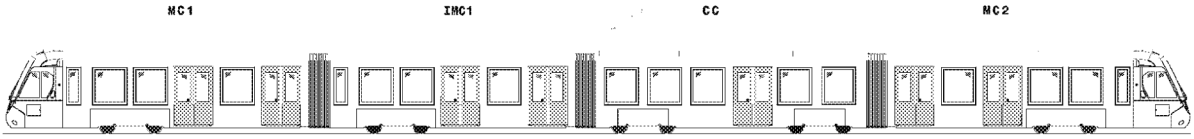
A. Vehicle

Purpose of this document is to describe the industrial means required for Ottawa LRT assembly in the OTTAWA MSF.

The vehicle length is 48 m and is spitted in 4 sections (see technical description)



Extended vehicles are not considered in this specification

B. Scope of supply

The MSF is built under Construction Contractor (EPC contractor) responsibility. The scope of supply agreed at LOI stage is the following One

VEHICLE ASSEMBLY IN MSF RESPONSIBILITIES

Activity	Alstom	EPC Contractor
Assembly of vehicles		
Access to the MSF for components delivery		X
MSF surface allocation for storage and construction		X
Various Duty (cleaning, guarding, telecom...)		X
Energy supply		X
Means of Lifting (crane, forklift...)		X
Specific tooling	X	
Subassembly and supplied component	X	
Signalling and communication equipments		X
Workforce for assembly and control	X	
Quality record	X	
Vehicles serial static testing		
MSF track allocation for static testing		X
Energy supply		X
Vehicle towing inside MSF		X
Specific tooling	X	
Workforce for test and control	X	
Quality record	X	
Vehicles dynamic testing		
Slot allocation on actual Ottawa track for dynamic testing		X
Energy supply		X
Specific tooling	X	
Workforce for test and control	X	
Driver		X
Quality record	X	

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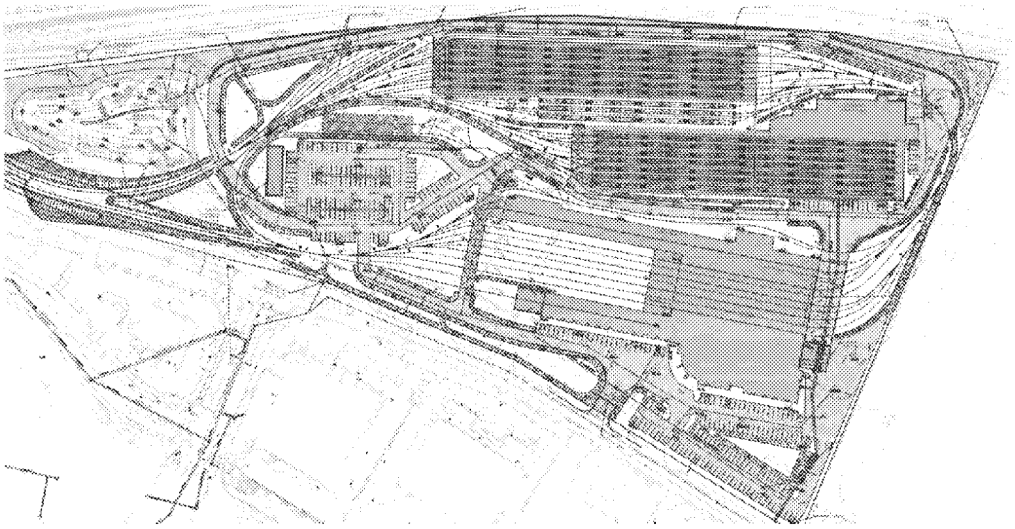
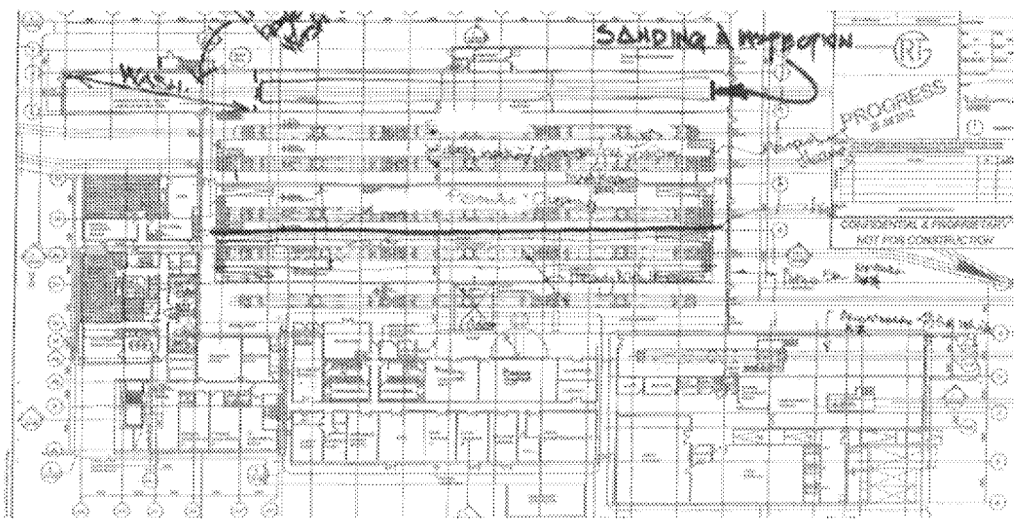
C. MSF layout

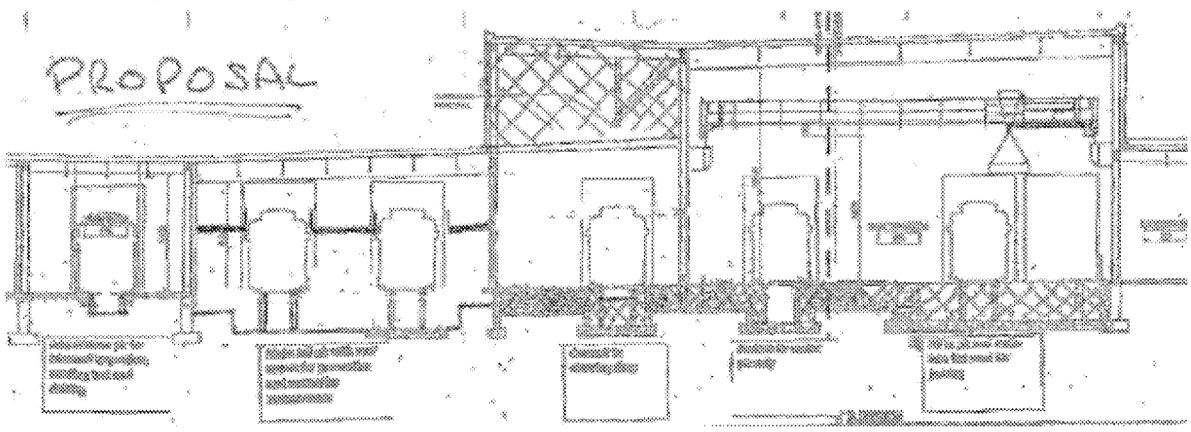
Site overview



Main assembly and testing facility : Top view



Main assembly and testing facility : Elevation



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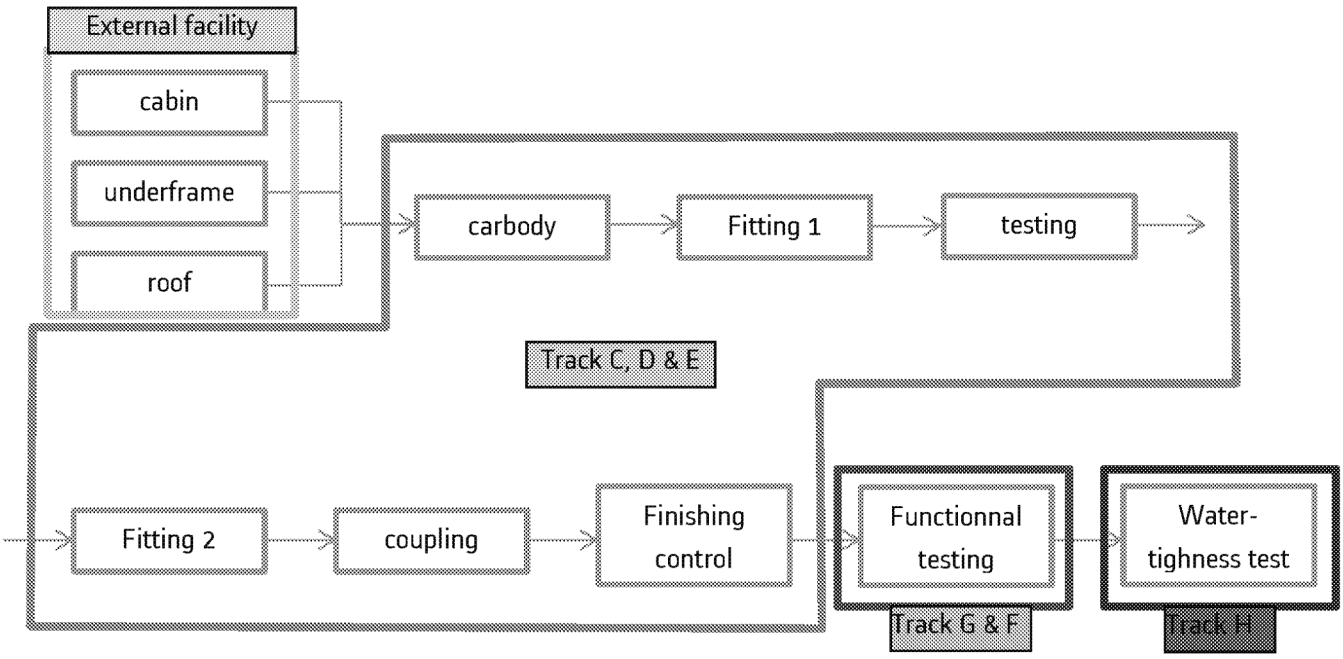
D. MSF manufacturing activities

- Fitting process



Appendix 1 shows the adaptation which will be made to the maintenance facility to ensure proper vehicle assembly.
Appendix 2 shows the actual manufacturing footprint within the MSF

Due to surface and height limitations, we cannot perform the pre-fitting of the main subassembly inside the MSF. Alstom will choose an external facility in respect with Canadian content obligations.

As temporary adaptation we have to create a 650 m² warehouse on a flat surface outside the buiding.



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- **Heavy means provided by Construction Contactor**

Manufacturing zones	Track	Surface	pits	crane	floor resistance	OCS	pneumatic supply	AC electric supply	Area purpose during maintenace	remarks
Cathedral, fitting, testing & coupling	C	111 x 16 m	10 m	2 x12T synchro 1 x 2T (6,87m under hook)	8T/m²	no	70 m3/h	200 KW	Heavy maintenace area	Lifting jack on track D
	D	111 x 9,3 m	95 m		8T/m²	no	50 m3/h	150 KW		
Control area	E	111 x 8,9 m	wheel lathe	no	4 T/m²	no	40 m3/h	55 KW	Cleaning & Wheel late shop	
Testing area	F	111 x 7,2 m	104 m	no	2 T/m²	yes	20 m3/h	25 KW	Testing area	OCS power 1,5MW + vehicle roof acces
	G	111 x 7,2 m	104 m	no	2 T/m²	yes	20 m3/h	25 KW		
Water-tightness testing	H	138 x 8 m	130 m	no	2 T/m²	yes	60 m3/h	25 KW	Train wash	
Office		500m² mini	NA	no	NA	no	NA	3 KW	office	
temporary warehouse		650 m² mini	NA	no	2 T/m²	no	NA	3 KW	Parking ?	temporary feature

- **Other Tooling provided by Construction Contactor**

The following list is similar to the maintenance specification

Item Description	Location	QTY
Hydraulic Oil Tank (500 Gallon)	Incl. with Vehicle Lubrication Equipment	1
Windshield Washer Fluid Tank (500 Gallon)	Incl. with Vehicle Lubrication Equipment	1
Battery Analyzer and Discharge Tester	Battery Shop	1
Battery Charger	Battery Shop	1
Charging Rack	Battery Shop	1
Mobile Work Platforms with Stairs	HM1, HM2, HM3	2
Electric Charger for Forklift	Storage Room	1
Forklift 6000 LB (Electric)	Storage Room	1
Bogie Lift System	HM3	1
Train Lifting Jacks	HM3	14
1/2 Ton Jib Crane	Component Changeout and Major Repairs	1
MIG Welder		2
Oxy-Acetylene Welding Rig		2
TIG / Stick Welder		2
Drill Press 15"	HM1, HM2, HM3	1
Pedestal Grinder, 8" w/ Dust Collector	HM1, HM2, HM3	2
Bridge Crane, 12 Ton	HM2, HM3	1
Small Parts Washer	HM1, HM2, HM3	1
Mobile Scissor Lift	HM1, HM2, HM3	2
Portable Lift Table	HM1, HM2, HM3	1
Hose Reels / Remote Controls		4
Mobile Hot Water Pressure Washer		1

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Mobile Hot Water Pressure Washer		1
Self Dumping Hopper	VCIF 1, VCIF 2	8
Self Dumping Hoppers (Mobile)	VCIF 1, VCIF 2	4
Single Axle Wheel Truing Machine w/ Chip Removal System	Wheel Lathe	1
Mobile Waste Oil Collector	HM1, HM2, HM3	2
Reel Bank (GO, Grease#1, Grease#2, Hydraulic Oil, Water)	HM1, HM2, HM3	16
Gear Oil Pump		1
Gear Oil Tank (500 Gallon)		1
Grease Pump		1
Hydraulic Pump		1
Windshield Washer Fluid (WWF) Pump		1
WWF Reel Bank		8
Air Receiver Tank	Sanding and Washing Track	1
Car Sanding System	Sanding and Washing Track	1
Sand Dispenser	Sanding and Washing Track	20
Sand Tower	Sanding and Washing Track	1
Car Washer With Air Stripper (Future Reclaim)	Sanding and Washing Track	1
Ice Cleaning System	Sanding and Washing Track	1
DC Shop Power Reels	HM1, HM2, HM3	14
Garbage Container	Store Room	3
Recycling Containers	Store Room	5
Small Paint Booth	Workshop	1
SNC Storage Assemblies & Industrial Furniture		1
SNC Installation of Above Items		1
Paint Can Shaker		1
Battery Wash Station		1
Paint Gun Cleaner		1
Anchor Pots		230
Future Paint Booth	MSF Painting is Outsourced	1
Walk Behind Lift Truck		1
Forklift 6000 lb (Propane)		1
Walkie/Rider Pallet Truck		1
Mobile Railcar Mover		1
Floor Sweeper/Scrubber		1
Industrial Central Vacuum		1
Cardboard Baler		1
Warehouse, banding machine		1
Warehouse, film wrapping system		1
Warehouse, foam packaging machine		1
Wind shield handling device		1
General work benches with vice		5
Warehouse, Static control bench		1
Bogie overhaul stands		2
Racking for warehouse large components		
Racking/drawer system for warehouse small components		
Racking for maintenance shop (Free issue materials)		
Racking for heavy maintenance shop (Free issue materials)		
Racking for bogie overhaul area (Free issue materials)		
Vehicle side light handling system		1
Small paint fume extraction equipment		1

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Dosing stations for cleaning products (Detergents etc)		4

E. MSF Infrastructures.

In order to ensure a fluid circulation of people and goods the MSF must be fitted with suitable access road, parking and track for

- Workers'car access and Park
- Delivery of goods by Trucks
- Shipment of the LRV assembled outside the MSF (preserial vehicles; option vehicles) :





- Parking

The parking will be design in reference to the number of workers on the site.
We intend to have 80-100 cars parking place on the site
Provide also parking for two wheel machine/bicycle. (20-30 places)

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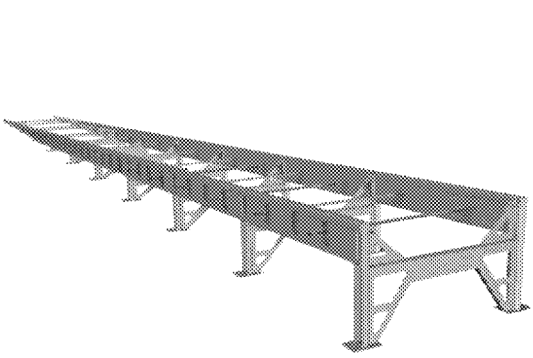
- **Delivery of Vehicles Manufactured outside MSF**

A ramp will be installed on a specific track

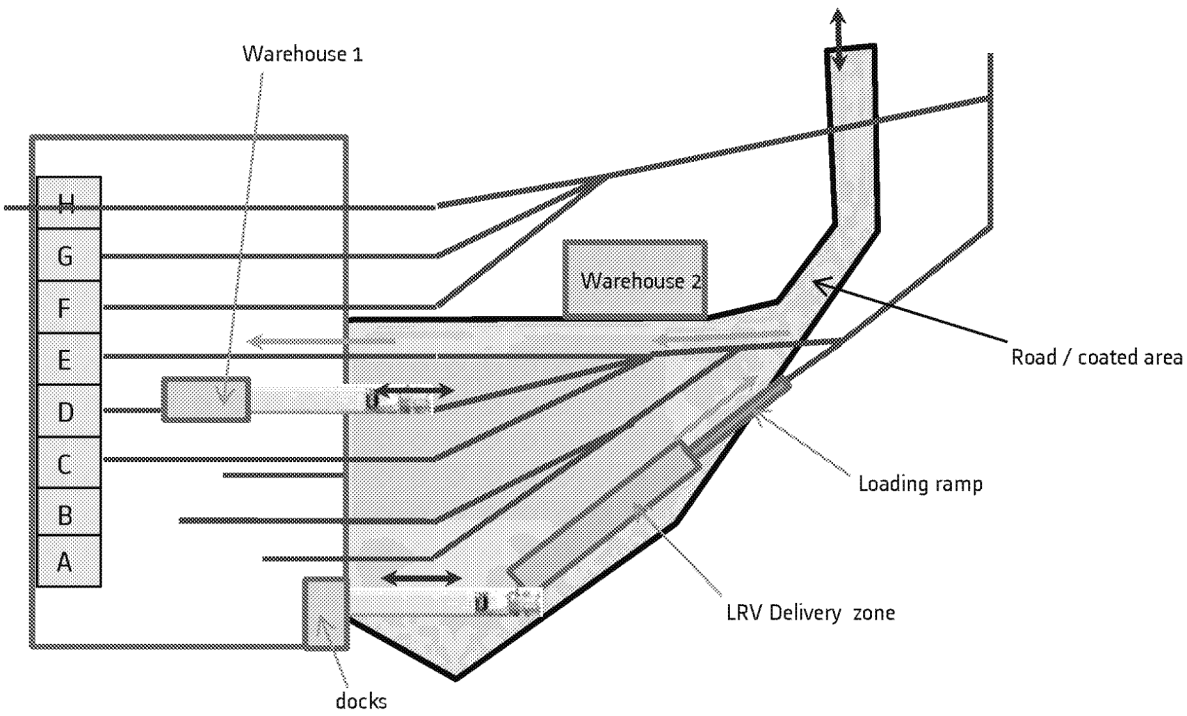




On the unloading area must be wide enough to allow all the needed operation (Crane access for ramp installation, transportation truck acces and manoeuver...) . For that a specific area of 2500m² coated area must be provided

- **General flow (see drawing)**

The MSF building must be fitted with automatics doors (dimensions are HxL : 6m x 4m).



Flow for LRV delivery

Flow for road truck access

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F. PEOPLE

Offices will be fully equipped to welcome the workers. All the installation shall be in accordance with Canadian EHS standards in term. The site should design be for up to 110 people capacity. The table below shows is a first estimation of the manufacturing team

Profile	Perimeter	Qty
Electrical fitters	Fitting & Preparations	18
Mechanical fitters	Fitting & Preparations	20
Tests technicians / Engineer	Testing & Commissioning	15
Manufacturing managers / Foremen	Workshop Management	5
Quality Technicians	Quality	4
Logistics	Warehouse	5
Mechanical Engineers	Support functions	2
Electrical Engineers	Support functions	2
Industrial Engineers	Support functions	4
Finance	Support functions	2
HR	Support functions	2
Facilities/maintenance		4
Sub-contracted people	Guardian/security/cleanliness	11

- **Specific needs for Managers**

About 10m² per person is needed. For each one, the personal furniture will be : a desk, a seat, a cabinet, a console with drawers, High speed internet access...

Three meeting rooms should be make available

- 1 x Capacity 8 persons
- 2 x Capacity 4 persons

- **Specific needs for Workers**

For all the workers on the site, the following facilities will be provided: Sanitaries, lockers room, canteen, break area,socials place,training room

- **Safety**

Safety is one of the Alstom's main priority. All manufacturing & testing activities in the MSF will be performed in accordance with Canadian laws and Alstom's rules

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G. APPENDIX

Appendix 1 : building layout

Appendix 2 : process layout

Appendix 4 : pit specification

Appendix 5 : security of the testing activities

Appendix 6 : spraying ramp

Appendix 7 : weighing track

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APPENDIX H4
PIT SPECIFICATION – V1

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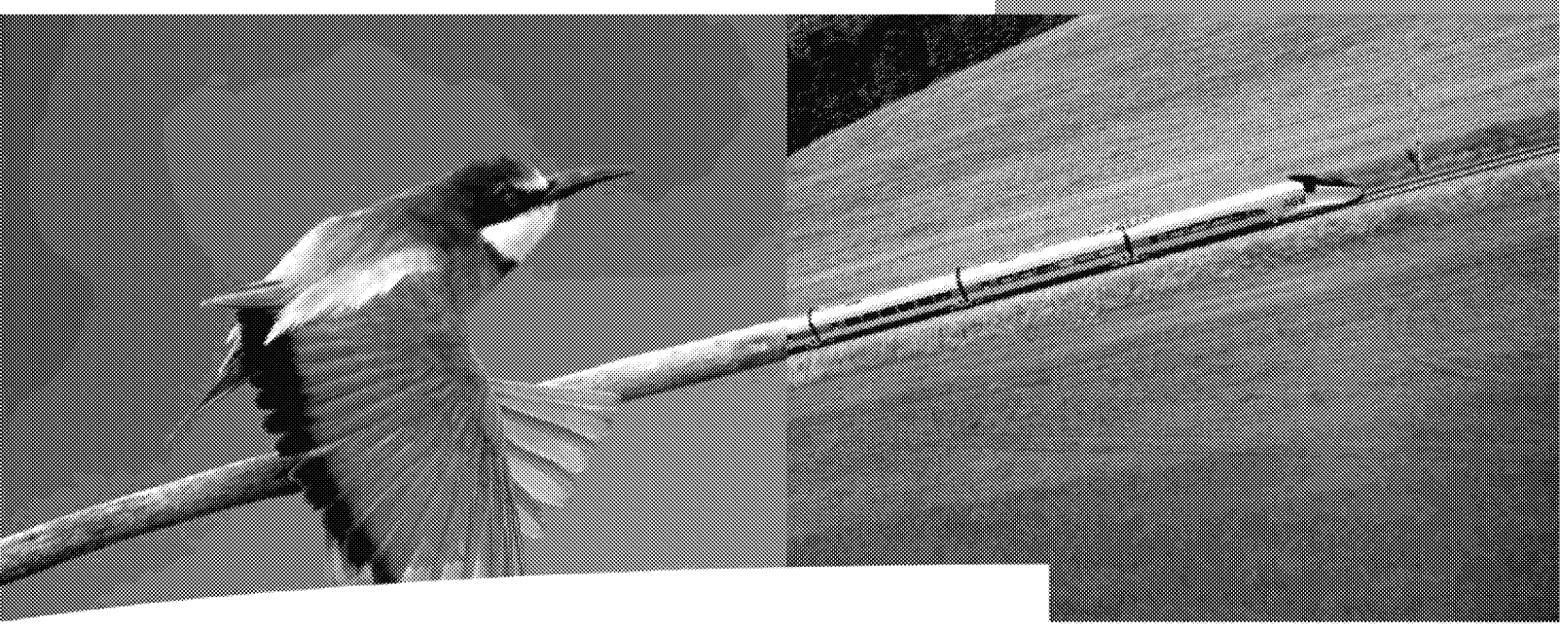
Technical Specifications



PIT specification – V1

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S. Blin

Alstom

27/06/2012

TRANSPORT | ALSTOM

No.....

draft ☐ for consultation ☑ for application ☐ confidential ☐

	FUNCTION	NAME	DATE	SIGNATURE
WRITTEN BY	Indus devpt	Blin Sylvain		
VERIFIED BY				
APPROVED BY				

Revisions:

who	date	Version	modification
S. Blin	30/06/2012	V1	initialisation

Industrial Development

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2. FINISHING 5
3. EQUIPMENT 5

II. EXTERNAL PIT ERREUR ! SIGNET NON DEFINI.

1. DESCRIPTION **ERREUR ! SIGNET NON DEFINI.**

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A. INTRODUCTION : description of the need

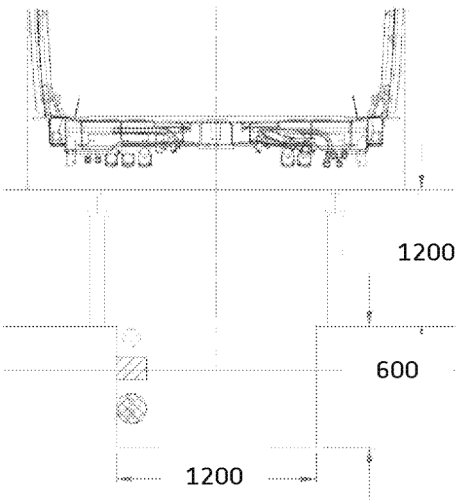
Pit are dedicated for the underframe working.

I. Internal pit

1. Description

Section of the pits in the different buildings.

a. Track G and F:



Ex of realisation :



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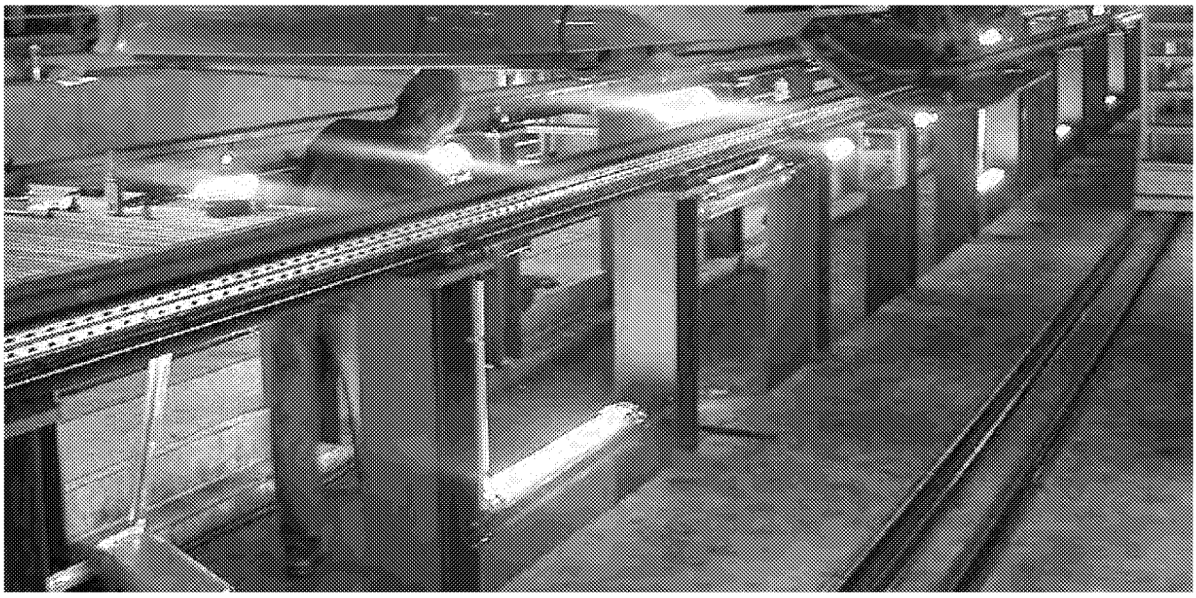



b. Track D:

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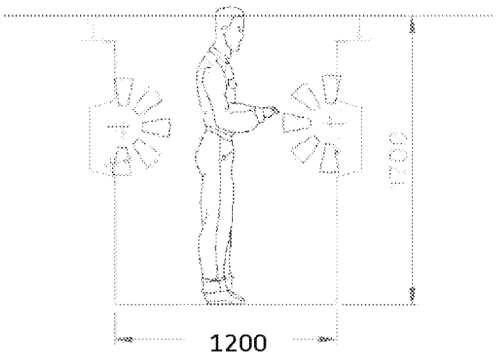


2. finishing

The pit will be totally painted in white color

3. equipment

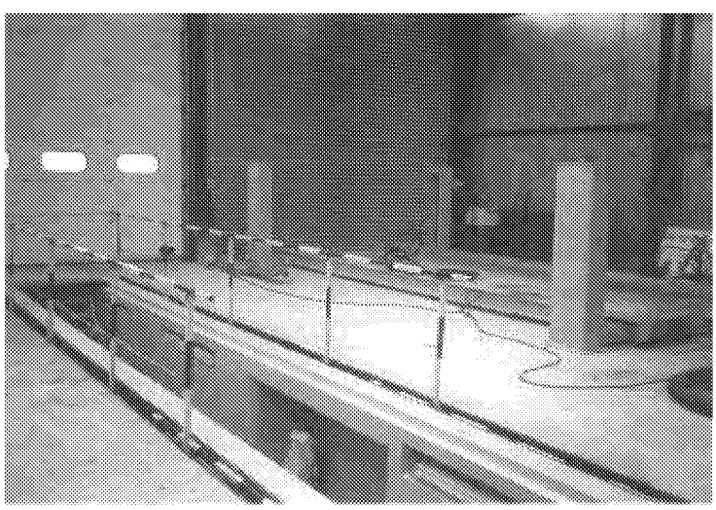
The pits should be fully equipped:

c. Stairs

We need to have steel stairs with secured step on each side on the pit to go down and up.
The steps consist of non-slip grating

d. protection

- pits cannot be left open when trams are absent for security reasons : so we would like to have a system of protection when no vehicle is above it
  see exemple :



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We'd like to have this kind of lifting barriers. These barriers can be placed in the ground as shown on the picture.

- ∞ also : on the extremity on the pit where the stairs are : we ask for a system of closing (to protect stairs area)

See example: (double click on the icone =>) 

e. energy

the pits will be full energy equipped (electricity + air + light) : (see buildings drawing for the positions)

- ∞ 230V : one inlet every 12 m with IP 55 requirement
- ∞ Air : 7bars : one inlet every 12 m
- ∞ Light 350 lux with IP 55 requirement
- ∞ + 380 V (several points => see on the drawing for the location)

f. Security

- ∞ 1 extinguisher on each pit

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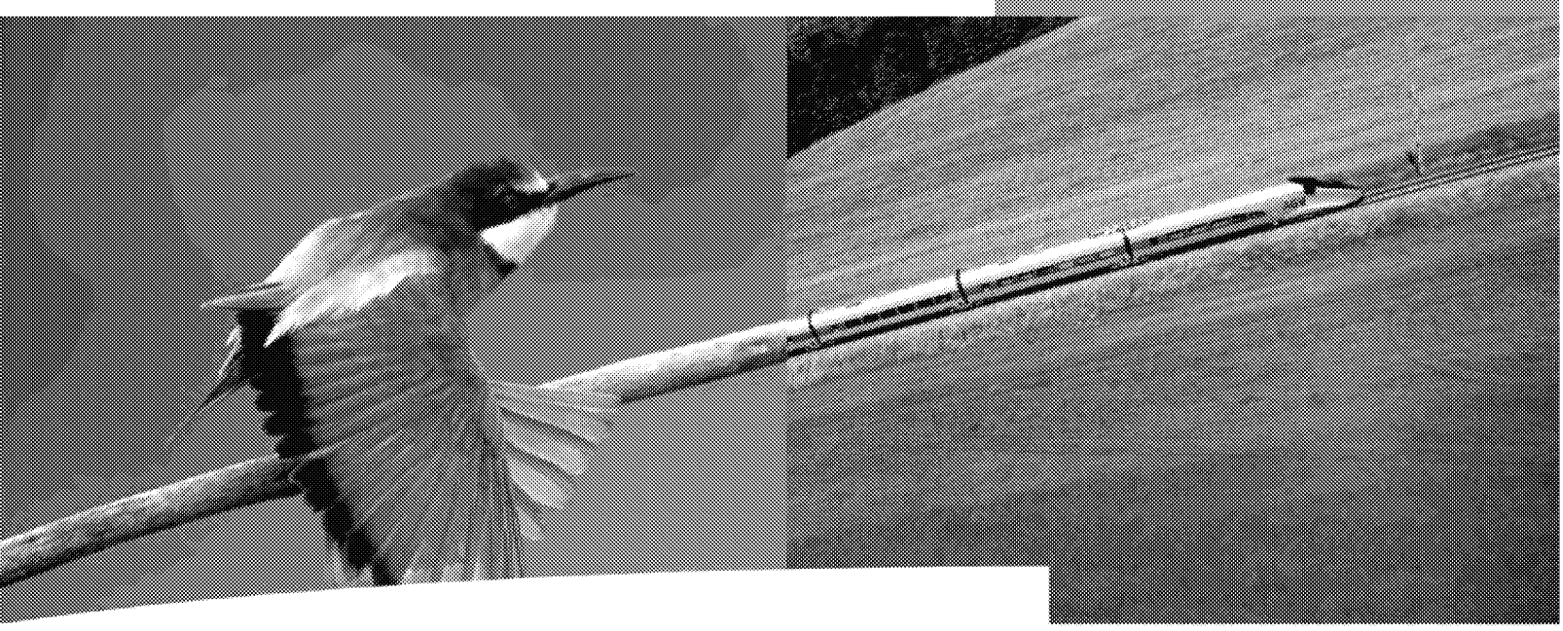
APPENDIX H5
SECURITY OF THE TESTING ACTIVITIES – V1

2012

Technical Specifications



Security of the testing activity – V1

TRANSPORT | ALSTOM

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11/07/2012

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TRANSPORT | ALSTOM

No.....

draft ☐ for consultation ☑ for application ☐ confidential ☐

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APPROVED BY				

Revisions:

who	date	Version	modification
S. Blin	11/07/2012	V1	initialisation

Industrial Development

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A. INTRODUCTION:

Subject:

Before each intervention on the train, we need to secure the catenary.

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Principle:

We use a tool (a telescopic pole) to secure and to link catenary with the railway track and also another one to check the absence of voltage.

B. Description of the need

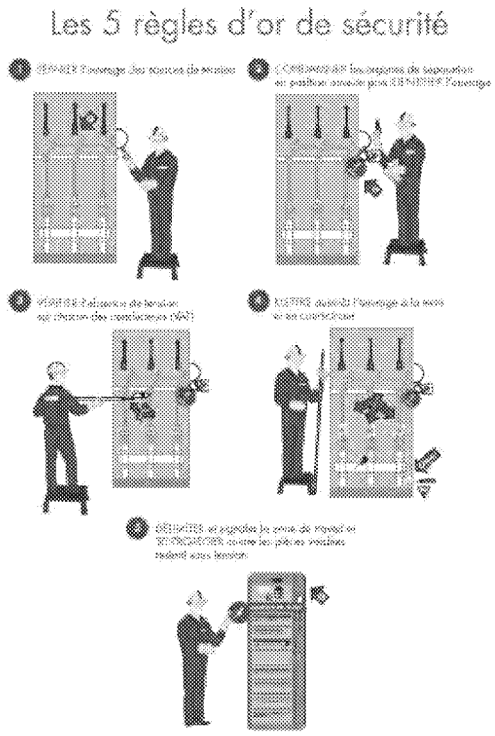
I. Golden rule of security

Outdoors, the grounding of the catenary must be carried out upstream and downstream of the work area. (Using two devices of grounding and short-circuit)

Indoors, the grounding of the catenary is not absolutely required IF the catenary are linked to the ground on the cabinet when we switch off the power.

5 golden rules to respect for any operation:

1. Turn off the power source
2. Consignment of the power source
3. Check the absence of voltage
4. Grounding and Short-circuit
5. Signalisation of the working area and protection



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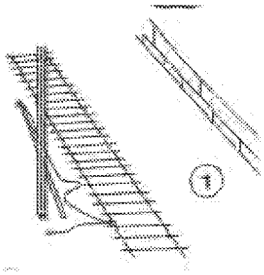
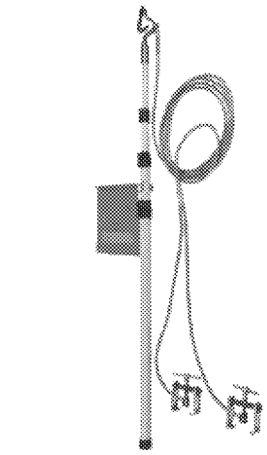
C. Grounding of the catenary

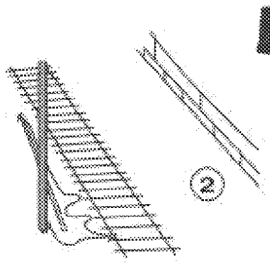
I. Procedure to follow



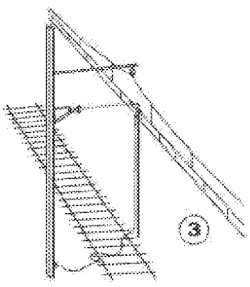




∞ Put in place the rail clamp



∞ tighten the contact on the mass of the support



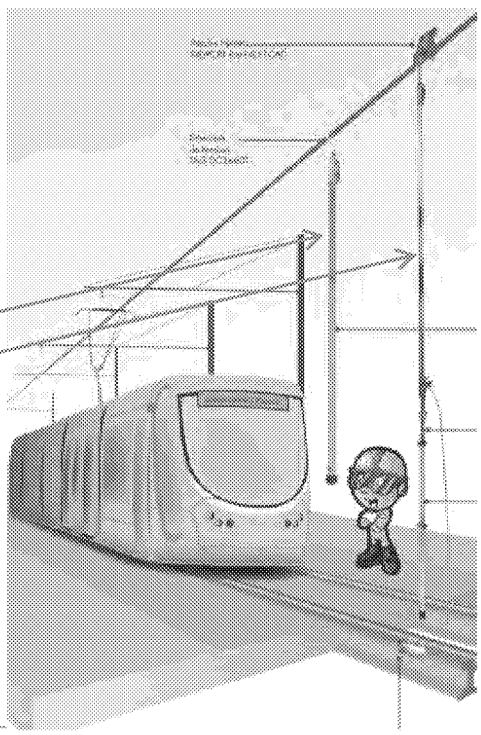
∞ hang the head of the pole on the catenary

II. Material needed

For the complete procedure of grounding the catenary, we need 2 different tools :

_ 1 : verification of the absence of voltage pole :

_ 2 : catenary – rail – support telescopic pole :



III. Exemple of supplier :

http://www.sf-electric.com

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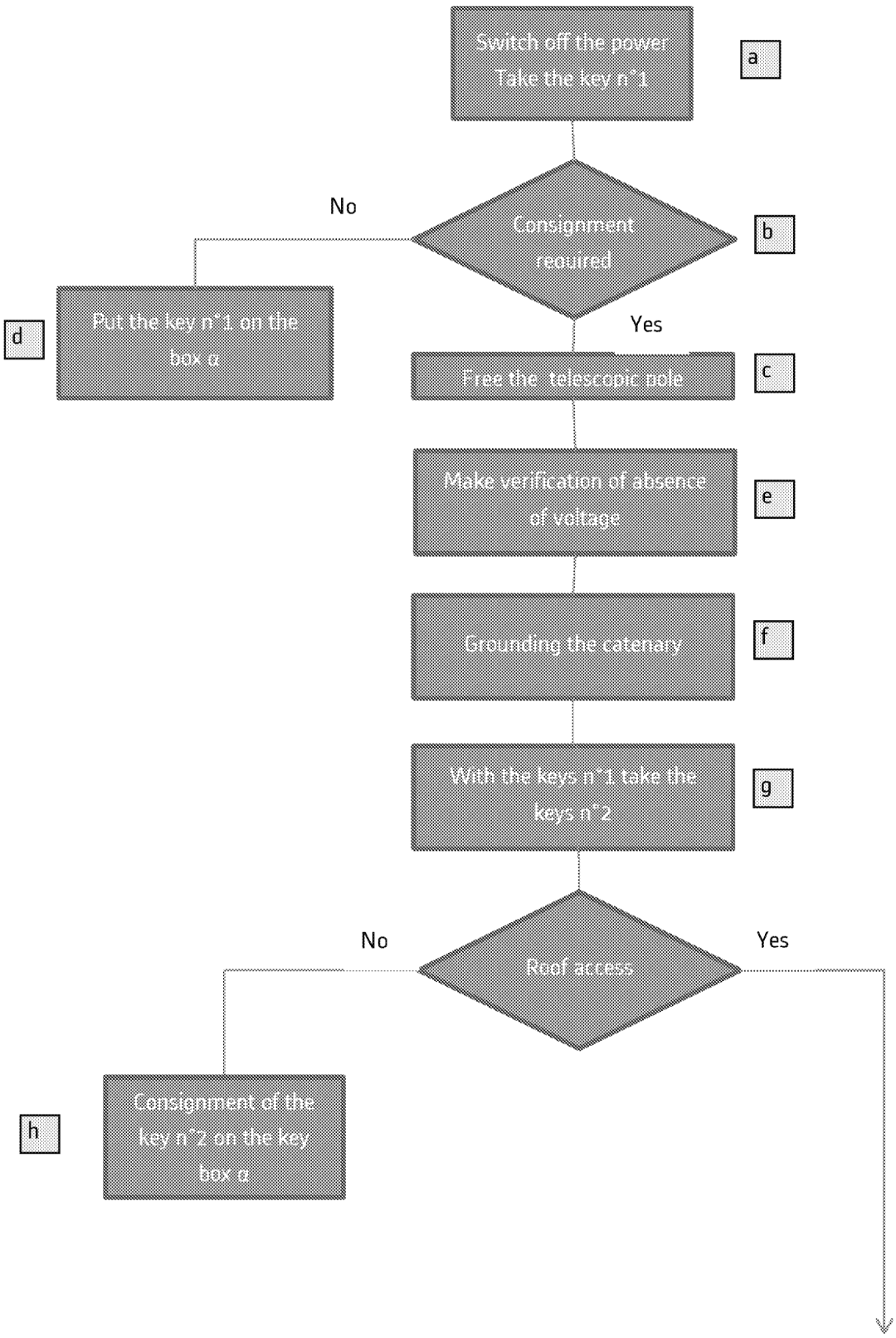
D. Testing building activity

I. Diagram of an intervention:



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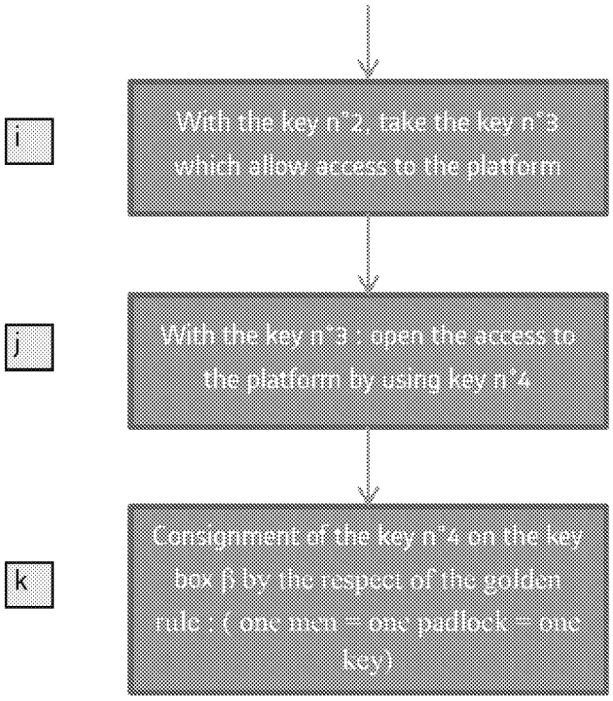

II. Schema of the material :

1. Telescopic pole station :



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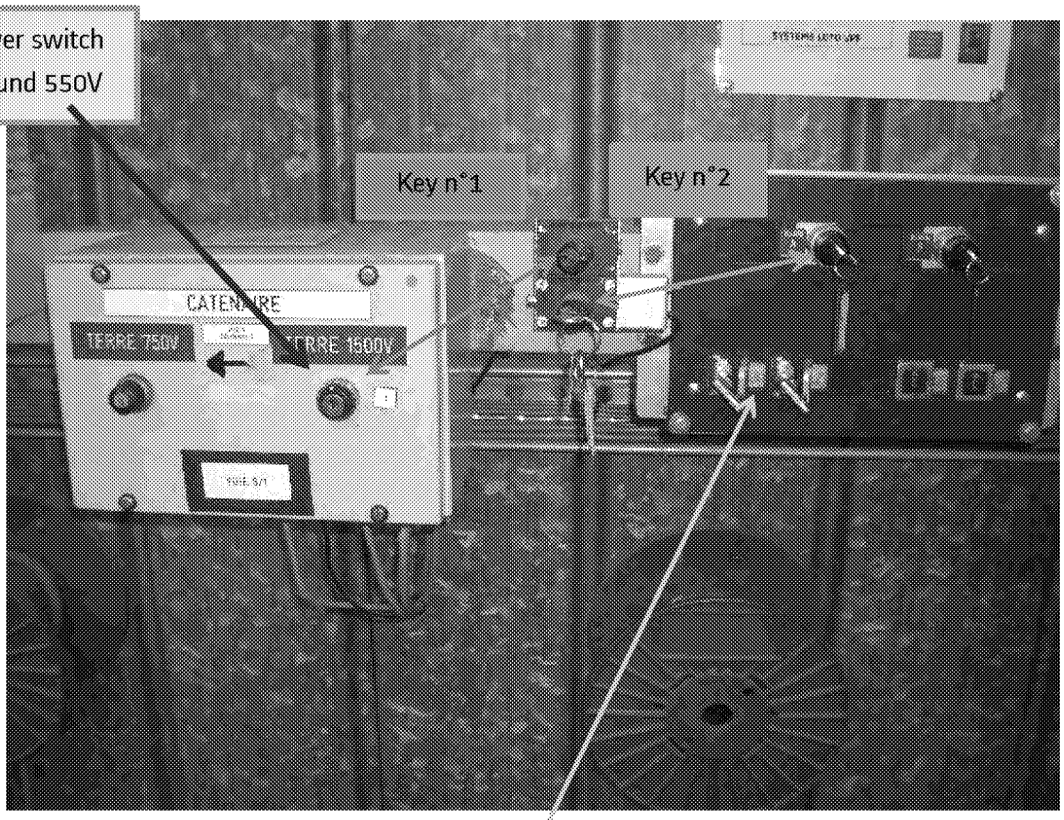
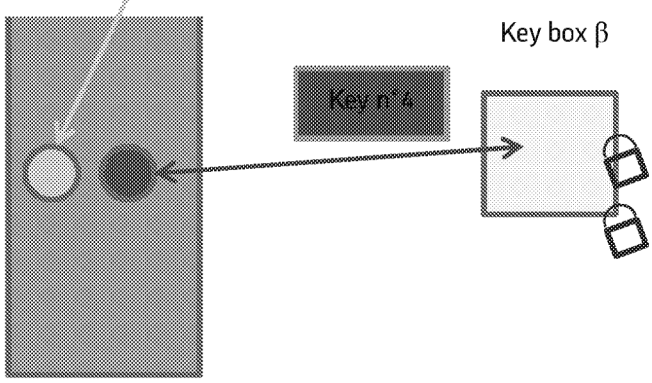


Keys n°3

Access Door to the platform

Key box β

Key n°4



2. **Control of the presence or not of the pole :**

Absence : sensor is on

presence : sensor is off



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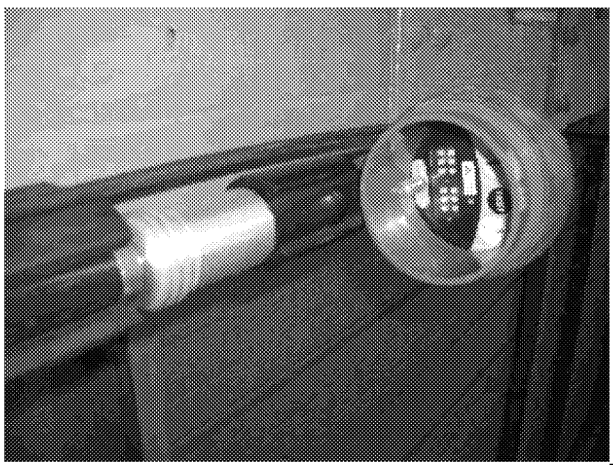
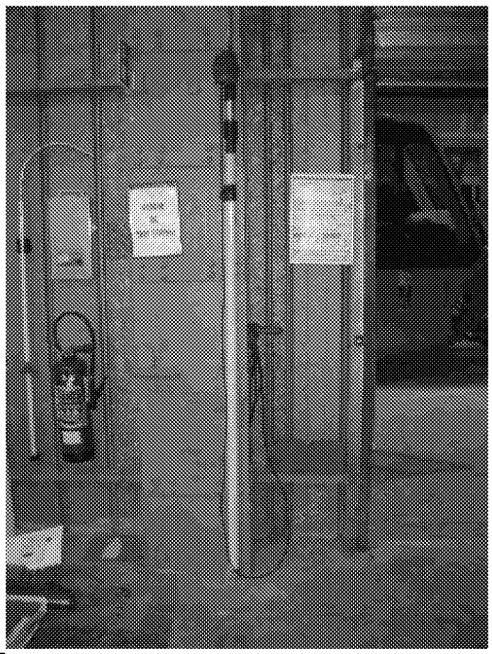
3. Verification of the absence of voltage pole :





This pole has to be taken each time with a standard telescopic pole, so we don't need to control the fact that we take it.

4. Information panel on the catenary activity :



As you can see on the example, we have 3 testing tracks :

Two tracks have a catenary divided into two parts and one track has a catenary in one part.

Green light indicate that there NO VOLTAGE on the catenary

Red light indicate that Tension is on.

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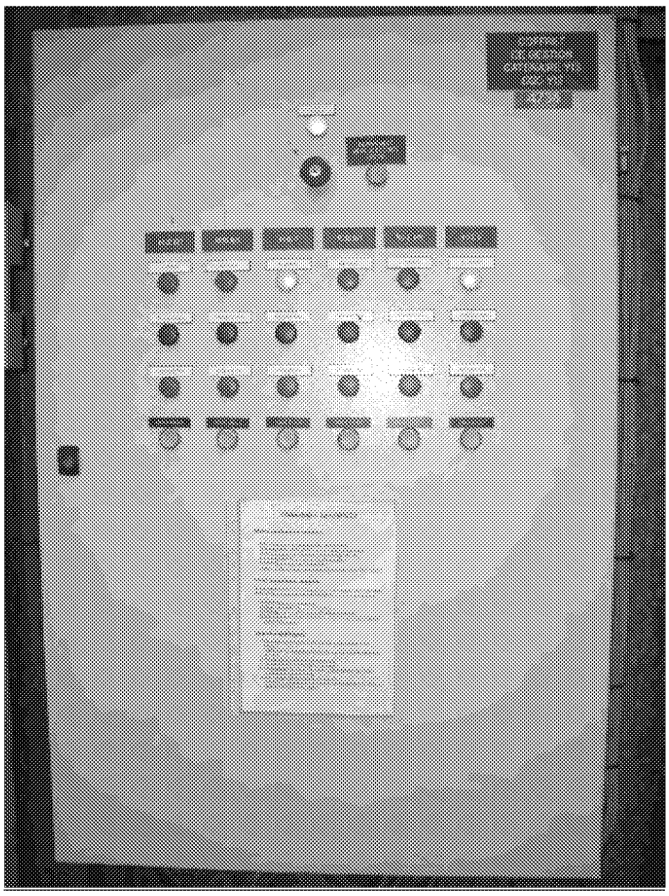
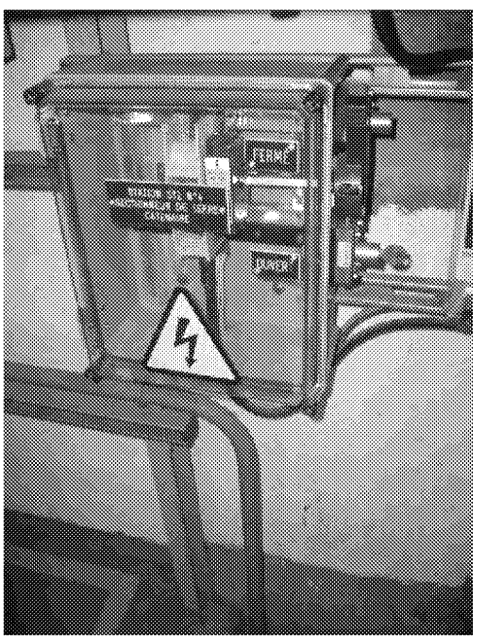
➢ ***Management cabinet:***



5. Details for power switch ground



For this operation, we prefer to have this kind of disconnector : for visibility + mechanical action + security with keys procedure

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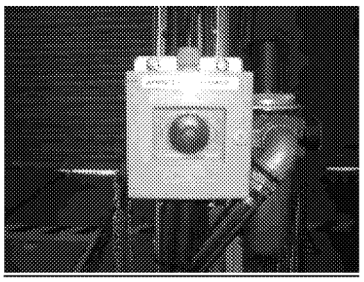
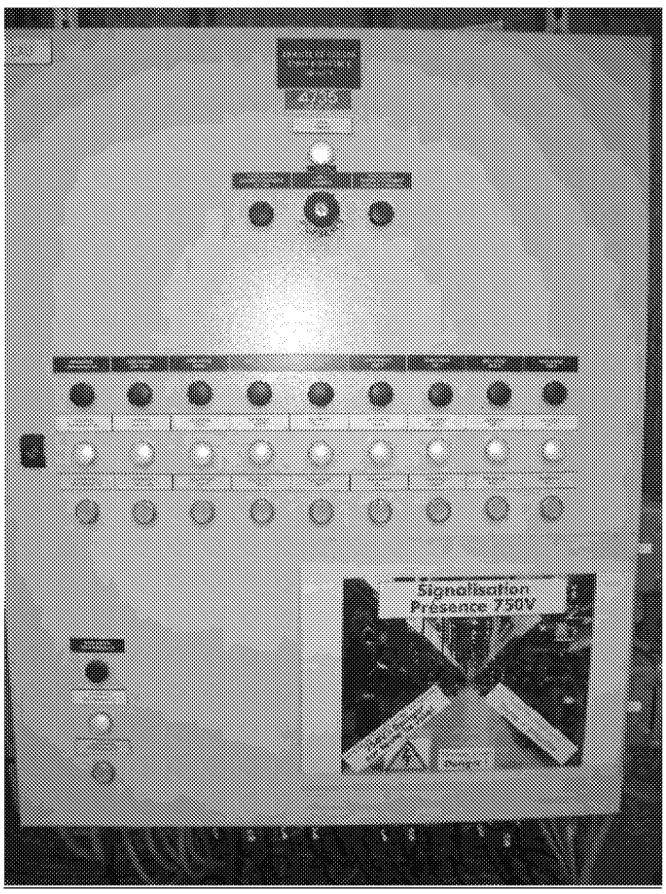
6. Emergency stop :

We need any emergency stop distributed over the work area :

- On each pit : 1 button every 20 m
- On the rest of the working area, we'll install emergency stop: 1 button every 14 m :
  - on the platform when we'll install them : but we need to think about it
  - on the side of the overhead rail



➢ ***Management cabinet***



III. Global explanation of the functionment :

Before an intervention on a tramway: we have to follow the process seen above.

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a. Cut the power with the key N°1 : you have to make sure that when we switch the power off : the system link the catenary to the ground
b. If the consignment is required, we can move the key n°1 to the second lock in order to free the telescopic pole (c.). If no requirement, just we put the key on the keybox α and the operator close the box with his personal security padlock. (one person = one key = one padlock) (d.)
    - Please note that we control the fact to remove the pole from his support.
e. We have freed the telescopic pole and we take also the verification telescopic pole to check if the tension is off.
f. After that, operator link the catenary to the ground
g. With the key n°1, we are able to take the key n°2 in order to free the key of the access door of the platform.
h. If we don't need any roof access, just put it on the keybox α. and the operator close the box with his personal security padlock. (one person = one key = one padlock)
i. With the key n°2, we can free the keys n°3 which maintain the access door of the platform closed. It's possible to have Two keys => one for the door at the bottom of the stairs and ond on the platform to segregate the platform into two independent parts.
j. With the keys n°3, we can remove key n°4 and open the access door
k. We put the key n°4 on the keybox β to secure it. the operators close the box with their personal security padlock. (one person = one key = one padlock)

IV. Scope to supply:

- Provide : one telescopic pole per working position, so 4 telescopic pole
- Provide one verification pole
- Provide the informative panel on the roof above each track to give status of the catenary : one information per working station (like on the picture)
- Provide the system of control of the pole with all the box, keys, etc....
- Provide all emergency button
- Not in scope: platform is not in the scope. But your scope will stop with the delivery of the lockers/keys that we'll install on the door of the platform.

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APPENDIX H6
SPRAYING RAMP – V2

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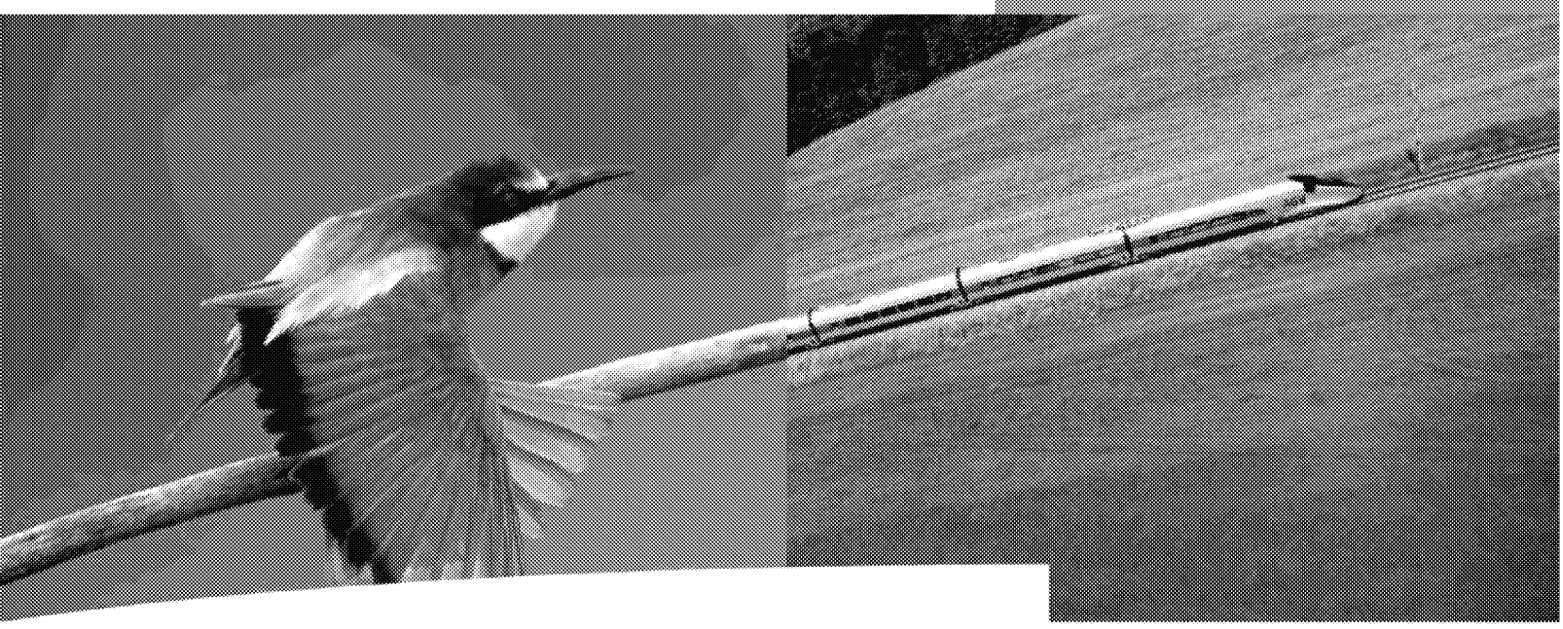

Spraying Ramp

TRANSPORT | ALSTOM

S. Blin

Alstom

27/05/2012

TRANSPORT | ALSTOM

No.....

draft ☐ for consultation ☑ for application ☐ confidential ☐

	FUNCTION	NAME	DATE	SIGNATURE
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APPROVED BY				

Revisions:

who	date	Version	modification
S. Blin	12/05/2012	V1	Creation of the document
S. Blin	05/07/2012	V2	Photos addition

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3. APPENDIX 3 : PRINCIPLE OF THE SPRAYING RAMP 18

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A. INTRODUCTION : description of the need

We require a specific system to water the train when they were finished to be assembly. The purpose is to be sure that the train is fully waterproof.

The final customer (Alstom Transport society or the partner) will be called the customer on that document!

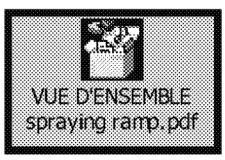
I. DOCUMENTS A RETURN TO THE CORE OFFERING

We ask the provider to send us :

- A technical and financial offer for the equipment, responding point by point to the functional specification and the general specifications
- A principle drawing of the system and its development
- Details of the proposed performance
- The turnaround time with major milestones

II. EXEMPLE

Double click on the icone to open it :



III. NORMATIVE DOCUMENTS

It is necessary to apply the following reference documents:

- European Norms
- ISO norm
- UIC standards

IV. SCOPE OF SUPPLY

It includes :

∞ The exhaustive study of the installation

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- ∞ The provision of equipment on the site.
- ∞ The development of the movement of the spraying ramp area
- ∞ The underground (if necessary) with the gutter
- ∞ The mounting, and the fluid power connections and the settings
- ∞ The commissioning and the support during first uses
- ∞ The documentation defined in the C. VIII

B. FUNCTIONNAL SPECIFICATIONS

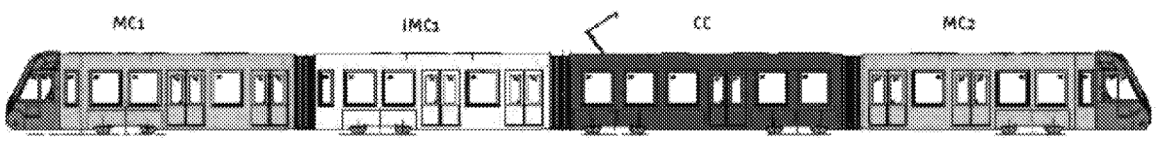
I. TECHNICAL SPECIFICATIONS

1. Vehicle type to water

We have to water tramway trainset.

number of vehicles to transhipp	one by one
Max load	< 80 tonnes
Max axle load	10 tonnes
Max width	2650 mm
Max length	35600 mm
Min height	3600 mm
distance between bogie pivots	See drawing below
spacing between extreme axles	
gauge	1430 mm (Interior rails)

Schema



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2. Number of watering

- The spraying ramp will be 50 – 150 waters by month

3. Conditions of use

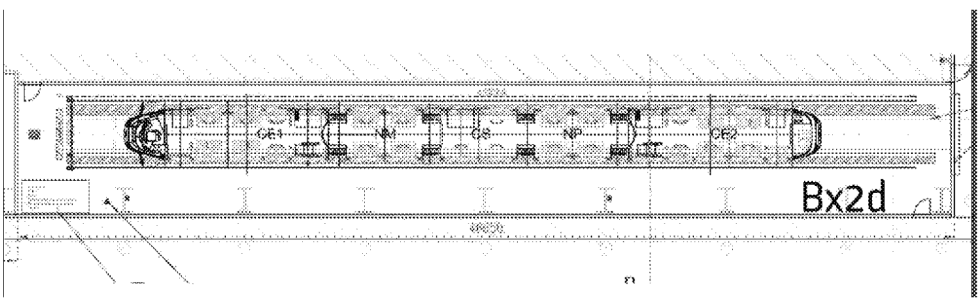
- The equipment will be used as random and intermittent day and night and will be installed on a building
- One operator will be required to manoeuvre the spraying ramp in conditions which comply with the safety standards on the date of receipt: an automatic and a manual mode will be provided.

4. Implementation

a. Description

The equipment will be installed indoors in the building Bx2d in a place specifically dedicated.
The floor and the wall will be prepared for this process.

See drawing below :



b. Specific condition

The establishment of the spraying ramp shall not affect the global building functionnement.

c. Nature of the soil of the location

The soil will be waterproof. Tile or resin. + presence of two gutters on each side of the railway track to recover the water.
On one side, one groove will remain open to allow a suction pipe to take water and bring it to the pump

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5. Dimensions

a. Dimension of cars :

- see I. 1)

The equipment is expected to water cars of appendix 1.

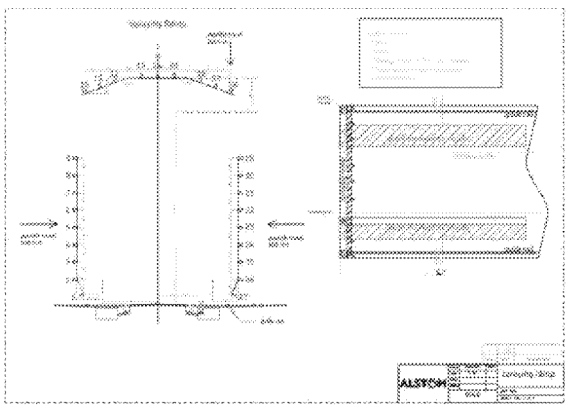
The spraying ramp travel length : 55 m

b. Others dimensions:

Distance between walls : 8 m

6. Principle of operation and diagram

([ctrl + clic] on the drawing to go to appendix 3)



The implementation of the ramp will be using a control console.

We provide several modes of work:

_ 1 fully manual mode with all of the available commands: (start/stop watering, advance / retreat of the ramp, tuning speed)

_ 1 automatic mode with advance auto of the porch at a constant speed can be adjusted

The possibility to mechanically isolate independently a ramp of watering to others and the ability to close individually each of the sprinklers.

Ratings are given for information only, the provider should conduct the field survey because it will be of course responsible for the good design of the truck transhipment mean for travel and for access to the docks.

Another requirement is to have the possibility to dry the trainset before going outside. So in parallel of the sprinkler, we'll provide a blowing system which will blow hot air with a important debit (same principle as the automobile automatic washing machine.
The system will be activated at the end of the spraying operation during a second phase.

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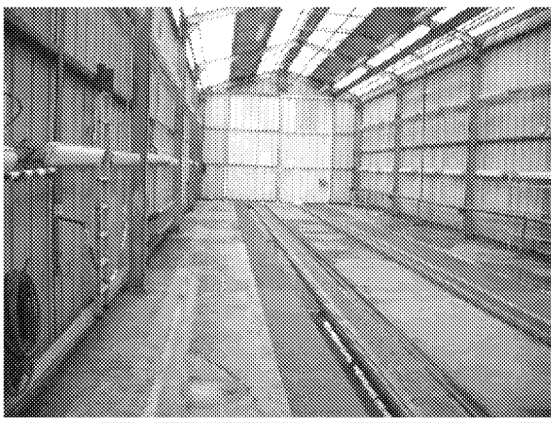
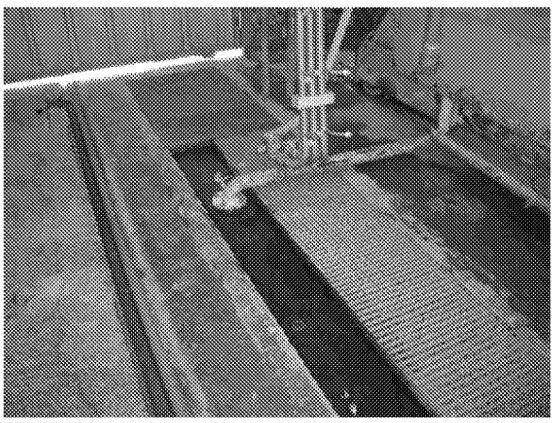
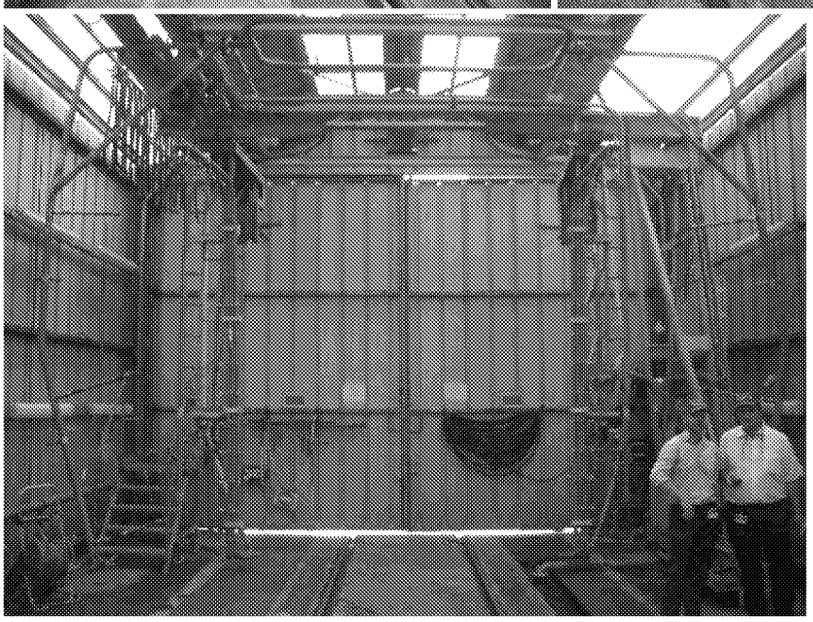
7. Exemple of realisation

But without blowing system on this exemple !







8. Technical specifications

- Pression Dynamics > 1 bar
- flow of a sprinkler > 7 l/min

Characteristics	**value**
1 – Water (dynamic) open ramp pressure	3 bar +/- 0,2
2 – Control accuracy of 3 pressure gauges	+ 0.5 bar suivant 1119.
3 – Flow sprinkler No. 1 (see Figure 1)	Sprinkler flow

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4 – Flow sprinkler No. 27 (see Figure 1)	7 + 1 l/min with 3 bar
5 – Form of jets: conical	Spray angle 60 ° +/-10 °
6 – Operation of all sprinklers	All sprinklers debiting
7 – Gantry speed	0.14 m/s + 10 %

- Fluid: water can be heated in option

Allow the possibility of completely empty water of the pipes for maintenance

Total Nomber of sprinklers : 27 sprinklers with the possibility to close them necessary by group or individually with a valve

- Range of translation of the ramp: 40 m

II. FUNCTION TO ASSURE

1. General

The spraying ramp will move independently.
The displacement will be on rails guide or other solutions (To be define by the manufacturer)

2. Motorization

The energy will be electric. The motorization will be fully electric.
The list of equipment will be delivered before acceptance meeting.

The maintenance and sustainable development aspects will also be to take into account.
The electrical equipment insulation class will at least be IP55, or more, according to the terms of use.

3. Travel speed

Ramp can move as said before at around 0,14m/s :
System with adjustable speed from 0,02m/s to 0,3 m/s

4. Water aspects

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Water used for the test: we'll think about the use of recycled water with a closed circuit composed by:

- ∞ Water recover floor design
- ∞ Drainage piping recover circuit
- ∞ pump
- ∞ Filter
- ∞ Storage tank ≈6 cubic meters
- ∞ Fresh water input connection from factory network
- ∞ Heater (to quote in option)

III. SECURITY

1. Staff movement

-

2. Signalization

Signage shall be consistent with the standards of safety : light, sonor signal

3. Ergonomics of the ramp remote

The ramp remote must be designed to allow the operator to carry out its task in the best conditions. Also, a number of criteria will need to be respected and will be submitted prior to agreement:

- ➢ Elimination of the sharp corners
- ➢ Legibility of control equipment, safety, color of the LEDs, pushbutton
- ➢ Accessibility controls, adjusting
- ➢ Physical and mental requirements imposed on the operator based on available to the workstation (intuitive command)
- ➢ Destination of the organs of command clearly indicated by inscriptions in Russian or logos according to European standards

4. Protection

All the mechanical elements with a danger to the operating personnel will be protected in accordance with European standards.

5. Compliance

The installation shall be in accordance with the legislation in force on the date of delivery.

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Compliance will be evidenced by a plaque fixed on devices, machines or devices for the protection of the CE mark, as well as a certificate of conformity, conformity with the legislation in force on the day of receipt.

Compliance of the final installation will be checked on customer site by an organization approved by the Ministry of labour. **This review will be the responsibility of the manufacturer.**
The constructor must proceed without delay to the compliance warnings requested in the report of this organization.
The comments made by the approved body will not objectionable by the provider and will be considered contractual.
If on examination, the machine is not conform, a deduction equal to the last term will be conducted on the payment of the invoices. This deference will be released only after compliance by the provider.

6. Installation on the site

For installation on the site, the provider will take knowledge of safety instructions in the company and in particular areas where it will have to intervene.

A folder of these instructions, will be sent to him. A risk prevention plan must be prepared jointly before the start of the work.

IV. PAINTING

All the provided elements will be effectively protected against corrosion.
The shades will be consistent with the European standards in force.
The choice of colours will be submitted to the approval of THE CUSTOMER prior to application.

V. MAINTENANCE

The constructor will provide for the installation and its components (under demountable units) the list of necessary spare parts (as well as their associated unit cost) that THE CUSTOMER can be led to supply.
Maintenance must be kept to a minimum and access to the various components of the equipment should be easy.

Each component will be removable for maintenance or repair.

The constructor will adopt the constructive provisions more favourable to facilitate the execution of the work.

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Obsolescence of components: the supplier undertakes to supply (including electronic) components for a period of 10 years from the date of commissioning of the installation.

The constructor will also provide :

- A preventive maintenance plan
  - The title of the preventive maintenance, the following three types of intervention will be admitted
  - the servicing (lubrication, etc.).
  - interventions pour the periodic maintenance (replacement of wear parts, filters, etc.).
  - functioning controls, the updates, periodic adjustments.

The manufacturer will specify preventive maintenance operations to achieve and their frequency and duration.

- A review of the functioning of the installation.
- A descriptive and operational record.
- All the global drawings, under units, retail, schemas and the synoptic associated
- The list ordered of all the components used and references associated with suppliers.

NB 1 : all these information are to provide under computer support (CD-Rom,...) at the latest on the date of provisional acceptance of the installation.

NB 2 : The provider undertakes to update the contractual documentation for development

o the functioning of the whole.

necessary to

OPTION :

will propose in option a maintenance contract for his installation

The provider w

HELF LIFE

VI. S

equipment will be at least 30 calendar years, including activity and rest time.
must maintain its features and performance for the duration of life, admitted to wear parts and elements listed as such.
cement shall not, in principle, be made at intervals of less than one year time. For hich cannot meet this requirement, a replacement within 1 hour should be possible.

Life of the e
Equipment
replace as w
Their replac
elements w

RELIABILITY, AVAILABILITY, TROUBLESHOOTING

VII. R

er should specify in its offer the performance that will have value of contractual nt.

ilization of the system shall not exceed 4 hours.
cturer will specify the terms of troubleshooting.

The provide
commitmen

The immobi
The manufa

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This document is the proper

C. GENERAL SPECIFICATIONS

I. TIME LIMITS

It is up to the provider to a schedule detailed the complete delivery (studies, manufacturing, installation...) compatible with the negotiated time to submit it for approval, and to clarify the milestones setting progress meetings.

II. MONITORING AND VALIDATION OF THE DELIVERY

1. Monitoring

THE CUSTOMER reserves the right to conduct visits to the provider and its subcontractors to ensure the proper implementation of material and the time limits.
Progress meetings will be organized as a result of which the claimant will prepare a report which will be co-signed by the 2 parties in meeting.
The claimant will be required to take into account any request agreed upon and justified.

2. Design validation

Before launching the manufacture, the provider will submit plans to THE CUSTOMER for approval at the design level.
Applications for justified changes will be taken into account by the claimant and will be his responsibility.

3. Reception

The installation will be validated according to the conditions of reception at the §C. V.
Manufacturing defects or quality issues, highlighted in the phase of startup or during the warranty period, lead a discount to the type of installation to complete claimant's workload or liability (or that of its suppliers) is committed.

III. PACKAGING AND TRANSPORT

The provider will ensure, packaging, transport and insurance of all to the plant. Existing ways of handling factory can be put at its disposal by THE CUSTOMER.

Unloading and transport will be provided by the supplier.

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The provider will be at least 3 days prior to shipping the exact delivery date.

IV. MOUNTING AND COMMISSIONING ON THE SITE

Editing our site shall not disrupt our production, the duration of work must be reduced to a minimum.

The provider will ensure work road of development of docks and (if necessary) existing networks, editing, energy connections and fluid, the implementation and training of users on the site.

THE CUSTOMER will be to get the fluid from the main network until instead of implementation needs identified by the provider, and a side implementation plan provided by him.

The supply will include the consumables necessary to the implementation of the whole.

It will be issued to the supplier before the start of the work, a work permit where there shall at a meeting of the initiation of construction in his presence or that of his representative, with a plan of prevention of occupational health and safety.

V. RECEPTION

1. Provisional acceptance on the THE CUSTOMER (transfer of property) website

The equipment will be received by THE CUSTOMER to his service. The following points will be taken into account :

- ∞ The conformity of the specifications
- ∞ The delivery of the contractual documentation
- ∞ The execution of the assembly
- ∞ Functionning with charge and without
- ∞ Respect of contractual performance
- ∞ The compliance of equipment in terms of safety and working conditions
- ∞ A provisional acceptance on site report will be prepared after receipt.

2. Final acceptance

Final acceptance not will be made by THE CUSTOMER until the guarantee period (M + 2 year), after verification of the following :

- ∞ The availability and reliability of the installation
- ∞ The delivery of the contractual documentation (with possible updates)
- ∞ Respect of contractual performance

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∞ The compliance of equipment in terms of safety and working conditions

If on examination, the installation does not meet the above requirements, a deduction equal to the last term will be conducted on the payment invoices. This deference will be released only after compliance by the provider.

VI. WARRANTY

24 months parts and labour and travel, from the provisional acceptance of the set on the site

A conflicting visit with THE CUSTOMER will close the end of the warranty period and will place the final acceptance.

If of Holdbacks are provided in the terms of payment, they may be dischargeable by advance against bank guarantee.

If a down payment to the order or delivery is expected also in the terms of payment, THE CUSTOMER reserves the right to cover this payment by a bank surety for restitution of deposit.

VII. PRIVACY – PROPERTIE OF STUDIES

1. Confidentiality

The provider undertakes not to disclose to third parties, as expensive or free of charge, (and in any form whatsoever) the information exchanged, and the results of the study carried out on behalf of THE CUSTOMER. Any possible derogation should be subject to a written agreement between THE CUSTOMER and the claimant.

The provider undertakes to respect the rules of the establishment (Photos prohibited,...).

2. Property of studies

The result of the research conducted under this agreement, whether patentable or not, are the exclusive property of THE CUSTOMER.
However, on the request written provider, THE CUSTOMER may be brought, for licence fee (to be negotiated on a case by case basis) to use to a third party all or part of this study.

VIII. TECHNICAL DOCUMENTATION to provide (in English and Russian)

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1. In the phase of validation of studies before installation

- A complete set of plans and patterns electric, pneumatic, hydraulic will be provided prior to execution of the installation, for approval.
  - Configuration and the plan of implementation of the facility and its equipment will be submitted to the approval of THE CUSTOMER before their manufacture, with the understanding that the manufacturer will keep responsibility for the definition of the installation.
  - The fluid connection points will be specified on the implementation plan.

- The characteristics of connection and fluid consumption (electricity, compressed air, water, gas, various,...) must be received no later than 4 months before delivery. THE CUSTOMER committing to changes on its network.
  - Electricity: voltage, total power installed, cos. Phi.
  - Compressed air: pressure, flow time, dew kite
  - Water: pressure, hourly flow rate.

2. After installation on the date of provisional acceptance

1 Copy

- The record of provisional duty with safety
- A complete set of plans and interim schemas
- The documents to the § B.V

3. No later than 8 weeks after provisional acceptance

After update of all the changes made possible by your care during the commissioning phase, duplicate best paper CD

- The final record of service with safety
- A complete set of plans and final schemas
- The final documents cited in the §B.V

IX. THE CUSTOMER STAFF TRAINING

The provider should specify the training program.

The cost of this benefit will be integrated in the offer.
This training will concern:

- the personal (mini 2 people)
- the personal maintenance and troubleshooting (2 mini people)

X. DELAY AND PENALTIES

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Penalties may be applied in case of delay of delivery or installation under terms negotiated in the commercial conditions.
Penalties will also be applied in the event of non-compliance with the objectives of reliability / availability.
In addition, THE CUSTOMER reserves the right to charge all or part of the costs induced by a dysfunction of the installation of its own manufacture.

XI. FEATURES

Conditions electric

Network: three-phase 400V, non-distributed impédant neutral (not available 230V)
Voltage tolerance 10%-5 % (to check)

Conditions pneumatic

7 bars available on the building

Conditions water

network available on the building

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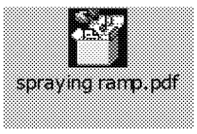
D. APPENDIX

1. **Appendix 1: diagram of the vehicle**

2. **Appendix 2 : layout of the spraying ramp**

3. **Appendix 3 : Principle of the spraying ramp**

(Double click on the drawing to open it)



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APPENDIX H7
WEIGHTING TRACK – V1

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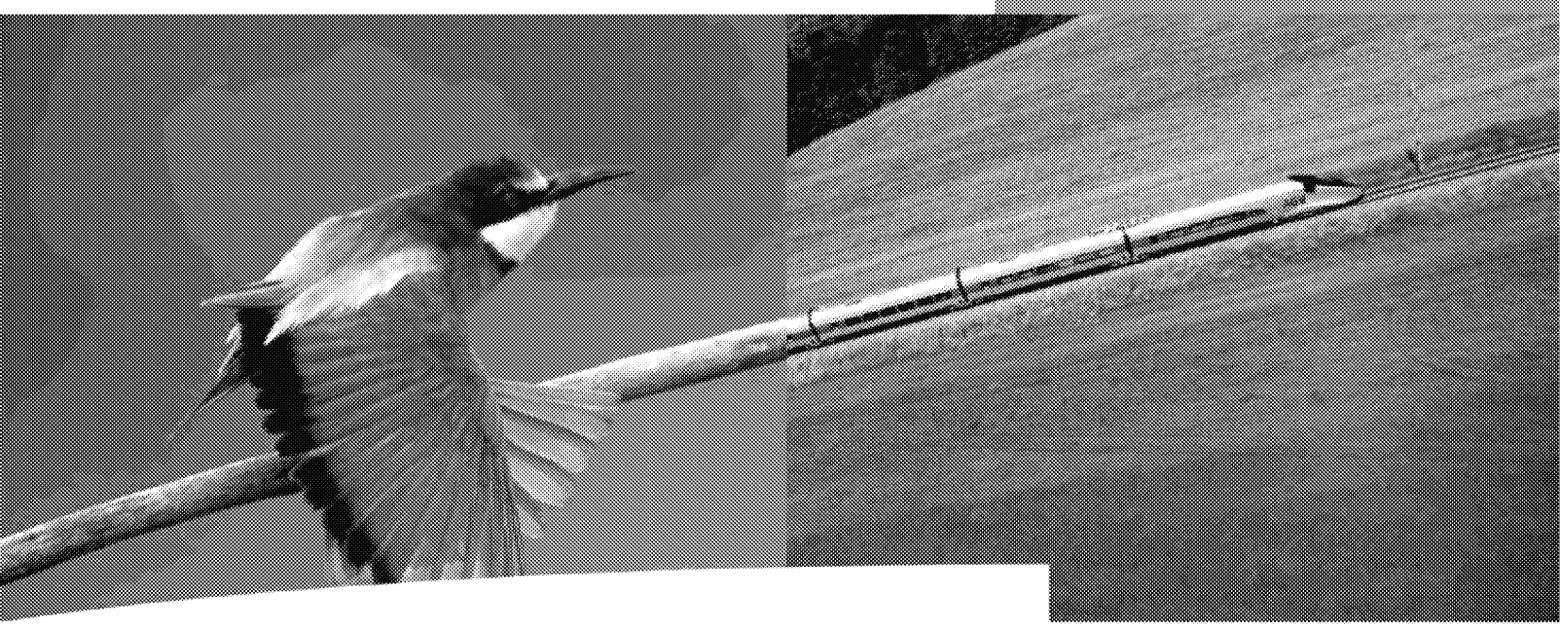
2012

Technical Specifications



Weighing track– V1

TRANSPORT | ALSTOM

S. Blin

Alstom

27/05/2012

draft for consultation for application confidential

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APPROVED BY				

Revisions:

who	date	Version	modification
S. Blin	20/05/2012	V1	Updating formatting

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2. WARPED 7
3. LONGITUDINAL LEVELLING 8
4. STRAIGHTENING 8
5. RAIL INCLINATION 8

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A. INTRODUCTION : description of the need

It covers the services, supplies, regulations and work to implement to achieve a weigh station in accordance with NF F 00 701 and UIC 610.

Subject:
Implementation of a system of legal metrology weighing out for approval or receipt of all types of railway vehicles defined by the standard NF F 00 701 and UIC 610.

Principle:
The weighing will be done Wheel by Wheel, the wheels of the bogies being weighed simultaneously. The vehicle moves, between measurements, then presented a stop on a measuring section successively for each bogie.

I) WEIGHING TRACK

1. description

The weighing track should be constituted by a new rail; put up in place of the existing rail is on track on Testing Hall.

This must be referenced rails according to one of the standards A45-3XX or one of the following UIC Cited below:

- UIC860 0
- UIC 861 1 0
- UIC 861 3 0

The weighing track should be placed on supports spaced at maximum 600mm.
To characterize the state of the weighing means, we are interested to the respective areas in which are located the points of wheel-rail contact of a bogie (or the abscence of axle bogies).
Two types of areas are considered:
Area Type A: Area occupied by a bogie in which is made by weighing a wheel
Area Type B: Areas where the bogies in which no action is performed

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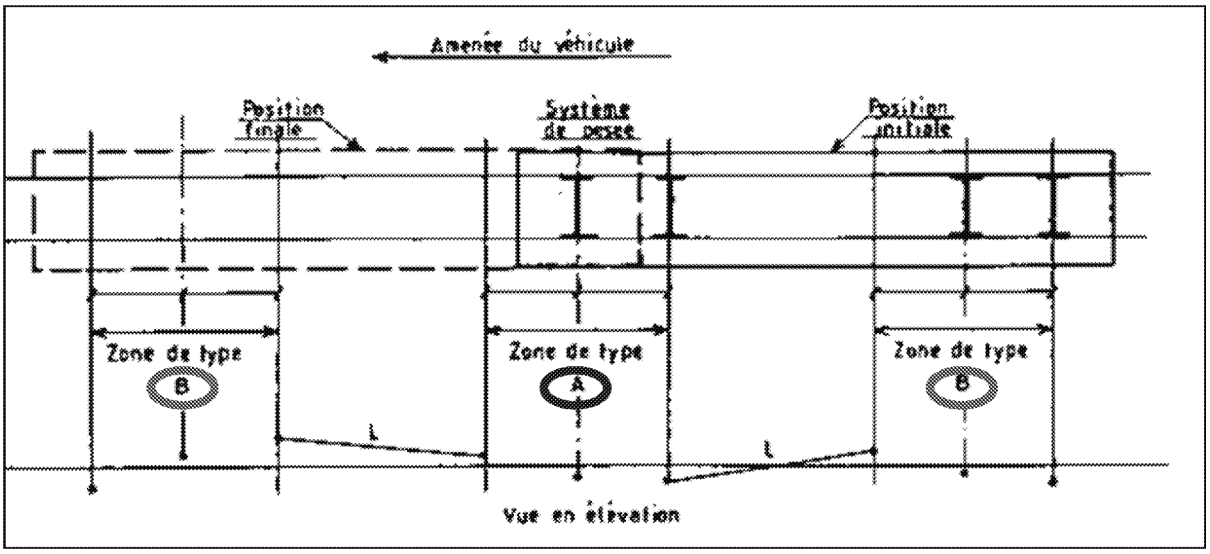

The type and placement of the rails on the track area including the positions occupied by the vehicle during the weighing must observe the characteristics as defined in § 7 of the NF F 00 701 and must be identical to that posed weighing on the sections.

2. Localization

The weighing track will be localized on the on the second track of this building
The length of this track should be around 100 m
The width should be 1430 mm

3. Acceptance

A control sheet of track geometry will be conducted by the manufacturer at the end of the work to monitor compliance with Standards NF F00 701 and UIC 610.
The checking will include

- The load levelling (typical Motor vehicle)
- The straightening
- The distance
- The inclination of the rails

Compliance of the final installation will be checked on site by an organization approved by the Ministry of labour. **This review will be the responsibility of the manufacturer.**

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The constructor must proceed without delay to the compliance warnings requested in the report of this organization.

The comments made by the approved body will not objectionable by the provider and will be considered contractual.

If on examination, the situation is not conform, a deduction equal to the last term will be conducted on the payment of the invoices. This deference will be released only after compliance by the provider.

II) NFF00701 STANDARD Based on UIC 610

The track spacing should be from :

- **1430 + / -1 mm (inner side rails)**

1. Banking

0 +/- 3mm

Rising of a rail compared to the other

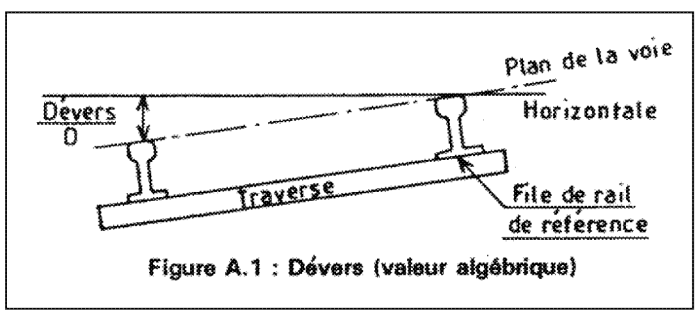
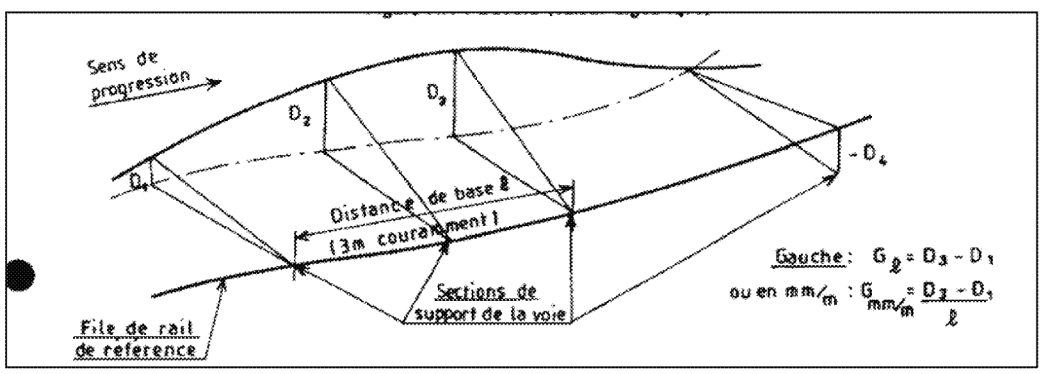


Figure A.1 : Dévers (valeur algébrique)

2. Warped

1mm / m on a base of 2,5m to 3m

Banking variation between two sections of track spaced a given distance (3m commonly) the value is expressed in mm / m and relative to the measurement basis.



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3. longitudinal levelling

+/- 5mm

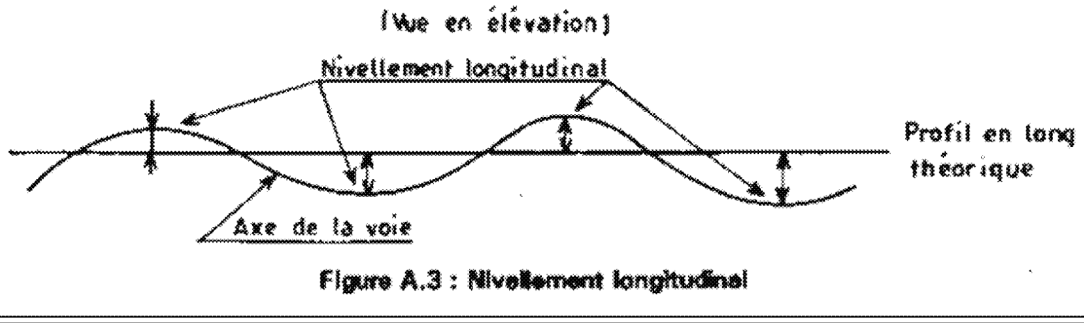

Figure A.3 : Nivellement longitudinal

4. Straightening

≤ 5mm based on 1,50m - Two successive measurements should not differ from 2mm

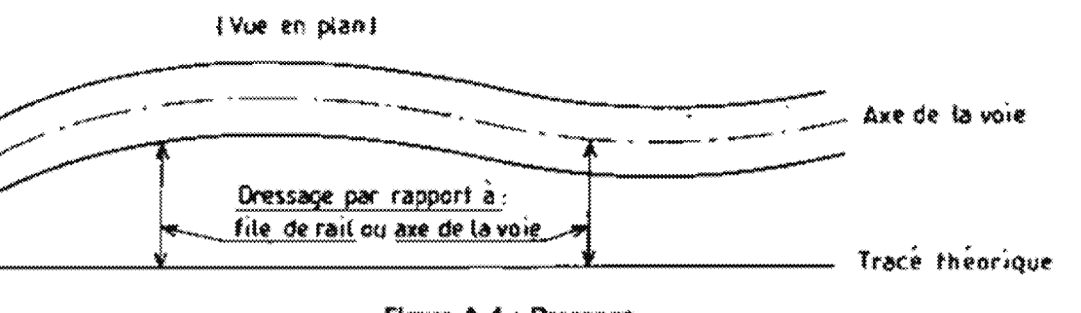

Figure A.4 : Dressage

5. rail inclination

2, 86 +/- 0,5mm

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APPENDIX I
SUBCONTRACT 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 Appendix I to the Subcontract, or any matter referred to for resolution pursuant to this Appendix I (collectively and individually, a "**Subcontract Dispute**") shall be resolved in accordance with the provisions of this Appendix 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 2.1 of this Appendix 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 Appendix 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 Appendix 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 with respect to such Subcontract Dispute and participate in proceedings referred to the Dispute Resolution Procedure in the Project Agreement, and the Subcontractor and the Construction Contractor 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, the Parties shall proceed in accordance with the applicable provisions of Clause 9 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 where the applicable provisions of Clause 9 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 Appendix 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 Subcontract 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, within thirty (30) days of receipt of a Subcontract Senior Representative Panel Notice stating that the Subcontract Senior Representative Panel has been unable to resolve the Subcontract Dispute or the Subcontract Senior Representative Panel's failure to issue such Subcontract Senior Representative Panel Notice within the time for doing so hereunder, require resolution of a Subcontract Dispute by providing written notice to the other Party (a "**Subcontract Arbitration Notice**") 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 Appendix I, 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 5 of this Appendix I (without the requirement for reference to the Subcontract Senior Representative Panel pursuant to Section 3 of this Appendix I) 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, the provisions of Clause 9 relating to Equivalent Project Relief shall apply.

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APPENDIX J
INSURANCE

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 Appendix J as insurances for which the Subontractor is responsible:

(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) "All Risks" Marine Cargo (if any exposure);

(e) "All Risks" Contractors' Equipment; and

(f) WSIB.

1.1.2 The Parties acknolwedge that Project Co and Construction Contract 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 Attachment 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 Attachment 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 as long as and for a limit equal to the limitations of liability set out in Sub-Clause 17.5.1 of the Subcontract are in effect. 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 J 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 Appendix J, 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. The Construction Contractor shall be liable for any increase in the insurance premiums in respect of the insurance policies that the Subcontractor is required to obtain and maintain, or cause to be obtained and maintained, where such increase is caused by the Construction Contractor, Project Co or the City.

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 Appendix J, 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, Ontario 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 insured and first loss payee/mortgagee, to the extent of their respective insurable interests, 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 insured**	**"Lenders" as loss payee/ mortgagee**	**Subrogation waiver in favour of "Lenders"**
Automobile Liability	No	No	No
Commercial General Liability and Non Owned Automobile Liability Ten Million Dollars ($10,000,000) each occurrence and in the annual aggregate	Yes	No	Yes
Aircraft and Watercraft Liability (if any exposure)	Yes	No	Yes
"All Risks" Marine Cargo (if any exposure)	Yes	Yes (subject to the Insurance Trust Agreement)	Yes
"All Risks" Contractors' Equipment	No	No	Yes
WSIB	No	No	No

(c) ensure that each of the insurance policies described in Article 2.1(a), Table 1, shall contain breach of conditions clause, IBC mortgage clause, non-vitiation clause and cross liability clause, as each of those terms are 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 Appendix J 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 Appendix J or the Subcontract, it is hereby agreed that the limits of liability specified in this Appendix J 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 and any cost savings resulting from the implementation of such additional and/or amended insurance shall be for the account of 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 J. 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 Subcontractor shall be responsible and liable for any waiting periods under any insurance that the Subcontractor is required to obtain and maintain (or cause to be obtained and maintained) under this Subcontract and the Subcontractor shall indemnify and hold harmless the Construction Contractor for any amounts that Project Co or the Construction Contractor would have been entitled to receive under the relevant insurance policy had such insurance policy not included a waiting period and had the relevant coverage period under such insurance policy been extended to include the period

comprising the waiting period. 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 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 Appendix J 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 Appendix J 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 Appendix J, 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 Appendix J. 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 Appendix J 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 Appendix J, the Subcontractor shall replace the Sub-subcontractor with a new Sub-subcontractor who can be covered by insurance required by this Appendix J.

11. RENEWAL AND REINSTATEMENT

11.1 The Subcontractor shall provide to the Construction Contractor, as soon as possible after the expiry date of any policy of insurance required to be obtained (or caused to be obtained) the by Subcontractor pursuant to Appendix J to the Subcontract, evidence of the renewal of each such policy reasonably 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.

12. ADDITIONAL INSUREDS AND WAIVER OF SUBROGATION

12.1 As applicable to the line of insurance as specified in Exhibit A to this Appendix J, all insurance provided by Subcontractor pursuant to Appendix J to this Subcontract, shall:

(a) include the Construction Contractor, Project Co, the City, HMQ and IO and any other party specified in Table 1 or Exhibit 1 as Additional Insureds to the extent specified in Table 1 or Exhibit 1;

(b) include the Construction Contractor City, HMQ, IO and any other party specified in Table 1 or Exhibit 1 as Additional Insureds and the "Lenders" as Additional Insureds, or loss payees to the extent of their respective insurable interests to the extent specified in Table 1 or Exhibit 1;

(c) except with respect to Automobile Liability, 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, and employees 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

Appendix J to this Subcontract, certain department and branches of the City and certain ministries and agencies of HMQ are listed as Additional Insureds.

13. CERTIFICATES OF INSURANCE AND CERTIFIED COPIES OF 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 Appendix J, fails to furnish to the Construction Contractor a certificate of insurance per Article 13 herein above or if 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, including but not limited to cancellation for non-payment of premium(s), adversely reduced, adversely materially altered or adversely materially amended 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". For greater certainty, the terms "adversely reduced", "adversely materially altered" and "adversely materially amended" as used in this provision shall mean any decrease or reduction in policy limits, aggregate limits or sub-limits (other than as a result of claims under the policy), any increase in any policy deductible or self-insured retention, any reduction in the policy coverage period, cancellation or suspension of coverage with respect to any insured parties from the time the policy was issued for that policy period, addition of any exclusions or restrictions from the time the policy was issued for that policy period and any reduction or restriction in the scope of coverage provided under the policy, in all cases when such adverse reduction, adverse material alteration or adverse material amendment is initiated by the insurer.

15.2 Not used.

15.3 Not used.

15.4 With respect to insurances described in section 1.1(a), (b) and (d) and section 1.2(d) of Schedule 25 to the Project Agreement, breach of any of the terms or conditions of the policies required to be provided by Project Co, the Construction Contractor or the Subcontractor, or any negligence or wilful act or omission or false representation by an Insured under these policies, shall not invalidate the insurance with respect to the Construction Contractor, Project Co, the City, HMQ, IO, the "Lenders" or any other Insured, but only to the extent that such breach is not known to these parties.

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 Appendix J 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 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 Appendix J to the Subcontract.

17. POLICY TERMS AND CONDITIONS

17.1 Not used.

17.2 To achieve the 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 Appendix J to the Subcontract shall relieve the Subcontractor of its liabilities and obligations elsewhere 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 and the Subcontract.

Exhibit 1 to Appendix J (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	$2 million (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	$10 million 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 ProtectiveBlanket Contractual (written) • Direct and Contingent Employers Liability		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 Subcontractor's involvement in the Design and Construction Works.

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Type	Amount	Maximum Deductibles	Principal Cover
extensions	• Personal Injury (nil participation) • 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 / tunneling/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		

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Type	Amount	Maximum Deductibles	Principal Cover
	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 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		

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Type	Amount	Maximum Deductibles	Principal Cover
	• 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	• ProjectCo, 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 by Subcontractor

Type	Amount	Maximum Deductibles	Principal Cover
Aircraft and Watercraft Liability (If any exposure)	Minimum $50 million inclusive, including $10 million passenger hazard – Owned Aircraft Minimum $10 million inclusive – Non-Owned Aircraft Minimum $10 million inclusive Owned or Non-Owned Watercraft	To be determined	
Comments	• ProjectCo, Construction Contractor, The City, HMQ, IO and the Lenders will be identified as Additional Insureds.		
"All Risks" Ocean Marine Cargo (if any exposure)	100% Replacement Cost Valuation basis	$25,000 per claim	Property of every description destined for incorporation into the System, during marine transit, on a full replacement value basis, with no co-insurance provision. This coverage shall be primary with respect to the System without right of contribution of any insurance carried by the City, HMQ, IO or the Lenders.
Comments	• Named Insured includes Project Co, the City, HMQ, IO, Lenders, Lenders' Agent, the Construction Contractor		
"All Risks" Contractors' Equipment	If Site equipment is three years old or less, the sum insured shall be equal to 100% of the replacement		All Risks coverage on all owned, rented, leased or borrowed contractors' equipment, used at the Site.

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Type	Amount	Maximum Deductibles	Principal Cover
To cover Subcontractor	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.		
Comments	• Waiver of Subrogation rights against Project Co, the City, HMQ, IO, the Construction Contractor		

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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
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 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.

APPENDIX K
INTERFACES

APPENDIX K1
INTERFACES

APPENDIX K - INTERFACES

1. Responsibilities of the Parties

	Construction Contractor	Vehicle Subcontractor
Acceptance of Vehicle to Start of Revenue Service Availability Date	a. The Construction Contractor will provide the Subcontractor with • A weekly commissioning activity plan indicating the number of Vehicle needed for commissioning (per Schedule 14) during the corresponding week. • A daily incident report for each Vehicle used.	b. The Subcontractor provides preventive and corrective maintenance of the Vehicles provided.
Start of Revenue Service Availability Date to End of Warranty Period	c. The Construction Contractor provides a daily incident report for each Vehicle. d. The Construction Contractor ensures that Maintenance Contractor will provide the Vehicle Subcontractor with access and rights to the MSF in accordance with the Subcontract.	e. The Subcontractor provides corrective maintenance and Defect analysis and correction.
Acceptance of Additional Vehicle (Schedule 35) to End of Warranty Period	f. The Construction Contractor will ensure that the Subcontractor has the necessary access to and space within the MSF to enable to Subcontractor to perform its obligations with respect to Additional Vehicle per Schedule 35.	g. The Subcontractor provides corrective maintenance and Defect analysis and correction.

1.1. Vehicle interfaces

a. The Subcontractor is responsible for providing, in timely manner, input regarding the Vehicle required by the Construction Contractor to manage and design interfaces between the Vehicles and the CBTC, Track, OCS, Power Supply, Telecom, guideway, bridges, tunnels, stations and other civil infrastructure ("Vehicle Interface").

2. CBTC

2.1 Design interface

a. The Construction Contractor is responsible to provide certain CBTC equipment
b. No later than 26 April 2013, the Construction Contractor (and its CBTC supplier) will provide a CBTC Specification in accordance with attached Exhibit A – CBTC and in accordance with the following statement :

> "The Vehicle Supplier shall cooperate with the Train Control Supplier for all aspects of the interface between all Vehicle and Train Control equipment as listed in the *Vehicle Onboard CBTC Scope Split* matrix attached as Annex F to the Letter of Intent from the Vehicle Supplier to the Design-Builder dated September 29, 2012."

The Vehicule Supplier shall be understood to refer to the Subcontractor and the Train Control Supplier shall be understood to refer to the CBTC supplier.

c. The Construction Contractor agrees that any CBTC equipment which is incorporated in the Vehicle shall comply with the general requirements of Appendices K2, K3 and K4. These requirements will be finalized by the Subcontractor and the Train Control Supplier prior to 26 April 2013.
d. If the Construction Contractor (and its CBTC supplier) has not provided a CBTC specification on or before the date indicated in Article 3.1 (b) herein, the Subcontractor will propose its own CBTC specification based on industry standards ("CBTC Specification"). The CBTC Specification shall be deemed "frozen" and shall serve as the basis for the Subcontractor to develop the corresponding interface for the Vehicles and for the Construction Contractor to develop the CBTC. Any change to the CBTC specification after the date indicated in Article 2.1 (b) constitutes a Variation per Article 14 of the Subcontract.

2.2 Supply chain

a. The CBTC equipment shall be delivered in accordance with Appendix D – Schedule to the Subcontract.

3. Tracks

3.1 Design interface

a. The Construction Contractor is responsible to provide input regarding the System tracks ("Tracks").
b. No later than 26 April 2013, the Construction Contractor (and its Tracks supplier) will provide a Tracks specification in accordance with sections 8.2 of Schedule A1 to the Subcontract as well as track roughness and decay rate at minimum in accordance with Prn ISO 3095-2010."
c. If the Construction Contractor (and its Tracks supplier) has not provided a Tracks specification on or before the date indicated in Article 3.1 (b) herein, the Subcontractor will propose its own Tracks specification based on industry standards ("Tracks Specification"). The Tracks Specification shall be deemed "frozen" and shall serve as the basis for the Subcontractor to develop the corresponding interface for the Vehicles and for the Construction Contractor to develop the Tracks. Any change to this Tracks specification after the date indicated in Article 3.1 (b) constitutes a Variation per Article 14 of the Subcontract.

4. OCS

4.1 Design interface

a. The Construction Contractor is responsible to provide certain OCS equipment.
b. No later than 26 April 2013, the Construction Contractor (and its OCS supplier) will provide an OCS Specification in accordance with section 9.2 of Schedule A1 to the Subcontract.
c. If the Construction Contractor (and its OCS supplier) has not provided an OCS Specification on or before the date indicated in Article 4.1 (b) herein, The Subcontractor will propose its own OCS specification based on industry standards ("OCS Specification"). The OCS Specification shall serve as the basis for the Subcontractor to develop the corresponding interface for the Vehicles and for the Construction Contractor to develop the OCS. Any change to the OCS Specification after the date indicated in Article 4.1 (b) constitutes a Variation per Article 14 of the Subcontract.

5. Power supply

5.1.Design interface

a. The Construction Contractor is responsible to provide certain power supply equipment ("Power Supply").

b. No later than 26 April 2013, the Construction Contractor (and its Power Supply supplier) will provide Power Supply specification in accordance with section 9.1 of Schedule A1 to the Subcontract.
c. If the Construction Contractor (and its Power Supply supplier) has not provided a Power Supply specification on or before the date indicated in Article 5.1 (b) herein, the Subcontractor will propose its own Power Supply specification based on industry standards ("Power Supply Specification"). The Power Supply Specification shall serve as the basis for the Subcontractor to develop the corresponding interface for the Vehicles and for the Construction Contractor to develop the Power Supply. Any change to the Power Supply Specification after the date indicated in Article 5.1 (b) constitutes a Variation per Article 14 of the Subcontract.

6. Telecom

6.1 Design interface

a. The Construction Contractor is responsible to provide certain Telecom equipment ("Telecom").
b. No later than 26 April 2013, the Construction Contractor (and its Telecom supplier) will provide a Telecom Specification according to the sections 26.2 & 26.5.1 of Schedule A1 to the Subcontract.
c. If the Construction Contractor (and its Telecom supplier) has not provided a Telecom specification on or before the date indicated in Article 6.1 (b) herein, the Subcontractor will propose its own Telecom specification based on industry standards ("Telecom Specification"). The Telecom Specification shall serve as the basis for the Subcontractor to develop the corresponding interface for the Vehicles and for the Construction Contractor to develop the Telecom. Any change to the Telecom Specification after the date indicated in Article 5.1 (b) constitutes a Variation per Article 14 of the Subcontract.

6.2 Supply chain

a. The Telecom shall be delivered in accordance with the applicable section of Appendix D - Schedule to the Subcontract.

7. MSF

The Subcontractor's price is based on the condition that the MSF is available to ALSTOM from June 2016 to May 2018 to assemble and test 32 serial Vehicles.

In order to best mitigate the consequence of any un-forecasted event linked to the MSF availability, the Parties agree on the following milestones:

7.1 No later than **31 January 2014**: the Construction Contractor shall provide written confirmation to the Subcontractor that the MSF will be available per the Subcontract's requirements for the assembly of the serial Vehicles. This is set to give visibility to the Subcontractor and to secure the overall Project planning.

Provided the Construction Contractor fails to confirm the availability of the MSF by 31 January 2014, the Parties may cooperate in order to (i) identify an alternative solution to maintain compliance to the planning delivery of the Vehicles or (ii) decide to continue as per the Subcontract. In any event, any delay resulting from (i) or (ii) shall be constitute a Relief Event and the Subcontractor shall be entitled to constitute a Variation per Article 14 of the Subcontract . If the Parties agree to cooperate on or before 31 January 2014 in finding a solution to possible delay of availability of the MSF, it is understood that the Parties will favor the following alternatives, by decreasing order of preference :

a. The Parties are able to find a location in Canada for the Vehicle manufacturing, enabling for similar planning;
b. The Parties cannot find another location in Canada enabling for similar planning but a waiver to the Canadian Content requirement is obtained to produce the Vehicles outside of Canada (i.e. Hornell NY ALSTOM).
c. The Parties cannot find another location in Canada enabling for similar planning and no waiver to the Canadian Content requirement is granted. The Parties will look for an optimized Industrial and sourcing strategy (with cost and/or planning impact).

7.2 No later than **31 January 2015**: the Construction Contractor shall provide written confirmation to the Subcontractor of the date where the MSF will be fully and entirely open, in order to enable the Subcontractor to prepare the installation of the production lines for the Vehicles. The level of risk of delay on the schedule is directly related to the accuracy of the forecast of the said date.

It is understood that, provided that the failure of the Construction Contractor to confirm the full opening date of the MSF by 31 January 2015 might constitute a Variation per Article 14 of the Subcontract, the Construction Contractor and the Subcontractor will cooperate in order to identify mitigating solutions, such as:

a. Subcontractor revises and adapts the sourcing and manufacturing planning in line with the portion of the MSF which is available (this could include storage of supplies ready ahead from reviewed industrial planning)
b. Subcontractor increases the number of Vehicles produced in ALSTOM first vehicles Factory, in order to stick to the original delivery planning as long as MSF is not available. (therefore, a waiver to the Canadian Content should be granted).

7.3 No later than **30 June 2016**: the Construction Contractor shall provide written confirmation to the Subcontractor of the date where the MSF will be available, so as to enable the Subcontractor to prepare the delivery and installation of the tooling.
It is understood that, provided that the failure of the Construction Contractor to confirm the availability of the MSF for tooling installation by 30 June 2016 will constitute a Variation per Article 14 of the Subcontract.

8. Infrastructure (Confederation Energized Line track)

The Subcontractor's price and schedule are based on the condition that at least 4 km of the Confederation Energized Line track will be available for the Acceptance Test of the Vehicle.

The Subcontractor's price and schedule are based on the condition that the entire Confederation Energized Line track will be available for Integration Tests of the Vehicles.

In order to mitigate the consequence of any possible delay of the availability of the Confederation Energized Line track, the Parties agree on the following milestones:

8.1 No later than **31 August 2016**, a section of at least 4 km long of Confederation Energized Line linked to the MSF are available to conduct the Acceptance Tests.

It is understood that the failure of the Construction Contractor to provide such portion of the Confederation track by 31 August 2016 will constitute a Variation per Article 14 of the Subcontract and Payment Milestone M10 will be deemed automatically achieved two (2) weeks after the date of Payment Milestone M9 for those Vehicle ready for the Acceptance Test per but cannot be tested to the lack of availability/congestion of the Confederation track.

8.2 No later than at Start of Revenue Service Availability Date, the entire Confederation Line shall be available for Integration Tests.

It is understood that the failure of the Construction Contractor to provide the Confederation track by the Start if Revenue Service Availability Date will constitute a Variation per Article 14 of the Subcontract, Payment Milestone M10 will be deemed automatically achieved at Revenue Service Availability Date and the General Warranty Period will start at the targeted Start of Revenue Service Availability.

Exhibit A – CBTC

See appendixes K2, K3, K4 :

K2 : Vehicle – Onboard CBTC Scope Split

K3 : General Interface Requirement Specifications dated September 27, 2012

K4 : Preliminary Rolling Stock / Signaling Interfaces Statements dated September 27, 2012

APPENDIX K2
VEHICLE – ONBOARD CBTC SCOPE SPLIT

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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 Diagonostic Computer	Thales	Thales	Alstom	Thales	Thales
CBTC Diagonostic Computer Connector and ethernet cable (to Thales' network switch)	Thales	Alstom	Alstom	Alstom	Alstom
CBTC Diagonostic 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 Diagonostic 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 cabe from interface relays to Vehicle Terminal Block	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Peripheral interface cables to Vehcile Terminal Block	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Train line wires to Vehicle Terminal Block	Thales	Thales	Alstom	Thales	Thales

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PPU/VIM Cables to power suppby CBs	Thales	Alstom	Alstom	Alstom	Alstom
PPU/VIM Connectors for cables to power suppy CBs	Thales	Thales	Alstom	Thales	Thales
PPU/VIM Power supply	Thales	Thales	Alstom	Thales	Thales
Acclerometer	Thales	Thales	Alstom	Thales	Thales
Acclerometer mounting plate	Thales	Thales	Alstom	Thales	Thales
Acclerometer 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 Eclosure (cubicle) compliant with EMI, IP and temperature requirements	Alstom	Alstom	Alstom	Alstom	Alstom
VOBC Rack Mounting Braket 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	Alsom	Alstom	Alstom	Alstom	Alstom
Terminal Blocks Mounting Braket and Hardware	Alsom	Alstom	Alstom	Alstom	Alstom
Event Logger	Alsom	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

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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 IntegrationTesting	n/a	Thales & Alstom	n/a	n/a	n/a
Early Onboard CBTC-Vehicle Intergration 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 Datalogging 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.				

PRRR0000120-00599

PRRR0000120

CITADIS

GENERIC INTERFACE REQUIREMENT SPECIFICATION

Devices connected on MVB

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VPFL 796001	Rel. **C**	Lang. **En**	N.Shts **19**

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1 DOCUMENT PRESENTATION

1.1 Scope of the document

The aim of this specification is to define the requirements that every device connected on the MVB vehicle network shall fulfil for the Citadis product.

This specification defines the characteristics, services and addressing that shall be implemented by any device connected on the MVB network. The document also defines the type of data exchange that shall take place, the event/faults services that shall allow the TCMS to retrieve faults or event logged on the device as well as the system data that every equipment will exchange on a periodic basis with the TCMS.

This specification shall be completed for each project with a second document describing the specific data for each device (traction , brake, ...).

1.2 APPLICABLE DOCUMENTS

[1] IEC 61375-1 Electrical railways equipment – Train bus – Part 1: Communication network on trains . First issue 1999-9

1.3 REFERENCE DOCUMENTS

[1] UIC 556 : Transmission of information on board the train unit. 2nd issue 1999-05

[2] UIC 557 : Diagnostic techniques inside vehicles . 2nd issue 1998-01

[3] ISO/CEI 8859-1 : Information technologies - Sets of characters encoded on a single byte – Part 1 : Latin alphabet n°1

[4] ICD MVB TCMS PLATFORM Specification Ref : TRV1144000488-3_TAG1

1.4 ABBREVIATIONS

Name	Description
MVB	Multiple Vehicle Bus
MPU	Main Process Unit
TCMS	Train Control & Monitoring System
CAN	Controller Area Network
PAPIS	Public Address & Passengers Information System
OAS	Operating Assistance System
BCE	Break Control Electronic
PCE	Propulsion Control Electronic
DDU	TCMS Driver display Unit
ATC	Automatic Train Control
EVR	Event Recorder

1.5 DOCUMENT PREVIEW

Chapter 1 describes the contents of this document

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Chapter 2 defines the characteristics of MVB

Chapter 3 specifies the functions related to fault and event.

Chapter 4 defines the system process variables

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2 MVB ESSENTIAL CHARACTERISTICS

2.1 Overview

This document consists in a set of specifications allowing to cover actual and further CITADIS Projects.

2.2 List and name of the equipment on the MVB network

List of equipment could be connected on the MVB network.

Equipment	Electronic
MPU1	Master Processing Unit "normal"
MPU2	Master Processing Unit "redundant"
PCE1	Propulsion control electronic 1
PCE2	Propulsion control electronic 2
PCE3	Propulsion control electronic 3
PCE4	Propulsion control electronic 4
PCE5	Propulsion control electronic 5
PCE6	Propulsion control electronic 6
PCE7	Propulsion control electronic 7
PCE8	Propulsion control electronic 8
DD1	TCMS DDU console in cab1
DD2	TCMS DDU console in cab2
ATC1	Automatic Train control system 1
ATC2	Automatic Train control system 2
BCE1	Brake control electronic 1
R1	Remote I /O Modules 1
R2	Remote I /O Modules 2
R3	Remote I /O Modules 3
R4	Remote I /O Modules 4
R5	Remote I /O Modules 5
R6	Remote I /O Modules 6
R7	Remote I /O Modules 7
R8	Remote I /O Modules 8
R9	Remote I /O Modules 9
GTW	MVB / WTB Gateway

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2.3 MVB Characteristics

Item	Value or reference
MVB protocol	Conform to reference document [1]
Physical layer	Electrical Medium Distance
Class	1
Bit rate	1,5 Mbits/s
Bit coding	Manchester
Basic period for the bus administrator	1 msec.
Medium redundancy	Yes
Bus Impedance	120Ω
MVB Master	MPU 1 or MPU2

2.4 MVB Device Addresses and port range

The Device Physical address shall be configurable in the range 0x01 to 0xFF.

Port address shall be configurable in the range 0x001 to 0xFFF.

The addressing (Port number) of each equipment shall also be configurable and will be defined in the interface control document specific for every device.

The size of a port shall be configurable between 16, 32, 64, 128, 256 bit of data.

The table below gives the actual proposed values for Device address and port range.

Name	MVB Device Address (hex)	Port for produced variable
MPU1	0x01	0x100 ..0x11F MPU to multiple devices
MPU2	0x02	0x120 ..0x13F MPU to DDU 0x140 ..0x15F MPU to PCE 0x160 ..0x16fF MPU to BCE 0x170 ..0x17FMPU to ATC 0x190 ..0x19F MPU to EVR 0x1B0 ..0x1BF MPU to OAS 0x1D0 ..0x1FF MPU to GTW 0x200 ..0x2FF MPU to RIOMs
R1	0x11	0x300 .. 0x4FF(port step of + 0x20)
R2	0x12	R1+0x20
R3	0x13	R1+0x40
R4	0x14	R1+0x60
R5	0x15	R1+0x80
R6	0x16	R1+0xA0

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Name	MVB Device Address (hex)	Port for produced variable
R7	0x17	R1+0xC0
R8	0x18	R1+0xE0
R9	0x19	R1+0x100
PCE1	0x41	0x500 .. 0x5FF (port step of +0x10)
PCE2	0x42	PCE1+0x10
PCE3	0x43	PCE1+0x20
PCEi	0x40 + i	PCE1+(i-1)*0x10
PCE7	0x47	PCE1+0x60
PCE8	0x48	PCE1+0x70
BCE	0x51 .. 0x5F	0x600 .. 0x67F(port step of +0x20)
BCE1	0x51	0x600
ATC1	0x61	0x680
ATC2	0x62	0x6A0
EVR1	0x81	0x780
GTW1	0xA1	0x880
GTW2	0xA2	0x8A0
DD1	0xB1	0x900
DD2	0xB2	0x920
OAS1	0xC1	0xA00

Note: if the number of equipment exceeds 32, an MVB repeater is needed

2.5 MVB options selected

Every device shall comply with the MVB options selected :

- MVB Medium Attachment Unit (MAU) is EMD
- MVB MAU uses redundant MVB lines
- MVB MAU master ship ability is limited to MPU

2.6 Real Time Protocol Options selected

Every device shall comply with the RTP options selected :

- Router function on device: not available
- Node directory function on device: not available

2.7 MVB services supported by every device

Each devices should be at least CLASS1 device supporting the following services :

- 1ms cycle time (port polling probably at 16 ms)
- DSW (device status word) poll
- redundant MVB

2.8 MVB Process variable Definition



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2.8.1 Introduction

A periodical data is a data that, according to a certain cycle:

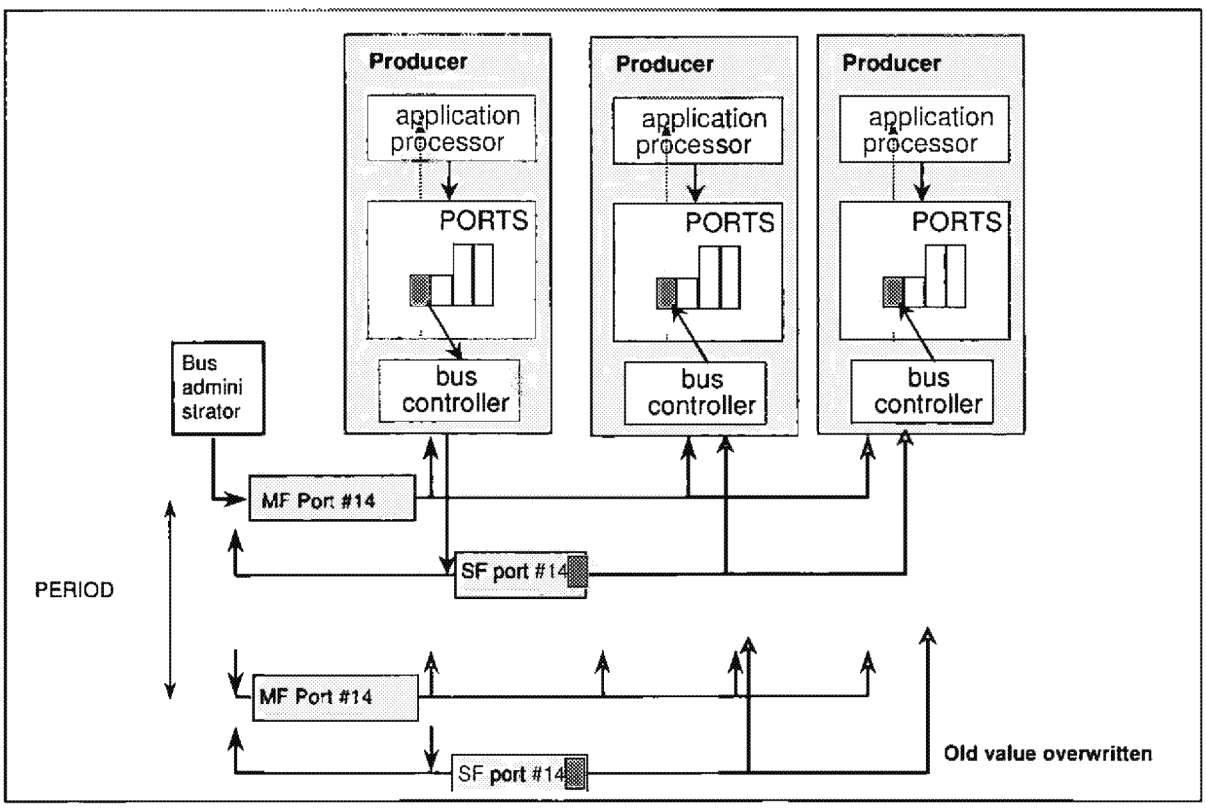
- Is produced by a device
- Is transmitted to the data processing network
- Is read and used by equipment that need to use such information.

When the periodical data is transmitted over the network, it becomes available for all devices but is used only by the concerned equipment.

The period according which the data is produced, transmitted and read can be set but remains fixed after definition. This period is called the polling period. It is the bus administrator responsibility to guarantee this polling.

Upon each cycle, the former value of the periodical data is erased by the new one, on producer and consumer side.

As a rule, periodical data are critical data concerning the equipment (control, status) and used for the monitoring/control and surveillance. They are also called 'process data '.



2.8.2 Attributes of a periodical data

The parameters of each Process variable defined below must also be configurable when stored on the equipment : change done either through a parameter file on the device or through a new software revision without a Hardware modification or Hardware removal.

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A periodical data is defined by the following fields :

Field name	Description	Possible values
Signal name	The periodical data is identified by its signal name . The maximum number of characters for the signal name will be limited to 15 characters as far as possible.	Text
Description	The "description " field allows a definition of the meaning, use and behaviour of the periodical data. This data is not stored in the on-board system.	Text
Bits	State the number of bits the signal shall use	Number
Bytes	State the number of byte the device shall use	Number
Offset	Bit offset within the port	0..255
Port	Port number	Refer to §2.4
Producer	Name of the producer of the variable. **A periodical data has only one producer.**	Refer to §2.2
Consumer(s)	Name of the consumer(s) of the periodical variable. At least one consumer is associated to each periodical data.	Refer to §2.2
Polling time	The polling time defines the period of time elapsed between two transmissions of the variable on the network by the producer. This period is defined at the time of network configuration (powering on of the network) and doesn't change. Any modification of this field requires modifications of the network configuration files. The acceptable values for this field are related to the type of network selected.	In msec.
Type	Define the type of the data (BOOLEAN,UNSIGNED INTEGER8,...)	Refer to § 2.8.3
minimum value	This field can be used only for analogue type values.	
maximum value	This field can be used only for analogue type values.	
default value	The default value gives the value of the periodical data recommended to users when no validity of data is present.	
Unit	This field describes the unit of the variable	
Refresh time	The refresh time determines the maximum time allowed without update of the periodical data by the producer before the user invalidates the data (obsolete data). The refresh time must be at least equal to or higher than the polling time	In msec.

2.8.3 Process variable Type definition

Only the following basic types will be used:

Type	Mnemonic	TypeNum	Description/Definition
Boolean	BOOLEAN1	1	Primitive type with two distinct values , TRUE and FALSE

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Type	Mnemonic	TypeNum	Description/Definition
Whole			Primitive type with distinct values that are whole numbers (positive for the non-signed ones, and negative for the signed ones), including zero as one of the values, and with a fixed bit size defined by suffix 8, 16 or 32.
32 bits			
signed	INTEGER32	8	-2^{31} .. $+2^{31}-1$
not signed	UNSIGNED32	5	0 .. $+2^{32}-1$
16 bits			
signed	INTEGER16	7	-32768 .. 32767 (-2^{15} .. $+2^{15}-1$)
not signed	UNSIGNED16	4	0 .. 65535 (0 .. $+2^{16}-1$)
8 bits			
signed	INTEGER8	6	-128 .. 127 (-2^{7} .. $+2^{7}-1$)
not signed	UNSIGNED8	3	0 .. 255 (0 .. $+2^{8}-1$)
Real	REAL32	15	Primitive type whose distinct values are part of a set of real numbers
Character	CHARACTER8	16	Primitive type whose distinct values are part of the set of characters defined in standard ISO 8859-1
String of character	STRING	32	Table of characters
Date and time	TIMEDATE48	48	Date and time in seconds and ticks since 1st of January 1970

2.8.4 Type Coding

2.8.4.1 BOOLEAN type

A Boolean type variable must be coded on one bit

0 = FALSE

1 = TRUE

Note : When binary signal are packed and transmitted : these shall be packed into byte (to achieve an efficient transfer) and sent over the bus. Up to 8 binary signals can be packed into one byte. The Boolean will be aligned on an even number of byte. This shall also be confirmed in the file defining periodical variables for each type of equipment.

Offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
first	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Example from ICD file :

NameSuffix	Part	Offset	variable Type Boolean1 Integer8 Unsigned8 Idem 16, 32 Real32 StringX
<EQU>_IMajorFltPres	**1664**	**16**	**SBoolean1**
<EQU>_IMinorFltPres	**1664**	**17**	SBoolean1

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<EQU>_IAutoTestInProg	1664	18	SBoolean1
<EQU>_IAutoTestDone	1664	19	SBoolean1
<EQU>_IAutoTestRes	1664	20	SBoolean1
<EQU>_ISpr680SB05	1664	21	SBoolean1
<EQU>_ISpr680SB06	1664	22	SBoolean1
<EQU>_ISpr680SB07	1664	23	SBoolean1
<EQU>_IDevOper	1664	24	SBoolean1
<EQU>_ICriticalFltPres	1664	25	SBoolean1
<EQU>_IInformFltPres	1664	26	SBoolean1
<EQU>_IMedium1OK	1664	27	SBoolean1
<EQU>_IMedium2OK	1664	28	SBoolean1
<EQU>_ISpr680SB14	1664	29	SBoolean1
<EQU>_ISpr680SB15	1664	30	SBoolean1

If <EQU>_IMajorFltPres and <EQU>_IMedium1OK are set to one, byte 2 of port 1664 will contain 0x01 and Byte 3 will contain 0x08

2.8.4.2 UNSIGNED8 type

The whole unsigned numbers are transmitted as binary representation, the most significant bit being transmitted first.

When the transmitted value is smaller than the type UNSIGNED#, its must be aligned on the right and extended to the left with zeros.

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $0..2^8-1$

2.8.4.3 UNSIGNED16 type

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
first	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $0..2^{16}-1$

2.8.4.4 UNSIGNED32 type

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
first	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
last	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
offset	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**

Range: $0..+ 2^{32}-1$

2.8.4.5 INTEGER8 type

The value shall be represented in binary 2's complement

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When the carried value has a smaller size than the INTEGER# type, it shall be Right-justified and sign-extended to the Left (if it is negative, with "1", otherwise, with "0")

offset	0	1	2	3	4	5	6	7
first	sign	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $-2^7 .. 2^7 - 1$

Example: '1111 1110'B = - 2

2.8.4.6 INTEGER16 type

offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
first	sign	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $-2^{15} .. 2^{15} - 1$

2.8.4.7 INTEGER32 type

offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
first	sign	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
last	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
offset	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Range: $-2^{31} .. + 2^{31} - 1$

2.8.4.8 REAL32 type

This type shall be encoded as IEEE 754 prescribes for Short Real Number (32-bit).

NOTES

1 - This is an ASN.1 'RealType', restricted to the IEEE 754 Short Real Number format.

2 - The 64-bit floating point number of IEEE 754 (REAL64) is not considered useful in this context.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
sign	2^7	biased exponent						2^0	2^{-1}	mantissa					2^{-7}
2^{-8}	mantissa														2^{-23}
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Range: $\pm 3.37 \times 10^{+38}$

2.8.4.9 STRING type

The STRING type is an ARRAY [X] OF UNSIGNED8, in which the stop element shall be the character '00'H, the actual size of the string is deduced from the number of significant characters, although the number of transmitted characters may be larger.

byte	0	1	2	3	4	5	6	7	...	X
Character order	1	2	3	4	5	6	7	8	...	X

Example:

ARRAY[8] OF UNSIGNED8 := "ABC"

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byte	0	1	2	3	4	5	6	7
Character	A	B	C	0x00	0x00	0x00	0x00	0x00

2.8.4.10 TIMEDATE48 type

The TIMEDATE48 type is an ARRAY OF 3 UNSIGNED16. It represents the time elapsed since 1st January 1970, 0H00 (Unix and ANSI-C format). It takes into account daylight saving time.

The 2 first elements of the array represent seconds. The 3rd element represents fractions of second (lsb = 1/65536s):

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
seconds (Most Significant Byte)															
seconds (Least Significant Byte)															
fractions of a second (1 tick = 1/65536s)															

2.9 Exchange of Message data

[redacted]

3 FAULTS AND EVENT

[redacted]

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4 PROCESS VARIABLE DEFINITION AND SERVICES

4.1 Introduction

Every device connected on the TCMS has two type of Process variable or periodical data :

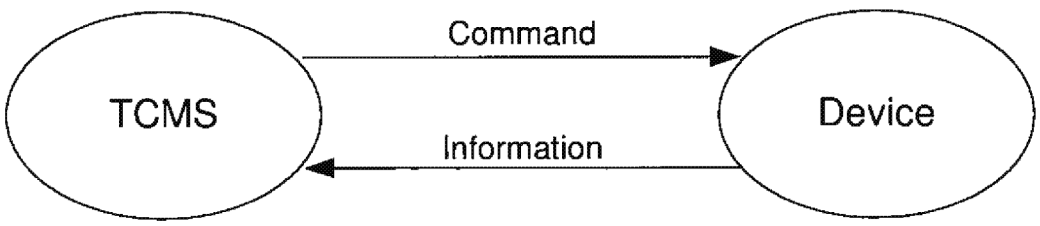
- application data (control/information)
- system data

System data are mandatory periodical variable used by the TCMS for network and device management. System data has the same format for all type of device (door, HVAC, brake, ...)

The application data are directly linked to the equipment function. Thus they are specific to each type of equipment (control signals related to the door equipment have nothing in common with those for air conditioning, the returned information is also different).

The equipment receives commands from the TCMS, modifies the system according to such commands and periodically informs on its current status.

The command can be issued from the TCMS to one or several device. The information sent by a device can also be read by any device on the network.



Communication model for Process variable

status/current status

Both system process variable and application process variables will be defined for each equipment in an Interface document.

This configuration of process variable can change during the life of the project. This modification shall not require hardware changes on the device. It shall be achieved by changing parameter file or software on the device . The specific communication channel dedicated to device maintenance operation can be used for this purpose.

A few services shall also be implemented using process variables.

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4.2 System Process variable

4.2.1 System Command

The list below indicates the system command that the TCMS sends to every equipment.

The ICD of each equipment will define the location in the port and within the port of this data.

signal name	Description	type	unit
MPU_CTCMSAlive	Counter incremented by the TCMS application software at each cycle	UNSIGNED16	/
MPU_CUnitOper	1 = unit or vehicle is ready and operational	BOOLEAN1	
MPU_CTrainOper	1 = train or set of unit of vehicle is ready and operational	BOOLEAN1	
MPU_CShutdownInP	Flag to indicate that shutdown is in progress.	BOOLEAN1	0 = no shutdown in progress 1 = shutdown in progress
MPU_CAuthorMaint	Flag to indicate that software uploading of the device or other maintenance operations is authorised.	BOOLEAN1	0 = not authorised 1 = authorised
MPU_CMPU1Oper	Master ship management	BOOLEAN1	
MPU_CMPU2Oper	Master ship management	BOOLEAN1	
MPU_CMPU1Master	Master ship management	BOOLEAN1	
MPU_CMPU1Master	Master ship management	BOOLEAN1	
MPU_CDateTime	Date and time provided by the TCMS.	TIMEDATE48	Date /time.
MPU_CNetwVersion	Identification of the network revision : the equipment receives the network revision in order to check its consistency between its own network revision and the one of the TCMS. Should there be incompatibility between the TCMS network version and equipment version, the latter shall configure itself into a safety status (door positioning on safety) and remain in that state (no system change, no functional process).	ARRAY [3] of UNSIGNED8	3 Byte defining the revision :
MPU_CTrainNumber	Number of the train or unit : A unit is a set of car whose configuration is not normally changed in normal operation. As far as possible, this should be recorded on the device as context to every fault.	UNSIGNED16	/
MPU_CTrainIsReady	TCMS informing the train is ready (1 = ready) All equipment connected on MVB awake. When this signal = 0, then battery can be disconnected (Not used by PCEs)	BOOLEAN1	

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signal name	Description	type	unit
MPU_COffLoadTest	TCMS informing the train is in OFF LOAD TEST state	BOOLEAN1	(1 = test in progress)
MPU_CReducPowrTest	TCMS informing the train is in REDUCED POWER TEST state)	BOOLEAN1	(1 = test in progress
MPU_CTrainInMaintc	TCMS informing the train is in MAINTENANCE state	BOOLEAN1	(1 = Maintenance state)
MPU_CIOSRescue	TCMS informing the Incorrect Operational State n° 1 : Rescue the train (used only by DDU)	BOOLEAN1	
MPU_CIOSDeTrain	TCMS informing the Incorrect Operational State n° 2 : De – train (used only by DDU)	BOOLEAN1	
MPU_CIOSEndLine	TCMS informing the Incorrect Operational State n° 3 : End of Line (used only by DDU)	BOOLEAN1	
MPU_CIOSEndDay	TCMS informing the Incorrect Operational State n° 4 : End of Day (used only by DDU)	BOOLEAN1	
MPU_CIOSMaintce	TCMS informing the Incorrect Operational State n° 5 : Maintenance Information (used only by DDU)	BOOLEAN1	
For each Equipment			
<EQU>_CResumeTest	Request of restarting autotest pulse with minimum 1s	BOOLEAN1	1= request to restart autotest

4.2.1.1 System status data

Each device send the following status to the TCMS

signal name	description	type	unit
<EQU>_IDevIsAlive	Counter incremented by the device application software at each cycle	UNSIGNED16	/
<EQU>_IDevOper	Bit indicating that the application of the device is running and OK	BOOLEAN1	0= application running 1 = application not running
<EQU>_IAutoTestInProg	Device has its autotest in progress	BOOLEAN1	1 = autotest running 0 = not running
<EQU>_IAutoTestDone	autotest finished on device	BOOLEAN1	1 = autotest

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signal name	description	type	unit
			finished
<EQU>_IAutoTestRes	Result of auto test	BOOLEAN1	0 = autotest OK 1 = autotest KO
<EQU>_ICriticalFltPres	Presence of a least one critical failure	BOOLEAN1	1 if failure present
<EQU>_IMajorFltPres	Presence of a least one major failure	BOOLEAN1	1 if failure present
<EQU>_IMinorFltPres	Presence of a least one minor failure	BOOLEAN1	1 if failure present
<EQU>_IInformFltPres	Presence of a least one information failure	BOOLEAN1	1 if failure present
<EQU>_IMedium1OK	State of MVB network :	BOOLEAN1	1 if Medium 1 is OK
<EQU>_IMedium2OK	State of MVB network :	BOOLEAN1	1 if Medium 2 is OK
<EQU>_IEqpInFault	The device informs the TCMS that it is in faulty state	BOOLEAN1	(1 = default state)
<EQU>_IEqpIsReady	The device informs the TCMS that it is ready	BOOLEAN1	(1 = ready)
<EQU>_IOffLoadTest	The device informs the TCMS that it is in OFF LOAD TEST state	BOOLEAN1	(1 = OLT state)
<EQU>_IReducPowrTest	The device informs the TCMS that it is in REDUCED POWER TEST state	BOOLEAN1	(1 = RdcPwrTst state)
<EQU>_IEqpInMaintc	The device informs the TCMS that it is in MAINTENANCE state	BOOLEAN1	(1 = Maintenance state)
<EQU>_ISerialNumber	Device serial Number	UNSIGNED16	/
<EQU>_INetwVersion	Network revision : The equipment sends its network Revision.	ARRAY [3] of UNSIGNED8	3 Byte defining the network revision :
<EQU>_ISoftwVersion	Revision of the software loaded on the device	ARRAY [3] of UNSIGNED8	3 Byte defining the software revision of the device
<EQU>_IHrdwVersion	Revision of the hardware of the device	ARRAY [3] of UNSIGNED8	3 Byte defining the hardware revision of the device
<EQU>_IAutoTestStep	Current step of the autotest of test number that failed or load test or reduce power test	UNSIGNED8	

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4.3 Services

4.3.1 Life signal and verification of application

Each device shall increment the counter (<EQU>_IDevIsAlive) with a period of maximum 500 ms.

When the application of the device is running , the device shall set to 1 the variable <EQU>_IDevOper.

4.3.2 Change System date

Upon detection of time difference of more than 5 second in the variable MPU_CDateTime between the reception of the system date and time from the TCMS and its own internal clock used for event dating, the device shall change its internal clock and log an event.

4.3.3 Auto test

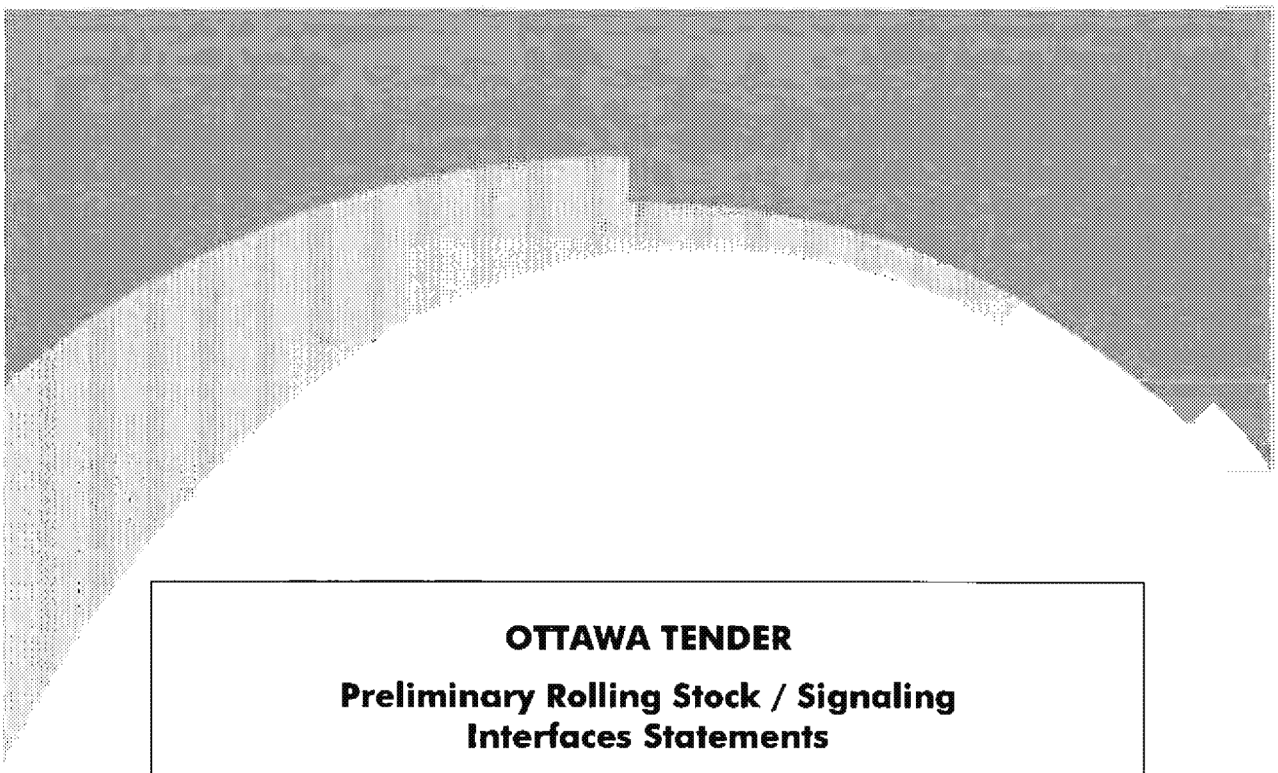
Auto test shall be performed at power up.

Auto test consist in a step of action. The device supplier will provide a table defining the step and the test performed.

Auto test result and progress shall be transmitted to the TCMS using the variables <EQU>_IAutoTestInProg, <EQU>_IAutoTestDone, <EQU>_IAutoTestRes and <EQU>_IAutoTestStep.

When a test has failed the equipment shall report in the variable <EQU>_IAutoTestStep, the step that failed.

The TCMS can request to restart the test procedure. A request is a detection of the TCMS command <EQU>_CResumeTest to 1.



OTTAWA TENDER

Preliminary Rolling Stock / Signaling Interfaces Statements

ROLLING STOCK ALSTOM / VOBC THALES

27/09/2012	A.HEUZE B.PARDOUX	A.HEUZE	S.GERAUD	ALSTOM TRANSPORT - Rolling Stock www.alstom.com 48, rue Alban Dhalenne 93482 Saint Ouen Cedex
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REVISIONS

Version	Auteur	Date	Page / Paragraph	Commentaries
0	- A. HEUZE - B. PARDOUX	17/08/2012	-	Creation
A	- A. HEUZE	27/09/2012		General update according to last Vehicle – On Board CBTC Interfaces Meeting (17th September 2012)

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1 GENERAL DESCRIPTION

1.1 Aim of the document

This document describes an overview of the TCMS / VOBC interfaces for the OTTAWA LRT project. This document is used to discuss between THALES and ALSTOM in order to consolidate the **Vehicle Interface Control Description (so called ICD)** between THALES VOBC and ALSTOM Rolling Stock.

This release is based on "Vehicle Interfaces Control Description" from THALES in version 2 and according to Vehicle / On-Board CBTC Interfaces Meeting (17th Sept 2012).

2 TRAIN MODES AND MAIN FUNCTIONS

2.1 TCMS Architecture and VOBC / TCMS Interfaces

Please find here attached update of the TCMS / ATC architecture.

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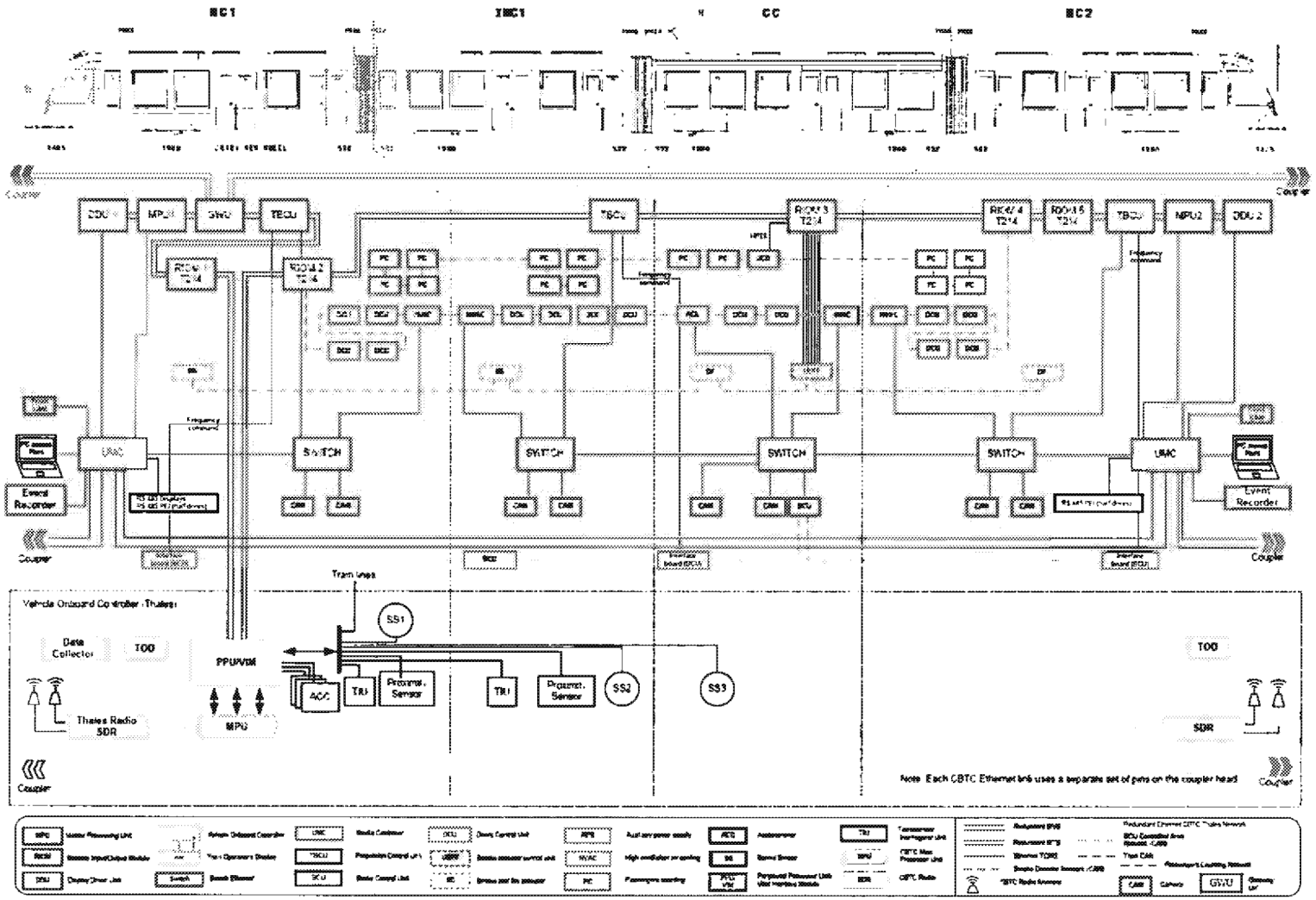
PRRR0000120



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2.2 Train Modes Matrix

Please find here below State Transition Diagram for OTTAWA LRT project.

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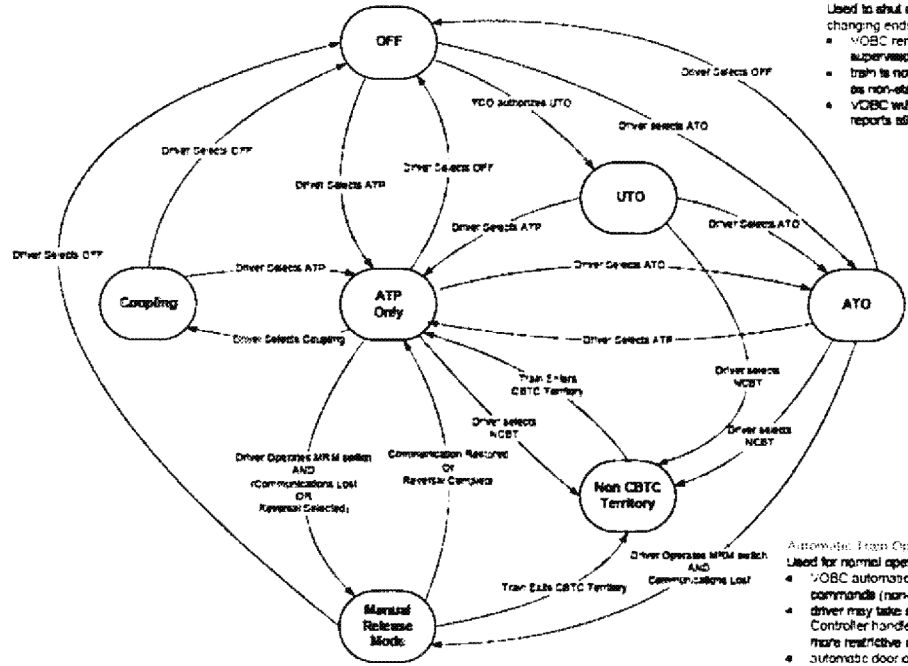
Train Mode State Transition Diagram



ATP Only Mode

Driver operates train in accordance with TOD 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

CBTC Bypass Mode

Used in the very unlikely event of total onboard CBTC failure to bypass all CBTC control of the train.

- mode activated by a switch in locked cabinet
- Master Controller commands passed directly to propulsion & braking systems
- propulsion system shall limit train speed
- an indicator that CBTC is bypassed will flash on the driver's panel

Notes

State transition details to be reviewed and agreed at Conceptual Design Review

MA – Movement Authority
TOD – Train Operator's Display
YOO - Yard Control Operator

Off Mode

Used to shut down cab before driver exits cab – e.g. changing ends at terminus, or end of shift.

- VOBC remains active and performs all required supervision
- train is not allowed to move and if the train is detected as non-stationary, the VOBC will apply EB
- VOBC will communicate with the wayside and TOC and reports all the available information

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
- Configurable Option – rear facing CCTV camera image provided to driver during reverse move

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

Automatic Train Operation Mode (ATO)

Used for normal operation on mainline

- VOBC automatically operates train according to ATS commands (non-vital) within the ATP envelop (vital)
- driver may take control of the train with the Master Controller handle - VOBC will control the train using the more restrictive commands
- automatic door open/close with driver override provided. Other options can be configured. ATP enforces that doors 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

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Please find sum-up of main driving train modes definitions and responsibility on main driving functions for each mode:

Mode	VOBC Communication mode	Doors controls (per side)		Driving Direction selection	Deadman	Speed regulation Traction/Brake request	dwell time management	Over Speed Protection	Emergency brake application	Emergency brake release
		Enabling	Opening / Closing							
Cut-Out	VOBC Isolated	DRIVER (according to train speed)	DRIVER	DRIVER (FWD or REV)	DRIVER	DRIVER	DRIVER	DRIVER and PROPULSION	DRIVER	DRIVER
Release Manual	CBTC or Non-CBTC	DRIVER (according to train speed)	DRIVER	DRIVER (FWD or REV)	DRIVER	DRIVER	DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER
Non-CBTC Territory Mode	Non-CBTC only	DRIVER (according to train speed)	DRIVER	FWD only	DRIVER	DRIVER	DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER
ATP Only	CBTC	VOBC	DRIVER	FWD only	DRIVER	DRIVER	DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER
ATO (Line Operation and Interlocking)	CBTC	VOBC	VOBC or DRIVER	VOBC	DRIVER	VOBC	VOBC OR DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER

2.3 Further statements

A. DTO mode is no more applicable. The associated requirements have been deleted from OLRT specification specification Schedule 15-2 part 4 v3.4.

B. All modes are desgined as far as they are defined in OLRT specification Schedule 15-2 part 4 v3.5 with the addition of UTO mode and OFF mode. See State Transition Diagram for details. State Transition Diagram shall be submitted to safety analysis to finalize functions and scope of each mode.

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PRRR000120

C. The use of cut-out mode (CBCTC bypass) can be considered in exceptional case only with specific procedures and responsibilities to the operator. RTG will define the procedure in cooperation with the city of OTTAWA. Propulsion system will limit train speed to its maximum design speed.

D. Provisions are made to implement remote auto-coupler and auto-coupler cover control by VOBC in order to offer automatic coupling mode as far as defined in OLRT specification Schedule 15-2 part 4 v3.5. Criticity and safety aspects of the function will be discussed later on through safety case. Unattended coupling & uncoupling will be provided in UTO Mode.

E. For each mode and functions, the safety critical functions will be ensured by hardware logic on train side with the requested level of integrity (safety analysis will be consolidated in project phase). Non-safety critical functions can be realized either by hardware logic or software.

F. In ATO mode, the deadman function remains active through driver actuation.

G. Three speed sensors will be mounted on independent non-motorized, braked axles on each vehicle. None unbraked axle is available.

H. As preferred option, specific on-board PACIS and ground PACIS wifi connection will be used for station CCTV upload on train and for maintenance data download to ground (including passenger counting information). In that case, use of 802.11a WiFi communication will avoid interference with VOBC WiFi. Final design will consolidated after business award in project phase. Risk will be minimized if the on-board PACIS system and the station PACIS system is the same (both ALSTOM). Non CBTC data will not be transmitted through CBTC network.

I. Passenger Information messages (audible and/or visual) are broadcasted according to triggers from VOBC (see chapter 5 where triggered are described).

J. Each vehicle will be be equipped with a 2oo3 VOBC offering redundancy on each vehicle. In 2-vehicle train, additionnal redundancy is provided because either VOBC on the train can control the train.

K. As an option, thanks to MVB interfaces, Driver Display Units (TCMS scope) can be used in redundancy of the Train Operator Display (TOD – THALES scope). If applied, final design of this option will be finalized in project phase. All data to be displayed shall be exchanged through MVB Interface. Even though the TOD's are powered all the time, the information displayed at the non-active cab shall be 'NO_COMMUNICATION'.

L. On Train network architecture, final list of equipment to be connected to UMC Ethernet port or to adjacent Ethernet switches will be consolidated during design phase.

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3 MVB CONNECTION

Software interface between TCMS and THALES equipment is done through MVB network between Train MPU and VOBC.
Please find attached generic MVB interface description on which ALSTOM is designing.



CITADIS ICD MVB
generic VPFL796001-I

(see appendix VPFL796001)

Example of time delay for similar service proven project with ATC on MVB Network:
Port = 0x0680 for the **fast** system variables (**T = 16 msec**)
Port = 0x0681 for the **slow** system variables (**T = 128 msec**)

At vehicle level, the VOBC is communicating on vehicle MVB network. Example : the data sent towards the MPU from ATC1take the following form: ATC1_IXXXXXXX.

At train level (multiple units of two vehicle), the two VOBC shall communicate together to determine which one is master. Only the master VOBC shall produce these data.

4 VOBC INPUTS / OUTPUTS

This chapter defines preliminary lists of vital / non-vital inputs/outputs on VOBC.
All information contained in this chapter 4 is prone to variations in project phases according to safety analysis from ALSTOM and THALES. Segregation between vital and non vital inputs/outputs will be finalized in project phase.
Outputs from VOBC are used by TCMS in various other functions.

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4.1 Typical Discrete VOBC Outputs (Vital) – from THALES ICD table 3 rev2

Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
EBC	Emergency Brake Command	Vital Output	Command, relay contact, double cut circuit	EB Brake Pipe Solenoids Typical 1.5 A through EBR slave relay	PPU	**EBC1** VIM2A **EBC2** VIM2B	TL Energized = EB held off. Slave EB relay used to control vehicle circuitry. See check-back input. Two independent commands to drive the two EB relays (+28,5Vdc).	"1" Energized (EB not applied) "0" De-energized (EB applied) Typically implemented with shielded wires
VZC	Velocity Zero Command	Vital Output	Command, relay contact, double cut circuit	Typical 1.5A	PPU	**VZC1** VIM2A **VZC2** VIM2B	Velocity Zero Command – VOBC Command. Two independent commands to drive the two slave VZC relays (+28,5Vdc).	"1" Energized (VZC sent) "0" De-energized (VZC not available) Typically implemented with shielded wires
PEC	Propulsion Enable Command	Vital Output	Command, relay contact, double cut circuit	max.200 mA	PPU	**PEC1** VIM2A **PEC2** VIM2B	Two independent dry-contacts.	"1" Energized (Propulsion enable commanded) "0" De-energized (Propulsion enable command OFF) Typically implemented with shielded wires
DER	Door Enable Right	Vital Output	Command, relay contact, double cut circuit	max.200 mA	PPU	**DER1** VIM2A **DER2** VIM2B	Two independent dry-contacts.	"1" Energized (Door Enable Right commanded) "0" De-energized (Door Enable Right command OFF) Typically implemented with shielded wires

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
DEL	Door Enable Left	Vital Output	Command, relay contact, double cut circuit	max.200 mA	PPU	**DEL1** VIM2A **DEL2** VIM2B	Two independent dry-contacts.	"1" Energized (Door Enable Left commanded) "0" De-energized (Door Enable Left command OFF) Typically implemented with shielded wires
PWR	Motoring command	Output	Command, relay dry-contact,	max.200 mA	PPU	PWR VIM2A	Connection to Motoring trainline. Motoring command in ATO (to be interlocked to the circuitry Propulsion Enable). Dry-contact.	"1" Energized (Motoring commanded) "0" De-energized (Motoring command OFF)
BRK	Braking command	Output	Command, relay dry-contact,	max.200 mA	PPU	**BRK** VIM2B	Connection to Braking trainline. Braking command in ATO. Dry-contact.	"1" Energized (Braking command OFF) "0" De-energized (Braking commanded)

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4.2 Typical Discrete VOBC Outputs (Non-Vital) – from THALES ICD table 4 rev2

As non-vital outputs, this data can be managed either trough MVB interface or hardware (non vital LV outputs and trainlines).

Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
FSB	Full Service Brake Command	Output	MVB telegram	MVB protocol	MPU	MPU MVB port	VOBC Full Service Brake Command.	"1" Energized (Full Service Brake commanded) "0" De-energized (Full Service Brake command OFF)
SM	Vehicle Sleep Mode	Output	No more useful because deletion of DTO mode					
STDBY	Stand by Enable	Output	MVB telegram	MVB protocol	MPU	MPU MVB port	Enables Stand-by mode by the VOBC	
DMR	ATO Mode Reset	Output/ input	MVB telegram	MVB protocol	MPU	MPU MVB port	Output drives trainline connected to reset ATO mode relays in both Cabs.	
DME	ATO Mode Enable	Output	MVB telegram	MVB protocol	MPU	MPU MVB port	VOBC recognizes input on DMS and closes relay contact to select ATO mode relay in Cab	
Auto-DCR	Door Close Request	Output	Status	MVB telegram	MPU	MPU MVB port	Active high (Open doors are commanded to close).	Read "1" (Doors commanded to close) Read "0" (Doors not commanded to close)

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Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
Auto-DORR	Door Open Right Request	Output	Status	MVB telegram	MPU	MPU MVB port	Active high (Right doors commanded to open). Door open command is taken into account only if the doors were previously enabled.	Read "1" (Right doors commanded to open) Read "0" (Right doors not commanded to open)
Auto-DOLR	Driver Door Open Left Request	Output	Status	MVB telegram	MPU	MPU MVB port	Active high (Left doors commanded to open). Door open command is taken into account if the doors were previously enabled	Read "1" (Left doors commanded to open) Read "0" (Left doors not commanded to open)
FWD	Forward Direction Selection	Output	Status	MVB telegram	MPU	MPU MVB port	Train travel direction selection by VOBC When VOBC controls the travel direction, FWDS and REVS inputs will provide the status of VOBC commands: FWD, REV.	
REV	Reverse Direction Selection	Output	Status	MVB telegram	MPU	MPU MVB port	Train travel direction See description for FWDS.	

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4.3 Typical VOBC Inputs (Vital, Non-vital) – from THALES ICD rev2 table 5

Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
EBS1	Emergency Brake Status	Vital Input	Status, optically isolated input	15 mA	PPU	**EBS1,** RET1 VIM1A	Status line from vehicle EB loop. Input referenced to RET 1.	Read "1" EB not applied Read "0" EB applied
EBS2	Emergency Brake Status	Vital Input	Status, optically isolated input	15 mA	PPU	**EBS2,** RET1 VIM1A	Status line from vehicle EB loop. Input referenced to RET1.	Read "1" EB not applied Read "0" EB applied
EB_CB	Slave EB Relay Check-back	Vital Input	Status, optically isolated input	15 mA	PPU	**EB_CB,** RET1 VIM1B	Monitor the back contact(s) of the VOBC slave **EB** relay. Power to contact(s) provided from BAT+. Implementation with one independent normal close contact of each EBR relay, connected in series. Input referenced RET1	Read "1", Both EB Relays OFF (EB Applied) Read "0", Both EB Relays ON (EB Raised) Read Failure if EB Relays are in opposite states. VOBC becomes passive, EB loop un-energized and EBs applied.
MODE1	Operating Mode Selection	Vital Input	Status, optically isolated input	15 mA	PPU	**MODE1,** RET3 VIM1A	Input referenced to RET3.	
MODE2	Operating Mode Selection	Vital Input	Status, optically isolated input	15 mA	PPU	**MODE2,** RET3 VIM1B	Input referenced to RET3.	

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
DCLS	Doors Closed and Locked Status Left/Right	Vital Input	Status, optically isolated input	2x15 mA	PPU	**DCLS1,** RET2 VIM1A **DCLS2,** RET2 VIM1B	Two independent status lines from door close loop. Summary signal for all doors closed. Input referenced to RET2.	Read "1" (Door are closed and Locked) Read "0" (No Door closed and lock)
TIA	Train Integrity	Vital Input	Status, optically isolated input	15 mA	PPU	TIA, **RET1** VIM1A	Trainline for detection of a parted train. Cab circuits provide power to the coupler status and EB buttons loop. VOBC monitors status input. Inputs referenced to battery return.	Read "1" (Train Integrity acquired) Read "0" (Train Integrity broken) Train Integrity input shall always be maintained "1" logic as long the train cars are connected in the normal train configuration and not be dependant of any train level interlocking
TIB	Train Integrity	Vital Input	Status, optically isolated input	15mA	PPU	**TIB** VIM1B	Trainline for detection of a parted train. Tc2 cab circuit provides power to the coupler status loop. VOBC monitors status input. Inputs referenced to battery negative.	Read "1" Train integrity acquired Read "0" Train integrity broken See above
TI Test	Train Integrity Test	Non vital input	Status, optically isolated input	15mA	PPU	**TI test** VIM1B	Input acquired for the Train Integrity test of the train integrity interface relays	
ACA	Active cab	Vital Input	Status, optically isolated input	15 mA	PPU	**ACA,** RET1 VIM1A	Active Cab 1(A) is energized when local cab (T1) is active. Antivalent with ACB. Input referenced to RET 1	Read "1" (Active Cab A available) Read "0" (Active Cab A not available)

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
ACB	Active cab	Vital Input	Status, optically isolated input	15 mA	PPU	**ACB,** RET1 VIM1B	Active Cab 2(B) is energized when remote cab (T2) is active. Antivalent with ACA. Input referenced to RET 1.	Read "1" (Active Cab B available) Read "0" (Active Cab B not available)
VZS	Velocity Zero Status trainline	Vital Input	Status, optically isolated input	15 mA	PPU	**VZS,** RET2 VIM1A	Monitor the status of **VZS** trainline. Input referenced to RET3.	Read "1" (Velocity Zero) Read "0"(Velocity not Zero)
VZS_CB	Velocity Zero relay check-back	Vital Input	Status, optically isolated input	15 mA	PPU	**VZS_CB,** RET1 VIM1B	Monitor the back contact(s) of the slave **VZ** relays. Power to contact(s) provided from BAT+. Implementation with one independent normal close contact of each VZ relay, connected in series. Input referenced to RET1	Read "1", Both VZ Relays OFF Read "0", Both VZ Relays ON Read Failure if VZ Relays are in opposite states. VOBC becomes passive, EB loop un-energized and EBs applied.
CSA	Coupler Status A	Vital Input	Status	15mA	PPU		Status of Coupler A	
CSB	Coupler Status B	Vital Input	Status, optically isolated input	15mA	PPU		Status of Coupler B	

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4.4 Typical VOBC Inputs (Non-vital) – from THALES ICD rev2 Table 6

As non-vital inputs, this data can be managed either trough MVB interface or hardware (non vital LV outputs and trainlines).

Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
BRS	Brake release status	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Status of Brakes are released via MVB telegram)	Read "1" (Brakes are released) Read "0" (Brakes are not released)
DCR	Door Close Request	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Open doors are commanded to close).	Read "1" (Doors commanded to close) Read "0" (Doors not commanded to close)
DORR	Door Open Right Request	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Right doors commanded to open). Door open right status is available only if the doors were previously enabled.	Read "1" (Right doors commanded to open) Read "0" (Right doors not commanded to open)
DOLR	Driver Door Open Left Request	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Left doors commanded to open). Door open left status is available only if the doors were previously enabled	Read "1" (Left doors commanded to open) Read "0" (Left doors not commanded to open)

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Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
FWDS	Forward Direction Selected	Input	Status	MVB telegram	MPU	MPU MVB port	Train travel direction When T1 cab is active (ACA='1', ACB='0'), - forward travel direction for T1 is equivalent to FWDS='1', REVS='0' - reverse travel direction for T1 is equivalent to FWDS='0', REVS='1' When VOBC controls the travel direction, FWDS and REVS inputs will provide the status of VOBC commands: FWD, REV.	
REVS	Reverse Direction Selected	Input	Status	MVB telegram	MPU	MPU MVB port	Train travel direction See description for FWDS.	
DEBR	Driver EB Reset Request	Input	Status	MVB telegram	MPU	MPU MVB port	Driver EB Reset requested. Active high. When the vehicle applies EB, the driver will activate the DEBR signal to request VOBC to raise the EB's. When all conditions are met, the VOBC will output EBC.	Read "1" Driver EB requested Read "0" Driver EB not requested
DMS	DTO Mode Select	Input	No more useful because deletion of DTO mode					

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4.5 Sensors, Antennas and Communication Links

Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
T1P1P	Speed Sensor 1	Input	Status, optically isolated input	2x50 mA	PPU	VIM3	Speed sensor power and signal. Shield connected at VOBC chassis.
T1P1S							
T1P2S							
T1P_Sh							
T2P1P	Speed Sensor 2	Input	Status, optically isolated input	2x50 mA	PPU	VIM3	Speed Sensor power and signal. Shield connected at VOBC chassis.
T2P1S							
T2P2S							
T2P_Sh							
T3P1P	Speed Sensor 3	Input	Status, optically isolated input	2x50 mA	PPU	VIM3	Speed Sensor power and signal. Shield connected at VOBC chassis.
T3P1S							
T3P2S							
T3P_Sh							
ACC1P	Accelerometer 1	Input	Status, analog input	< 40mA	PPU	VIM3	Accelerometer power and signal. Shield connected at VOBC chassis.
ACC1N							
ACC1S							
ACC1G							
ACC1_Sh							
ACC2P	Accelerometer 2	Input	Status, analog input	< 40mA	PPU	VIM3	Accelerometer power and signal. Shield connected at VOBC chassis.
ACC2N							
ACC2S							

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
ACC2G							
ACC2_Sh							
ACC3P	Accelerometer 3	Input	Status, analog input	< 40mA	PPU	VIM3	Accelerometer power and signal. Shield connected at VOBC chassis.
ACC3N							
ACC3S							
ACC3G							
ACC3_Sh							
PROX1P	Proximity Sensor 1	Input	Status, optically isolated input	15 mA	PPU	See inputs (VIM3)	Proximity Sensor power and signal. Based on proximity sensor model, the signal PRX1N is not used. Shield connected at VOBC chassis.
PROX1N							
PROX1S (PROX)							
PROX2_Sh							
PROX2P	Proximity Sensor 2	Input	Status, optically isolated input	15 mA	PPU	See inputs (VIM3)	Proximity Sensor power and signal. Based on proximity sensor model, the signal PRX2N is not used. Shield connected at VOBC chassis.
PROX2N							
PROX2S (PROX)							
PROX2_Sh							
RAD1A	Radio Antenna 1 – SDR 1	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.
RAD2A	Radio Antenna 2 – SDR 1	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.
RAD1A	Radio Antenna 1 – SDR 2	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
RAD2A	Radio Antenna 2 – SDR 2	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.
TI UNIT1	Transponder Interrogator Unit and Antenna	Output	RF signal		TI	-	CIR connection
TI UNIT2	Transponder Interrogator Unit and Antenna	Output	RF signal		TI	-	CIR connection
ETHERNET1	Network Communication Link	Output	ETHERNET Network		SDR 1 SDR2 Network switches TOD1 TOD2 MPU Diagnostic Computer	-	
ETHERNET2	Network Communication Link	Output	ETHERNET Network		SDR 1 SDR2 Network switches TOD1 TOD2 MPU Diagnostic Computer	-	

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
MVB1	Serial Communication Link	Input/ Output	MVB Network		MPU	-	Interface to: Vehicle TDMS Various Vehicle non-vital systems
MVB2	Serial Communication Link	Input/ Output	MVB Network		MPU	-	Interface to: Vehicle TDMS Various Vehicle non-vital systems

Traction and Braking effort are exchanged through MVB network from VOBC to Propulsion and Brake controller. Traction and Braking effort are taking into account only if they are validated by at least suitable status of PEC, PWR and BRK hardware logic trainlines (refer to associated description here above).

As option Traction and Braking effort can be managed through analogic signal between VOBC and Rolling Stock TCMS such as:

EFF1+ **EFF1-** EFF1_Sh	Motoring/Braking Effort Demand	Analog Output	Current output 0 – 20 mA	Max 20 mA	PPU	(PASC) VIM3	Current output 0-20 mA to vehicle propulsion controller. Interface load: 50Ω.
EFF2+ **EFF2-** EFF2_Sh	Motoring/Braking Effort Demand	Analog Output	Current output 0 – 20 mA	Max 20 mA	PPU	(PASC) VIM3	Current output 0-20 mA to vehicle propulsion controller. Interface load: 50Ω.

This effort is given through an analog 0-20 mA signal.

- 0-2 mA (0 mA) corresponds to a zero effort.
- 18-20 mA corresponds to the maximum brake effort / fast brake effort or full traction effort.

Braking/Motoring transfer characteristic will be finalized pending vehicle motor/braking characteristics, after vehicle submits this information for review during implementation phase (tolerance values for min and max will be determined based on this information).

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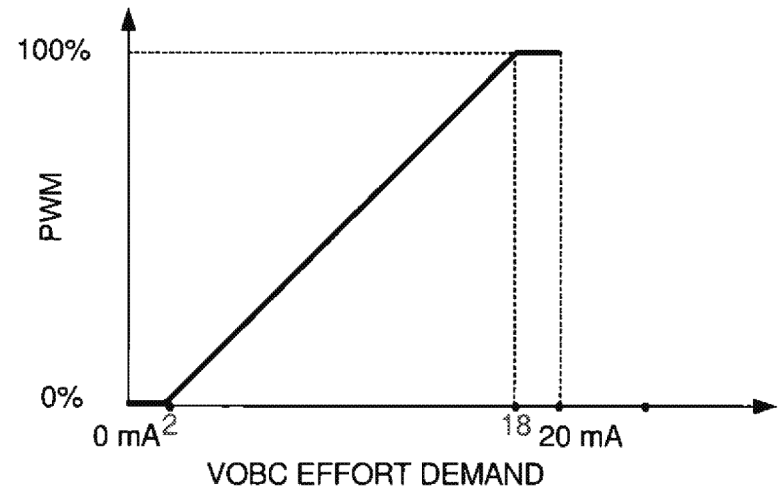

5 ADDITIONAL DATA ON MVB INTERFACES

This chapter list minimal additional data used to fulfill the TCMS / VOBC interface. This data shall be exchanged on MVB interfaces as defined in chapter 3 here above.

5.1 From the Alstom TCMS (MPU) to the ATC

MPU_CUnitOper	BOOL	When functioning, the applicative software of TCMS shall set this variable to 1 (to be recorded in EVR) (to send to ATC)
MPU_CTrainOper	BOOL	As there is no M.U. service, this variable is the same as unit oper (=1 when application running).
MPU_CShutDownInP	BOOL	Flag to indicate that shutdown is in progress (= 1 during about 30s).(to be recorded in EVR)
MPU_CAuthorMaint	BOOL	Flag to indicate that software uploading of the device or other maintenance operations is authorized. (1 = authorized).
MPU_CMPU1Oper	BOOL	mastership management (to be recorded in EVR)
MPU_CMPU2Oper	BOOL	mastership management (to be recorded in EVR)
MPU_CMPU1Master	BOOL	mastership management (to be recorded in EVR)
MPU_CMPU2Master	BOOL	mastership management (to be recorded in EVR)
MPU_CTEffDmd	INT	Total effort demand in step of 0.1% (-100 to +100%) according to driver or ATC demand (for PCE, BCE, DDU)
MPU_CAutoMode	BOOL	Automatic driving mode done by ATC (ATO) (for BCE, PCE)
MPU_CDateTimeSec	DWORD	Date and time provided by the TCMS to all equipment.

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		(to be recorded in EVR)
MPU_CDateTimeTick	WORD	Date and time provided by the TCMS to all equipment. (to be recorded in EVR)
MPU_CTrainNumber	WORD	Number of the train or unit : A unit is a set of car whose configuration is not normally changed in normal operation. As far as possible, this should be recorded on the device as context to every fault. (to be recorded in EVR)
MPU_CSerialNumber	WORD	Device serial Number (to be recorded in EVR)
MPU_CNetwVersion0	USINT	Identification of the network revision : the equipment receives the network revision in order to check its consistency between its own network revision and the one of the TCMS. Should there be incompatibility between the TCMS network version and equipment version, the latter shall configure itself into a safety status (door positioning on safety) and remain in that state (no system change, no functional process). Divided in 3 "char8 variables" (to be recorded in EVR)
ATC_CDDU1Oper	BOOL	DDU operational in cabin Mc1 (E1) 0: Not operational 1: Operational
ATC_CDDU2Oper	BOOL	DDU operational in cabin Mc2 (E2) 0: Not operational 1: Operational
ATC_CHighVoltagePresence	BOOL	High voltage presence on the trainset 0: No High voltage presence 1: voltage presence
ATC_CFSDAlarm	BOOL	Fire or smoke detection on the train 0: No Fire and smoke detection 1: Fire or smoke detection
ATC_CFullServBrak	BOOL	Driving control handle position full service brake 0: No full service brake 1: Full service brake
OCC_CIOS1	BOOL	IOS1
OCC_CIOS2	BOOL	IOS2
OCC_CIOS...	BOOL	IOS...
OCC_CIOS142	BOOL	IOS142
OCC_CIOS143	BOOL	IOS143

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5.2 From the ATC to the Alstom TCMS (MPU)

<ATCi>_IDevIsAlive	WORD	Counter incremented by the ATC application software at each cycle
<ATCi>_IDevOper	BOOL	Bit indicating that the application of the device is running and OK. 0: Application not running 1: Application running
<ATCi>_IAutoTestInProg	BOOL	Device has its autotest in progress 0: Not running 1: Autotest running
<ATCi>_IAutoTestDone	BOOL	autotest finished on device 0: Autotest not finished 1: Autotest finished
<ATCi>_IAutoTestRes	BOOL	Result of auto test 0: Autotest OK 1: Autotest not OK
<ATCi>_IFaultxxx	BOOL	A bit by fault which can be send to the TCMS and to inform the driver
<ATCi>_IMedium1OK	BOOL	State of MVB network: 0: Medium 1 is not OK 1: Medium 1 is OK
<ATCi>_IMedium2OK	BOOL	State of MVB network 0: Medium 2 is not OK 1: Medium 2 is OK
<ATCi>_IAccelSp	INT	Acceleration setpoint in step of 0,1% (-100 to +100 %) from ATCi
<ATCi>_IFSBCmd	BOOL	ATC, ATPM mode enabled and maximum service brake ordered 0: No full Service Brake Command from ATCi (with i=1 or 2) 1: Full Service Brake Command from ATCi (with i=1 or 2)
<ATCi>_ITractionPowerGap	BOOL	Indicates the close presence of a non-bridgeable cut-out to the rolling stock 0: Area OK 1: Non-bridgeable cut-out area
<ATCi>_ITractionInhibition	BOOL	Traction inhibition 0: Traction is not inhibited 1: Traction is inhibited
<ATCi>_IEmyBrkATP	BOOL	Emergency brake ATP demand from ATCi 0: No emergency 1: Emergency
<ATCi>_ICoastCmd	BOOL	Coasting command from ATCi (with i=1 or 2)

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		0: No coasting command requested 1: Coasting command requested
<ATCi>_ITractCmd	BOOL	Traction command from ATCi (with i=1 or 2) 0: No traction command requested 1: Traction command requested
<ATCi>_IBrakCmd	BOOL	Braking command from ATCi (with i=1 or 2) 0: No braking command requested 1: Braking command requested
<ATCi>_ITrainWithMission	BOOL	Train mission status (L4) 0: No mission 1: Mission
<ATCi>_INetwVersion0	USINT	Network revision : The equipment sends its network Revision. Char 0
<ATCi>_INetwVersion1	USINT	Network revision : The equipment sends its network Revision. Char 1
<ATCi>_INetwVersion2	USINT	Network revision : The equipment sends its network Revision. Char 2
<ATCi>_ISoftwVersion0	USINT	Revision of the software loaded on the device. Char 0
<ATCi>_ISoftwVersion1	USINT	Revision of the software loaded on the device.Char 1
<ATCi>_ISoftwVersion2	USINT	Revision of the software loaded on the device. Char 2
<ATCi>_IHardwVersion0	USINT	Revision of the Hardware loaded on the device. Char 1
<ATCi>_IHardwVersion1	USINT	Revision of the Hardware loaded on the device. Char 2
<ATCi>_IHardwVersion2	USINT	Revision of the Hardware loaded on the device. Char 3
<ATCi>_ITrainNumber	WORD	Train number
<ATCi>_ITrainSpeed	INT	Train speed in step of 0,1 kph (-120 to +120 kph) from ATCi
<ATCi>_IDestStationIdx	BYTE	ATCi confirming the index of the destination station n=11 [0x01...0x0B] for line 2 n=14 [0x01...0x0E] for line 4
<ATCi>_INxtStationIdx	BYTE	ATCi confirming the index of the next station n=11 [0x01...0x0B] for line 2 n=14 [0x01...0x0E] for line 4
<ATCi>_ICurStationIdx	BYTE	ATCi confirming the index of the current station n=11[0x01...0x0B] for line 2 n=14 [0x01...0x0E] for line 4
<ATCi>_ILineNumbIdx	BYTE	ATCi confirming the index of the Line_Number [0x00] Not yet defined [0x02] For Line 2 [0x04] For Line 4
<ATCi>_ITrainLoc	BYTE	Train localisation [0x01,0x02,0x03] 1 : stopped in station

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		2 : out of tunnel 3 : in tunnel
<ATCi>_ILRUList	BYTE	List of the removable ATC component statuses at first maintenance level.(LRU:Line Replaceable Unit) For Line 2:Bit0: OBCU A Rack; Bit1: OBCU A Fan; Bit2: Odometer A; Bit3: Not applicable; Bit4: TIA antenna; Bit5: CIU A; Bit6: TOD end1; Bit7: TOD end2
<ATCi>_IIsMaster	BOOL	ATCi confirming it is the master (with i=1,2) 0: Not OK 1: OK
<ATCi>_ITrigArrival	BOOL	trigger of station arrival 0: No trigger 1: Trigger OK
<ATCi>_ITrigPreArrival	BOOL	trigger station pré-arrival 0: No trigger 1: Trigger OK

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6 MECHANICAL AND ELECTRICAL INTEGRATION

6.1 Mechanical Integration

ALSTOM proposed vehicle for OLRT project will include provisions to integrate THALES equipment within the scope of supply defined by THALES through ICD and according vehicle architecture presented in chapter 2.1. As represented on train architecture (chapter 2.1), the VOBC equipment is located as follows:

- In an electrical cabinet (VOBC enclosure),: MPU, PPU/VIM, Network Switched, Diagnostic Computer, relays and three accelerometers;
- Three speed sensors will be mounted on independent non-motorized, braked axles of the vehicle. None unbraked axle is available.
- Two proximity sensor is to be mounted on the bogie frames.
- Three accelerometers are to be installed on the floor inside the vehicle locker as close as possible to the centerline of the vehicle.
- Two Transponder Interrogator Unit is to be mounted on the bogie frame of the car.
- Four radio antennas (two at each end of the train) are to be mounted in the interior of the vehicle, near the ceiling at each end of the train.

The following equipment should be located in the driver's cabs or suitable lockable enclosure at each end of the train:

- Train Operator Display (TOD);
- Two SDRs (one at each end of the train) with power supplies, each with its own dedicated mounting bracket (to be supplied by vehicle supplier);
- Pushbuttons and switches required for the CBTC system.

Preliminary data taken into consideration on equipment to integrate are such as :

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Item	Description	Qty per VOBC	H (mm)	W (mm)	D (mm)	Maximum Weight (kg)
1	MPU Subrack	1	133	482	279	12
2	PPU/VIM Subrack	1	266	482	381	15
3	SDR unit	2	75	207	254	see(2)
4	Radio Antenna	4	101	95	32	0.11
5	Transponder Interrogator Subrack	2	133	482	233	5.4
6	TI antenna	2	50	560	200	3.5
7	Speed Sensor	3	See ref.[7]	See ref.[7]	See ref.[7]	0.2
8	Speed Sensor Gears	3	see(2)	see(2)	see(2)	2
9	Accelerometer Assembly, with mounting plate	3	43	135	80	0.4
10	Diagnostic Computer	1	152	255	59	2.5
11	Proximity Sensor	2	150	280	72	3.5
12	On board rack (s)	1	See ref.[7]	See ref.[7]	See ref.[7]	See ref.[7]
13	Network Switch	2	154	100	65	1.4
14	Connector Kit	1	N/A(3)	N/A(3)	N/A(3)	see(2)
15	Cable Kit	1	NA(3)	NA(3)	NA(3)	see(2)
16	Power Supply Unit (for SDR,TIU)	2	111.2	168.5	38.7	0.77
17	TOD	2	144	196	16.5	0.5

Detailed mechanical interfaces for each equipment will be consolidated in project phase. Contrains on antenas, speed sensors, accelerometers, proximity sensors localisation will be take into account to avoid any risk of interferences within feasibility constrains. Thales "design" scope in this regard has to specify

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their requirements pertaining to electrical, mechanical and performance characteristics of said equipment. With respect to cable lengths, Alstom and Thales will have to collaborate in defining solutions which will accommodate both Thales' maximum cable length requirements and Alstom's cable routing constraints.

6.2 Equipment Layout and Assembly

The following sections provide detailed preliminary information taken into consideration regarding mechanical layout and assembly data.

6.2.1 Rack Assembly VOBC

The clearances relative to the rack enclosure, including envelopes for installation/ withdrawal, orientation and cable routing criteria/connector location are covered by ALSTOM.

The rack assembly VOBC houses the following components:

- MPU, 19" subrack
- PPU/VIM, 19" subrack
- TI, 19" subrack

Where permitted, Diagnostic Computer, Network switches, and relays will be mounted in the rack.

6.2.2 CBTC Equipment Enclosure

The CBTC equipment enclosure (cabinet) is supplied by the ALSTOM (refer to Chapter 8).

The CBTC Equipment enclosure will be constructed to provide a dry, secure environment for the equipment that is suitable for the environmental conditions it is likely to encounter. The equipment cabinet must shelter the VOBC equipment from external contaminants (i.e. dust, metal filings and splashing liquids).

The equipment cabinet will prevent the accumulation of hot air as designed for other electronics installed on vehicle.

If the equipment cabinet houses non-VOBC equipment, the additional equipment will comply with the applicable EMI/EMC requirements.

The cabinets provide shielding and grounding to minimize external sources of electrical interference. The enclosure should be located away from sources of electrical noise (i.e. propulsion and HVAC equipment) and shall be connected to the vehicle earth with a heavy conductor.

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Equipment cabinets shall be furnished with the necessary features to permit service personnel to access the equipment from the front and back. Installation and removal of CBTC equipment is performed from the front of the rack mounted in the cabinet.

6.2.3 Radio Antennas

The radio antennas are mounted at the front of the front/rear cars, in a space behind the car body.

The antennas will be set at a height of at least 2000 mm from TOR. The separation between antennas shall be more than 250 mm.

The connections between SDR radio and the radio antennas are made through N-type connectors located at the front of the subrack to be specified by THALES.

6.2.4 Speed sensors

Speed sensors will be mounted on non-motorised, braked, independent axles. Mounting interfaces and mechanical envelope shall be clarified by THALES and discussed in project phase.

6.2.5 Gear Speed Sensor

Mounting interfaces and mechanical envelope shall be clarified by THALES and discussed in project phase.

6.2.6 Accelerometers

THALES shall provide the mechanical envelope and assembly drawing for the accelerometer.

The accelerometer assemblies are mounted onto a plate fixed to the vehicle's floor inside the electronic equipment cabinet, in close proximity to the electronic unit and as close as possible to the centre line of the vehicle.

The accelerometer assemblies are mounted longitudinal to the longitudinal axis of the vehicle and the forward direction of accelerometers is towards the cab in the front/rear car.

Three M4 studs are used to mount the Accelerometer assembly. The mounting plate must be leveled with respect to a level track at time of installation.

Mounting details for the assembly on the vehicle floor will be defined by ALSTOM.

6.2.7 Proximity Sensor

The Proximity sensor is intended to provide additional positional information to the VOBC during station docking. THALES shall detail the assembly drawing for this proximity sensor.

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The installation of the proximity sensor shall be detailed by THALES.

The wheel wear will be compensated through removable spacers with maximum height of 35 mm corresponding to maximum wheel diameter (840 mm) and the adjustment shall be part of scheduled maintenance of the vehicle. The adjustment shall be done in 7 mm steps. [5 mm steps are acceptable].

Installation requirements:

- The installation tolerance of the proximity sensor shall be +/- 3 mm
- The proximity plate is installed, on the trackside, at 15 mm above the TOR or as required by the application

6.2.8 Train Operator Display

The TOD is a self-contained LRU that is mounted with M5 fasteners to the Cab Console in the space provided by the vehicle manufacturer, as shown below.

The overall dimensions of the TOD shall be defined by THALES.

6.3 Electrical Interfaces

The supply circuits are distributed to supply power to the following equipment:

- MPU subrack
- PPU/VIM subrack
- TI unit
- SDR and TOD units

The Network Switched, Diagnostic Computer power supply scheme is to be defined.

Proposed vehicle for OLRT project will provide 28,5V DC (under battery charging – 24V DC (EN 50155) otherwise) for all VOBC equipment within the required power range such as :

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PRRR000120-00651

PRRR000120

Item	Description	Rated voltage supply (VDC)	Rated Power consumption (W)	Equivalent current draw at 28,5V (A)
1	MPU Subrack	28,5	75	tbc
2	PPU/VIM Subrack	28,5	165	tbc
3	SDR unit	28,5	30	tbc
4	Transponder Interrogator unit	13,5	25	tbc
5	TOD	28,5	25	tbc
6	Diagnostic Computer	28,5	25	tbc

Cables and connectors shall be specified by THALES (see Chapter 8).

7 TRANSVERSE REQUIREMENTS

Rolling Stock / Signaling interfaces will take into account contrains from applicable standards defined through OLRT specification, Canadian Regulations and ALSTOM golden rules.

8 SCOPE OF SUPPLY

The here attached file defines scope of supply between both THALES and ALSTOM.

Thales-Alstom Scope of Supply Interface M

(see appendix THALES ALSTOM SCOEP OF SUPPLY INTERFACES MEETING 17 SEPT 12)

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APPENDIX K3
GENERAL INTERFACE REQUIREMENT SPECIFICATIONS
DATED SEPTEMBER 27, 2012

CITADIS

GENERIC INTERFACE REQUIREMENT SPECIFICATION

Devices connected on MVB

27/09/2012					ALSTOM ALSTOM TRANSPORT Etablissement de Valenciennes
	L. MOUNIER *TCMS Designer*	**M. GOURISSE** *Software Leader*	**L. MONTEYNE** *Product TCMS Leader*	**P. VIVEGNIS** *Head of the group TCMS*	
DATE	**ESTABLISHED**	**CHECKED**	**VALIDATED**	**APPROVED**	

DISTRIBUTION	Confidentiality Category		Control Category		Parc d'Activités Lavoisier Rue Jacquard 59494 Petite-Forêt - FRANCE
	Restricted ☐	*Normal* ☒	*Controlled* ☐	*Not Controlled* ☒	

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VPFL 796001	Rel. **C**	Lang. **En**	N.Shts **19**

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REVISIONS

Release	Author	Date	Page / Paragraph	Comments
A	JF Roussel	4 june 2007	All	Creation
B	A.Gam	06 November 2007	All	Updated
	A.Gam	07 November 2007	Page 4, 6 , 8, 9, 11, 16 and 20	Modification of paragraph 2.2, 2.4, 2.5, 2.7 and 4.2
	A.Gam	27 November 2007	Page 4,7 à 11, 13 and 20	Correction of paragraph 1.1, 1.3, 1.4, 2, 2.8.2 and 4.2
	A.Gam	27 November 2007	All	Official issue
C	L. Mounier	7 October 2008	9 / 2.8.2 10 / 2.8.3 14 / 2.8.4.10 11 / 2.8.4.1	Minimum and maximum value description updated. TIMEDATE48 type added. Correction of example.

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1 DOCUMENT PRESENTATION

1.1 Scope of the document

The aim of this specification is to define the requirements that every device connected on the MVB vehicle network shall fulfil for the Citadis product.

This specification defines the characteristics, services and addressing that shall be implemented by any device connected on the MVB network. The document also defines the type of data exchange that shall take place, the event/faults services that shall allow the TCMS to retrieve faults or event logged on the device as well as the system data that every equipment will exchange on a periodic basis with the TCMS.

This specification shall be completed for each project with a second document describing the specific data for each device (traction , brake, ...).

1.2 APPLICABLE DOCUMENTS

[1] IEC 61375-1 Electrical railways equipment – Train bus – Part 1: Communication network on trains . First issue 1999-9

1.3 REFERENCE DOCUMENTS

[1] UIC 556 : Transmission of information on board the train unit. 2nd issue 1999-05

[2] UIC 557 : Diagnostic techniques inside vehicles . 2nd issue 1998-01

[3] ISO/CEI 8859-1 : Information technologies - Sets of characters encoded on a single byte – Part 1 : Latin alphabet n°1

[4] ICD MVB TCMS PLATFORM Specification Ref : TRV1144000488-3_TAG1

1.4 ABBREVIATIONS

Name	Description
MVB	Multiple Vehicle Bus
MPU	Main Process Unit
TCMS	Train Control & Monitoring System
CAN	Controller Area Network
PAPIS	Public Address & Passengers Information System
OAS	Operating Assistance System
BCE	Break Control Electronic
PCE	Propulsion Control Electronic
DDU	TCMS Driver display Unit
ATC	Automatic Train Control
EVR	Event Recorder

1.5 DOCUMENT PREVIEW

Chapter 1 describes the contents of this document

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Chapter 2 defines the characteristics of MVB

Chapter 3 specifies the functions related to fault and event.

Chapter 4 defines the system process variables

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2 MVB ESSENTIAL CHARACTERISTICS

2.1 Overview

This document consists in a set of specifications allowing to cover actual and further CITADIS Projects.

2.2 List and name of the equipment on the MVB network

List of equipment could be connected on the MVB network.

Equipment	Electronic
MPU1	Master Processing Unit "normal"
MPU2	Master Processing Unit "redundant"
PCE1	Propulsion control electronic 1
PCE2	Propulsion control electronic 2
PCE3	Propulsion control electronic 3
PCE4	Propulsion control electronic 4
PCE5	Propulsion control electronic 5
PCE6	Propulsion control electronic 6
PCE7	Propulsion control electronic 7
PCE8	Propulsion control electronic 8
DD1	TCMS DDU console in cab1
DD2	TCMS DDU console in cab2
ATC1	Automatic Train control system 1
ATC2	Automatic Train control system 2
BCE1	Brake control electronic 1
R1	Remote I /O Modules 1
R2	Remote I /O Modules 2
R3	Remote I /O Modules 3
R4	Remote I /O Modules 4
R5	Remote I /O Modules 5
R6	Remote I /O Modules 6
R7	Remote I /O Modules 7
R8	Remote I /O Modules 8
R9	Remote I /O Modules 9
GTW	MVB / WTB Gateway

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2.3 MVB Characteristics

Item	Value or reference
MVB protocol	Conform to reference document [1]
Physical layer	Electrical Medium Distance
Class	1
Bit rate	1,5 Mbits/s
Bit coding	Manchester
Basic period for the bus administrator	1 msec.
Medium redundancy	Yes
Bus Impedance	120Ω
MVB Master	MPU 1 or MPU2

2.4 MVB Device Addresses and port range

The Device Physical address shall be configurable in the range 0x01 to 0xFF.

Port address shall be configurable in the range 0x001 to 0xFFF.

The addressing (Port number) of each equipment shall also be configurable and will be defined in the interface control document specific for every device.

The size of a port shall be configurable between 16, 32, 64, 128, 256 bit of data.

The table below gives the actual proposed values for Device address and port range.

Name	MVB Device Address (hex)	Port for produced variable
MPU1	0x01	0x100 ..0x11F MPU to multiple devices
MPU2	0x02	0x120 ..0x13F MPU to DDU 0x140 ..0x15F MPU to PCE 0x160 ..0x16fF MPU to BCE 0x170 ..0x17FMPU to ATC 0x190 ..0x19F MPU to EVR 0x1B0 ..0x1BF MPU to OAS 0x1D0 ..0x1FF MPU to GTW 0x200 ..0x2FF MPU to RIOMs
R1	0x11	0x300 .. 0x4FF(port step of + 0x20)
R2	0x12	R1+0x20
R3	0x13	R1+0x40
R4	0x14	R1+0x60
R5	0x15	R1+0x80
R6	0x16	R1+0xA0

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Name	MVB Device Address (hex)	Port for produced variable
R7	0x17	R1+0xC0
R8	0x18	R1+0xE0
R9	0x19	R1+0x100
PCE1	0x41	0x500 .. 0x5FF (port step of +0x10)
PCE2	0x42	PCE1+0x10
PCE3	0x43	PCE1+0x20
PCEi	0x40 + i	PCE1+(i-1)*0x10
PCE7	0x47	PCE1+0x60
PCE8	0x48	PCE1+0x70
BCE	0x51 .. 0x5F	0x600 .. 0x67F(port step of +0x20)
BCE1	0x51	0x600
ATC1	0x61	0x680
ATC2	0x62	0x6A0
EVR1	0x81	0x780
GTW1	0xA1	0x880
GTW2	0xA2	0x8A0
DD1	0xB1	0x900
DD2	0xB2	0x920
OAS1	0xC1	0xA00

Note: if the number of equipment exceeds 32, an MVB repeater is needed

2.5 MVB options selected

Every device shall comply with the MVB options selected :

- MVB Medium Attachment Unit (MAU) is EMD
- MVB MAU uses redundant MVB lines
- MVB MAU master ship ability is limited to MPU

2.6 Real Time Protocol Options selected

Every device shall comply with the RTP options selected :

- Router function on device: not available
- Node directory function on device: not available

2.7 MVB services supported by every device

Each devices should be at least CLASS1 device supporting the following services :

- 1ms cycle time (port polling probably at 16 ms)
- DSW (device status word) poll
- redundant MVB

2.8 MVB Process variable Definition

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2.8.1 Introduction

A periodical data is a data that, according to a certain cycle:

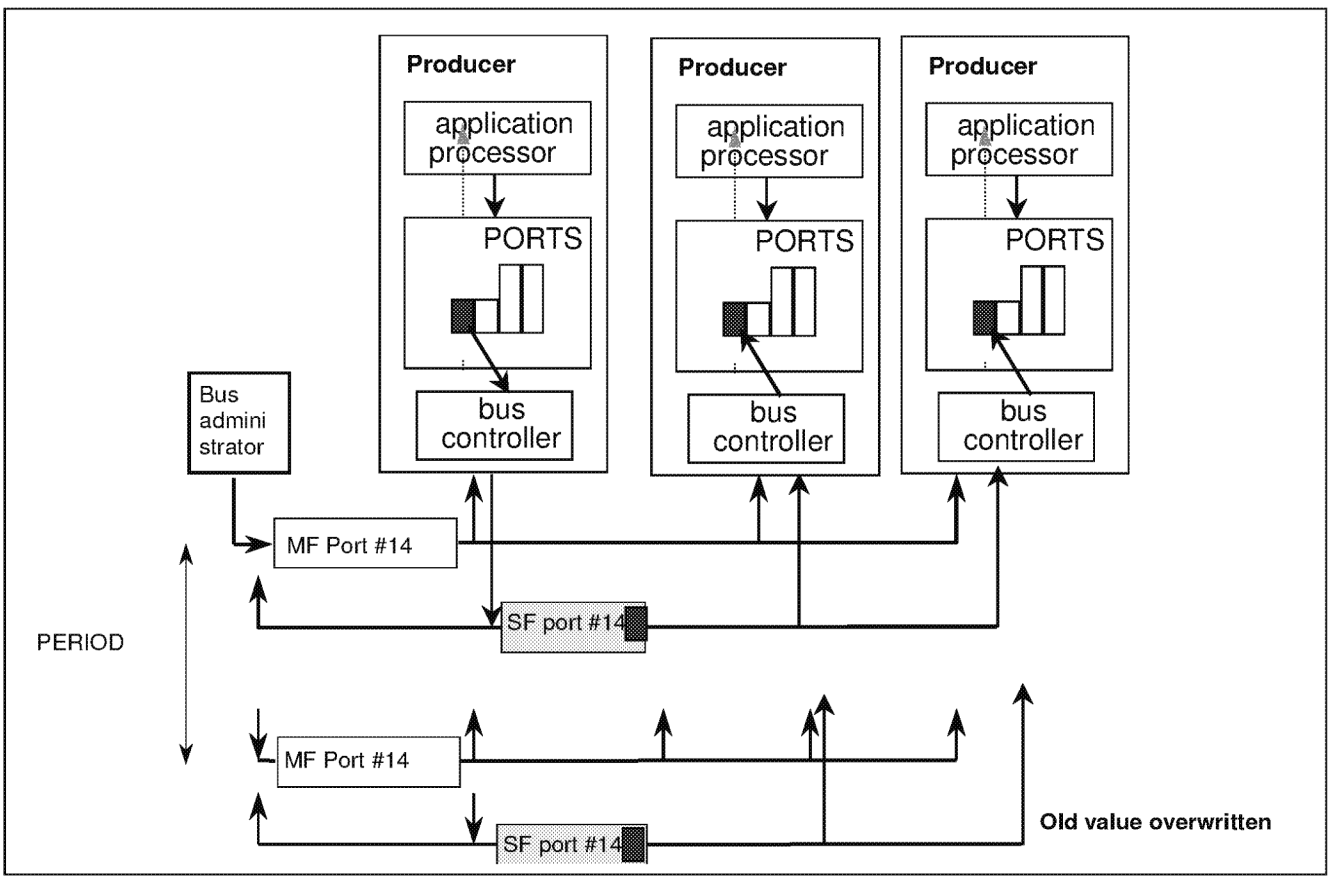
- Is produced by a device
- Is transmitted to the data processing network
- Is read and used by equipment that need to use such information.

When the periodical data is transmitted over the network, it becomes available for all devices but is used only by the concerned equipment.

The period according which the data is produced, transmitted and read can be set but remains fixed after definition. This period is called the polling period. It is the bus administrator responsibility to guarantee this polling.

Upon each cycle, the former value of the periodical data is erased by the new one, on producer and consumer side.

As a rule, periodical data are critical data concerning the equipment (control, status) and used for the monitoring/control and surveillance. They are also called 'process data '.



2.8.2 Attributes of a periodical data

The parameters of each Process variable defined below must also be configurable when stored on the equipment : change done either through a parameter file on the device or through a new software revision without a Hardware modification or Hardware removal.

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A periodical data is defined by the following fields :

Field name	Description	Possible values
Signal name	The periodical data is identified by its signal name . The maximum number of characters for the signal name will be limited to 15 characters as far as possible.	Text
Description	The "description " field allows a definition of the meaning, use and behaviour of the periodical data. This data is not stored in the on-board system.	Text
Bits	State the number of bits the signal shall use	Number
Bytes	State the number of byte the device shall use	Number
Offset	Bit offset within the port	0..255
Port	Port number	Refer to §2.4
Producer	Name of the producer of the variable. **A periodical data has only one producer.**	Refer to §2.2
Consumer(s)	Name of the consumer(s) of the periodical variable. At least one consumer is associated to each periodical data.	Refer to §2.2
Polling time	The polling time defines the period of time elapsed between two transmissions of the variable on the network by the producer. This period is defined at the time of network configuration (powering on of the network) and doesn't change. Any modification of this field requires modifications of the network configuration files. The acceptable values for this field are related to the type of network selected.	In msec.
Type	Define the type of the data (BOOLEAN,UNSIGNED INTEGER8,...)	Refer to § 2.8.3
minimum value	This field can be used only for analogue type values.	
maximum value	This field can be used only for analogue type values.	
default value	The default value gives the value of the periodical data recommended to users when no validity of data is present.	
Unit	This field describes the unit of the variable	
Refresh time	The refresh time determines the maximum time allowed without update of the periodical data by the producer before the user invalidates the data (obsolete data). The refresh time must be at least equal to or higher than the polling time	In msec.

2.8.3 Process variable Type definition

Only the following basic types will be used:

Type	Mnemonic	TypeNum	Description/Definition
Boolean	BOOLEAN1	1	Primitive type with two distinct values , TRUE and FALSE

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Type	Mnemonic	TypeNum	Description/Definition
Whole 32 bits			Primitive type with distinct values that are whole numbers (positive for the non-signed ones, and negative for the signed ones), including zero as one of the values, and with a fixed bit size defined by suffix 8, 16 or 32.
signed	INTEGER32	8	-2^{31} .. $+2^{31}-1$
not signed	UNSIGNED32	5	0 .. $+2^{32}-1$
16 bits			
signed	INTEGER16	7	-32768 .. 32767 (-2^{15} .. $+2^{15}-1$)
not signed	UNSIGNED16	4	0 .. 65535 (0 .. $+2^{16}-1$)
8 bits			
signed	INTEGER8	6	-128 .. 127 (-2^{7} .. $+2^{7}-1$)
not signed	UNSIGNED8	3	0 .. 255 (0 .. $+2^{8}-1$)
Real	REAL32	15	Primitive type whose distinct values are part of a set of real numbers
Character	CHARACTER8	16	Primitive type whose distinct values are part of the set of characters defined in standard ISO 8859-1
String of character	STRING	32	Table of characters
Date and time	TIMEDATE48	48	Date and time in seconds and ticks since 1st of January 1970

2.8.4 Type Coding

2.8.4.1 BOOLEAN type

A Boolean type variable must be coded on one bit

0 = FALSE

1 = TRUE

Note : When binary signal are packed and transmitted : these shall be packed into byte (to achieve an efficient transfer) and sent over the bus. Up to 8 binary signals can be packed into one byte. The Boolean will be aligned on an even number of byte. This shall also be confirmed in the file defining periodical variables for each type of equipment.

Offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
first	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Example from ICD file :

NameSuffix	Port	Offset	variable Type Boolean1 Integer8 Unsigned8 Idem 16, 32 Real32 StringX
<EQU>_IMajorFltPres	**1664**	**16**	SBoolean1
<EQU>_IMinorFltPres	**1664**	**17**	SBoolean1

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<EQU>_IAutoTestInProg	**1664**	**18**	SBoolean1
<EQU>_IAutoTestDone	**1664**	**19**	SBoolean1
<EQU>_IAutoTestRes	**1664**	**20**	SBoolean1
<EQU>_ISpr680SB05	**1664**	**21**	SBoolean1
<EQU>_ISpr680SB06	**1664**	**22**	SBoolean1
<EQU>_ISpr680SB07	**1664**	**23**	SBoolean1
<EQU>_IDevOper	**1664**	**24**	SBoolean1
<EQU>_ICriticalFltPres	**1664**	**25**	SBoolean1
<EQU>_IInformFltPres	**1664**	**26**	SBoolean1
<EQU>_IMedium1OK	**1664**	**27**	SBoolean1
<EQU>_IMedium2OK	**1664**	**28**	SBoolean1
<EQU>_ISpr680SB14	**1664**	**29**	SBoolean1
<EQU>_ISpr680SB15	**1664**	**30**	SBoolean1

If <EQU>_IMajorFltPres and <EQU>_IMedium1OK are set to one, byte 2 of port 1664 will contain 0x01 and Byte 3 will contain 0x08

2.8.4.2 UNSIGNED8 type

The whole unsigned numbers are transmitted as binary representation, the most significant bit being transmitted first.

When the transmitted value is smaller than the type UNSIGNED#, its must be aligned on the right and extended to the left with zeros.

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $0..2^8-1$

2.8.4.3 UNSIGNED16 type

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
first	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $0..2^{16}-1$

2.8.4.4 UNSIGNED32 type

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
first	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
last	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
offset	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**

Range: $0..+ 2^{32}-1$

2.8.4.5 INTEGER8 type

The value shall be represented in binary 2's complement

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When the carried value has a smaller size than the INTEGER# type, it shall be Right-justified and sign-extended to the Left (if it is negative, with "1", otherwise, with "0")

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
first	sign	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $-2^7 .. 2^7 - 1$

Example: '1111 1110'B = - 2

2.8.4.6 INTEGER16 type

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
first	sign	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Range: $-2^{15} .. 2^{15} - 1$

2.8.4.7 INTEGER32 type

offset	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
first	sign	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
last	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
offset	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**

Range: $-2^{31} .. + 2^{31} - 1$

2.8.4.8 REAL32 type

This type shall be encoded as IEEE 754 prescribes for Short Real Number (32-bit).

NOTES

1 - This is an ASN.1 'RealType', restricted to the IEEE 754 Short Real Number format.

2 - The 64-bit floating point number of IEEE 754 (REAL64) is not considered useful in this context.

0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
sign	2^7	biased exponent						2^0	2^{-1}	mantissa					2^{-7}
2^{-8}	mantissa														2^{-23}
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**

Range: $\pm$ 3.37 x 10^{+38}

2.8.4.9 STRING type

The STRING type is an ARRAY [X] OF UNSIGNED8, in which the stop element shall be the character '00'H, the actual size of the string is deduced from the number of significant characters, although the number of transmitted characters may be larger.

byte	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	...	**X**
Character order	1	2	3	4	5	6	7	8	...	X

Example:

ARRAY[8] OF UNSIGNED8 = "ABC"

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byte	0	1	2	3	4	5	6	7
Character	A	B	C	0x00	0x00	0x00	0x00	0x00

2.8.4.10 TIMEDATE48 type

The TIMEDATE48 type is an ARRAY OF 3 UNSIGNED16. It represents the time elapsed since 1st January 1970, 0H00 (Unix and ANSI-C format). It takes into account daylight saving time.

The 2 first elements of the array represent seconds. The 3rd element represents fractions of second (lsb = 1/65536s):

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
seconds (Most Significant Byte)															
seconds (Least Significant Byte)															
fractions of a second (1 tick = 1/65536s)															

2.9 Exchange of Message data

Not mandatory for CITADIS project

3 FAULTS AND EVENT

Not mandatory for CITADIS project

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4 PROCESS VARIABLE DEFINITION AND SERVICES

4.1 Introduction

Every device connected on the TCMS has two type of Process variable or periodical data :

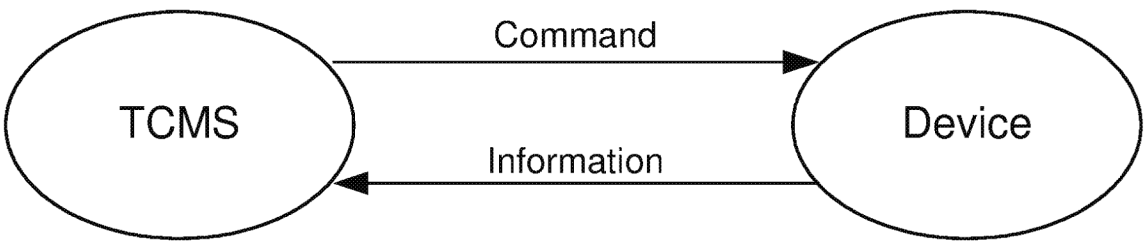
- application data (control/information)
- system data

System data are mandatory periodical variable used by the TCMS for network and device management. System data has the same format for all type of device (door, HVAC, brake, ...)

The application data are directly linked to the equipment function. Thus they are specific to each type of equipment (control signals related to the door equipment have nothing in common with those for air conditioning, the returned information is also different).

The equipment receives commands from the TCMS, modifies the system according to such commands and periodically informs on its current status.

The command can be issued from the TCMS to one or several device. The information sent by a device can also be read by any device on the network.



Communication model for Process variable

status/current status

Both system process variable and application process variables will be defined for each equipment in an Interface document.

This configuration of process variable can change during the life of the project. This modification shall not require hardware changes on the device. It shall be achieved by changing parameter file or software on the device . The specific communication channel dedicated to device maintenance operation can be used for this purpose.

A few services shall also be implemented using process variables.

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4.2 System Process variable

4.2.1 System Command

The list below indicates the system command that the TCMS sends to every equipment.

The ICD of each equipment will define the location in the port and within the port of this data.

signal name	Description	type	unit
MPU_CTCMSAlive	Counter incremented by the TCMS application software at each cycle	UNSIGNED16	/
MPU_CUnitOper	1 = unit or vehicle is ready and operational	BOOLEAN1	
MPU_CTrainOper	1 = train or set of unit of vehicle is ready and operational	BOOLEAN1	
MPU_CShutdownInP	Flag to indicate that shutdown is in progress.	BOOLEAN1	0 = no shutdown in progress 1 = shutdown in progress
MPU_CAuthorMaint	Flag to indicate that software uploading of the device or other maintenance operations is authorised.	BOOLEAN1	0 = not authorised 1 = authorised
MPU_CMPU1Oper	Master ship management	BOOLEAN1	
MPU_CMPU2Oper	Master ship management	BOOLEAN1	
MPU_CMPU1Master	Master ship management	BOOLEAN1	
MPU_CMPU1Master	Master ship management	BOOLEAN1	
MPU_CDateTime	Date and time provided by the TCMS.	TIMEDATE48	Date /time.
MPU_CNetwVersion	Identification of the network revision : the equipment receives the network revision in order to check its consistency between its own network revision and the one of the TCMS. Should there be incompatibility between the TCMS network version and equipment version, the latter shall configure itself into a safety status (door positioning on safety) and remain in that state (no system change, no functional process).	ARRAY [3] of UNSIGNED8	3 Byte defining the revision :
MPU_CTrainNumber	Number of the train or unit : A unit is a set of car whose configuration is not normally changed in normal operation. As far as possible, this should be recorded on the device as context to every fault.	UNSIGNED16	/
MPU_CTrainIsReady	TCMS informing the train is ready (1 = ready) All equipment connected on MVB awake. When this signal = 0, then battery can be disconnected (Not used by PCEs)	BOOLEAN1	

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signal name	Description	type	unit
MPU_COffLoadTest	TCMS informing the train is in OFF LOAD TEST state	BOOLEAN1	(1 = test in progress)
MPU_CReducPowrTest	TCMS informing the train is in REDUCED POWER TEST state)	BOOLEAN1	(1 = test in progress
MPU_CTrainInMaintc	TCMS informing the train is in MAINTENANCE state	BOOLEAN1	(1 = Maintenance state)
MPU_CIOSRescue	TCMS informing the Incorrect Operational State n° 1 : Rescue the train (used only by DDU)	BOOLEAN1	
MPU_CIOSDeTrain	TCMS informing the Incorrect Operational State n° 2 : De – train (used only by DDU)	BOOLEAN1	
MPU_CIOSEndLine	TCMS informing the Incorrect Operational State n° 3 : End of Line (used only by DDU)	BOOLEAN1	
MPU_CIOSEndDay	TCMS informing the Incorrect Operational State n° 4 : End of Day (used only by DDU)	BOOLEAN1	
MPU_CIOSMaintce	TCMS informing the Incorrect Operational State n° 5 : Maintenance Information (used only by DDU)	BOOLEAN1	
For each Equipment			
<EQU>_CResumeTest	Request of restarting autotest pulse with minimum 1s	BOOLEAN1	1= request to restart autotest

4.2.1.1 System status data

Each device send the following status to the TCMS

signal name	description	type	unit
<EQU>_IDevIsAlive	Counter incremented by the device application software at each cycle	UNSIGNED16	/
<EQU>_IDevOper	Bit indicating that the application of the device is running and OK	BOOLEAN1	0= application running 1 = application not running
<EQU>_IAutoTestInProg	Device has its autotest in progress	BOOLEAN1	1 = autotest running 0 = not running
<EQU>_IAutoTestDone	autotest finished on device	BOOLEAN1	1 = autotest

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signal name	description	type	unit
			finished
<EQU>_IAutoTestRes	Result of auto test	BOOLEAN1	0 = autotest OK 1 = autotest KO
<EQU>_ICriticalFltPres	Presence of a least one critical failure	BOOLEAN1	1 if failure present
<EQU>_IMajorFltPres	Presence of a least one major failure	BOOLEAN1	1 if failure present
<EQU>_IMinorFltPres	Presence of a least one minor failure	BOOLEAN1	1 if failure present
<EQU>_IInformFltPres	Presence of a least one information failure	BOOLEAN1	1 if failure present
<EQU>_IMedium1OK	State of MVB network :	BOOLEAN1	1 if Medium 1 is OK
<EQU>_IMedium2OK	State of MVB network :	BOOLEAN1	1 if Medium 2 is OK
<EQU>_IEqpInFault	The device informs the TCMS that it is in faulty state	BOOLEAN1	(1 = default state)
<EQU>_IEqpIsReady	The device informs the TCMS that it is ready	BOOLEAN1	(1 = ready)
<EQU>_IOffLoadTest	The device informs the TCMS that it is in OFF LOAD TEST state	BOOLEAN1	(1 = OLT state)
<EQU>_IReducPowrTest	The device informs the TCMS that it is in REDUCED POWER TEST state	BOOLEAN1	(1 = RdcPwrTst state)
<EQU>_IEqpInMaintc	The device informs the TCMS that it is in MAINTENANCE state	BOOLEAN1	(1 = Maintenance state)
<EQU>_ISerialNumber	Device serial Number	UNSIGNED16	/
<EQU>_INetwVersion	Network revision : The equipment sends its network Revision.	ARRAY [3] of UNSIGNED8	3 Byte defining the network revision :
<EQU>_ISoftwVersion	Revision of the software loaded on the device	ARRAY [3] of UNSIGNED8	3 Byte defining the software revision of the device
<EQU>_IHrdwVersion	Revision of the hardware of the device	ARRAY [3] of UNSIGNED8	3 Byte defining the hardware revision of the device
<EQU>_IAutoTestStep	Current step of the autotest of test number that failed or load test or reduce power test	UNSIGNED8	

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4.3 Services

4.3.1 Life signal and verification of application

Each device shall increment the counter (<EQU>_IDevIsAlive) with a period of maximum 500 ms.

When the application of the device is running , the device shall set to 1 the variable <EQU>_IDevOper.

4.3.2 Change System date

Upon detection of time difference of more than 5 second in the variable MPU_CDateTime between the reception of the system date and time from the TCMS and its own internal clock used for event dating, the device shall change its internal clock and log an event.

4.3.3 Auto test

Auto test shall be performed at power up.

Auto test consist in a step of action. The device supplier will provide a table defining the step and the test performed.

Auto test result and progress shall be transmitted to the TCMS using the variables <EQU>_IAutoTestInProg, <EQU>_IAutoTestDone, <EQU>_IAutoTestRes and <EQU>_IAutoTestStep.

When a test has failed the equipment shall report in the variable <EQU>_IAutoTestStep, the step that failed.

The TCMS can request to restart the test procedure. A request is a detection of the TCMS command <EQU>_CResumeTest to 1.

APPENDIX K4
PRELIMINARY ROLLING STOCK / SIGNALING INTERFACES STATEMENTS DATED SEPTEMBER 27, 2012

OTTAWA TENDER

Preliminary Rolling Stock / Signaling Interfaces Statements

ROLLING STOCK ALSTOM / VOBC THALES

27/09/2012	A.HEUZE B.PARDOUX	A.HEUZE	S.GERAUD	ALSTOM TRANSPORT– Rolling Stock www.alstom.com 48, rue Albert Dhalenne 93482 Saint Ouen Cedex
DATE	**ESTABLISHED**	**CHECKED**	**APPROVED**	
DISTRIBUTION	Confidentiality Category *Restricted* ☐ *Normal* ☒		Control Category *Controlled* ☐ *Not Controlled* ☒	

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REVISIONS

Version	Auteur	Date	Page / Paragraph	Commentaries
0	- A. HEUZE - B. PARDOUX	17/08/2012	-	Creation
A	- A. HEUZE	27/09/2012		General update according to last Vehicle – On Board CBTC Interfaces Meeting (17th September 2012)

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1 GENERAL DESCRIPTION

1.1 Aim of the document

This document describes an overview of the TCMS / VOBC interfaces for the OTTAWA LRT project. This document is used to discuss between THALES and ALSTOM in order to consolidate the **Vehicle Interface Control Description (so called ICD)** between THALES VOBC and ALSTOM Rolling Stock.

This release is based on "Vehicle Interfaces Control Description" from THALES in version 2 and according to Vehicle / On-Board CBTC Interfaces Meeting (17th Sept 2012).

2 TRAIN MODES AND MAIN FUNCTIONS

2.1 TCMS Architecture and VOBC / TCMS Interfaces

Please find here attached update of the TCMS / ATC architecture.

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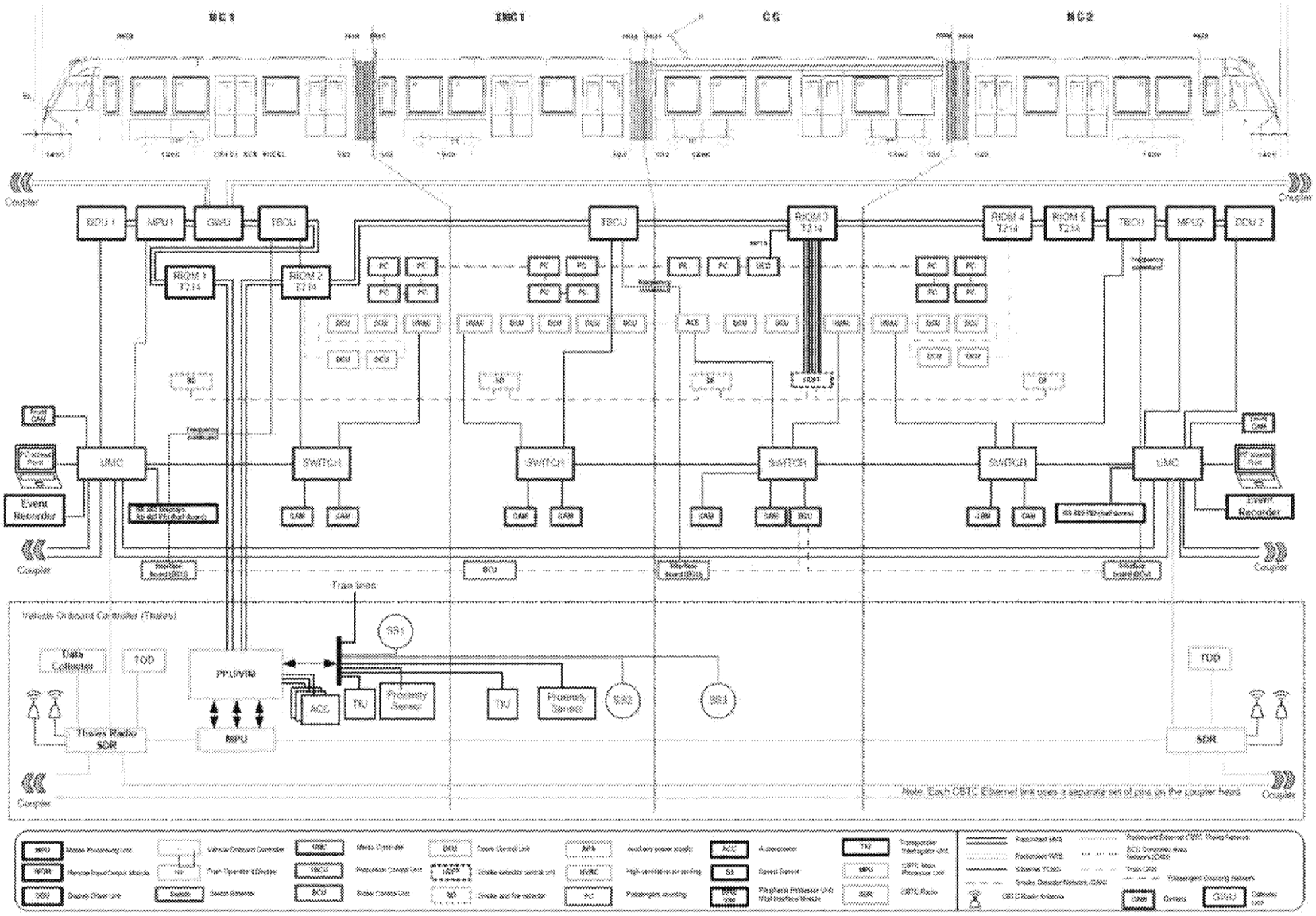

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2.2 Train Modes Matrix

Please find here below State Transition Diagram for OTTAWA LRT project.

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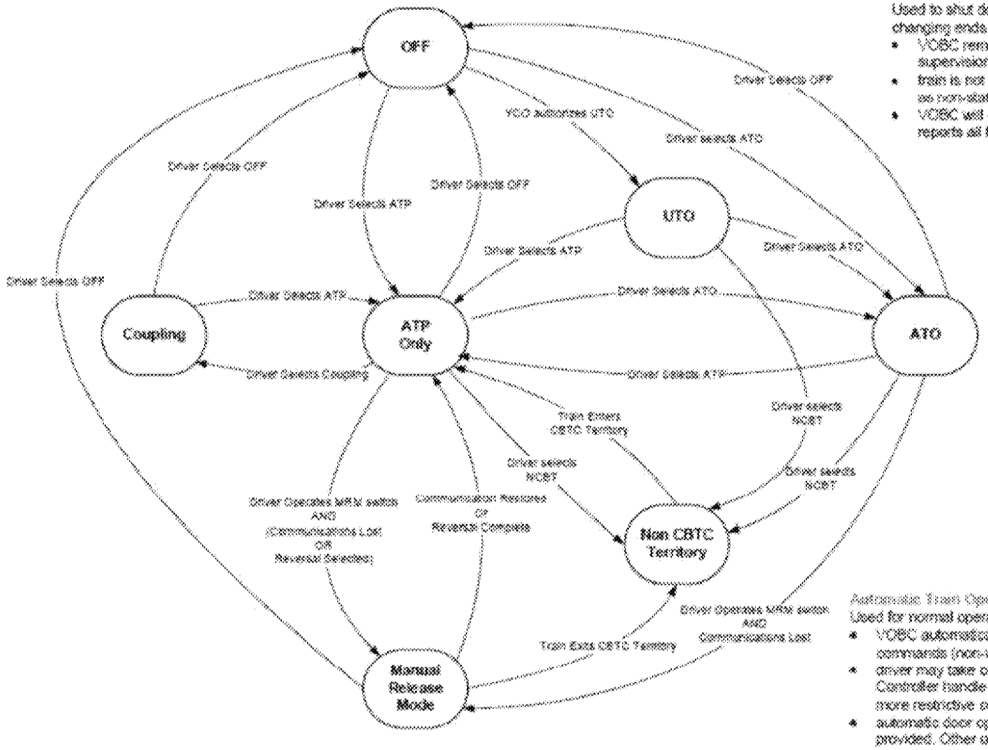
Train Mode State Transition Diagram



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

CBTC Bypass Mode
Used in the very unlikely event of total onboard CBTC failure to bypass all CBTC control of the train:
- mode activated by a switch in locked cabinet
- Master Controller commands passed directly to propulsion & braking systems
- propulsion system shall limit train speed
- an indicator that CBTC is bypassed will flash on the driver's panel

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

Off Mode
Used to shut down cab before driver exits cab – e.g. changing ends at terminus, or end of shift.
- VOBC remains active and performs all required supervision
- train is not allowed to move and if the train is detected as non-stationary, the VOBC will apply EB
- VOBC will communicate with the wayside and TOD and reports all the available information

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.
- Configurable Option – rear facing CCTV camera image provided to driver during reverse move

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

Automatic Train Operation Mode (ATO)
Used for normal operation on mainline.
- VOBC automatically operates train according to ATS commands (non-vital) within the ATP envelop (vital)
- driver may take control of the train with the Master Controller handle - VOBC will control the train using the more restrictive command
- automatic door operation with driver override provided. Other options can be configured. ATP enforces that doors 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

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Please find sum-up of main driving train modes definitions and responsibility on main driving functions for each mode:

Mode	VOBC Communication mode	Doors controls (per side)		Driving Direction selection	Deadman	Speed regulation Traction/Brake request	dwell time management	Over Speed Protection	Emergency brake application	Emergency brake release
		Enabling	Opening / Closing							
Cut-Out	VOBC Isolated	DRIVER (according to train speed)	DRIVER	DRIVER (FWD or REV)	DRIVER	DRIVER	DRIVER	DRIVER and PROPULSION	DRIVER	DRIVER
Release Manual	CBTC or Non-CBTC	DRIVER (according to train speed)	DRIVER	DRIVER (FWD or REV)	DRIVER	DRIVER	DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER
Non-CBTC Territory Mode	Non-CBTC only	DRIVER (according to train speed)	DRIVER	FWD only	DRIVER	DRIVER	DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER
ATP Only	CBTC	VOBC	DRIVER	FWD only	DRIVER	DRIVER	DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER
ATO (Line Operation and Interlocking)	CBTC	VOBC	VOBC or DRIVER	VOBC	DRIVER	VOBC	VOBC OR DRIVER	VOBC (through retrievable full service brake application)	VOBC or DRIVER	DRIVER

2.3 Further statements

A. DTO mode is no more applicable. The associated requirements have been deleted from OLRT specification specification Schedule 15-2 part 4 v3.4.

B. All modes are desgined as far as they are defined in OLRT specification Schedule 15-2 part 4 v3.5 with the addition of UTO mode and OFF mode. See State Transition Diagram for details. State Transition Diagram shall be submitted to safety analysis to finalize functions and scope of each mode.

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C. The use of cut-out mode (CBCTC bypass) can be considered in exceptional case only with specific procedures and responsibilities to the operator. RTG will define the procedure in cooperation with the city of OTTAWA. Propulsion system will limit train speed to its maximum design speed.

D. Provisions are made to implement remote auto-coupler and auto-coupler cover control by VOBC in order to offer automatic coupling mode as far as defined in OLRT specification Schedule 15-2 part 4 v3.5. Criticity and safety aspects of the function will be discussed later on through safety case. Unattended coupling & uncoupling will be provided in UTO Mode.

E. For each mode and functions, the safety critical functions will be ensured by hardware logic on train side with the requested level of integrity (safety analysis will be consolidated in project phase). Non-safety critical functions can be realized either by hardware logic or software.

F. In ATO mode, the deadman function remains active through driver actuation.

G. Three speed sensors will be mounted on independent non-motorized, braked axles on each vehicle. None unbraked axle is available.

H. As preferred option, specific on-board PACIS and ground PACIS wifi connection will be used for station CCTV upload on train and for maintenance data download to ground (including passenger counting information). In that case, use of 802.11a WiFi communication will avoid interference with VOBC WiFi. Final design will consolidated after business award in project phase. Risk will be minimized if the on-board PACIS system and the station PACIS system is the same (both ALSTOM). Non CBTC data will not be transmitted through CBTC network.

I. Passenger Information messages (audible and/or visual) are broadcasted according to triggers from VOBC (see chapter 5 where triggered are described).

J. Each vehicle will be be equipped with a 2oo3 VOBC offering redundancy on each vehicle. In 2-vehicle train, additionnal redundancy is provided because either VOBC on the train can control the train.

K. As an option, thanks to MVB interfaces, Driver Display Units (TCMS scope) can be used in redundancy of the Train Operator Display (TOD – THALES scope). If applied, final design of this option will be finalized in project phase. All data to be displayed shall be exchanged through MVB Interface. Even though the TOD's are powered all the time, the information displayed at the non-active cab shall be 'NO_COMMUNICATION'.

L. On Train network architecture, final list of equipment to be connected to UMC Ethernet port or to adjacent Ethernet switches will be consolidated during design phase.

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3 MVB CONNECTION

Software interface between TCMS and THALES equipment is done through MVB network between Train MPU and VOBC.
Please find attached generic MVB interface description on which ALSTOM is designing.



CITADIS ICD MVB
generic VPFL796001-I

(see appendix VPFL796001)

Example of time delay for similar service proven project with ATC on MVB Network:
Port = 0x0680 for the **fast** system variables (**T = 16 msec**)
Port = 0x0681 for the **slow** system variables (**T = 128 msec**)

At vehicle level, the VOBC is communicating on vehicle MVB network. Example : the data sent towards the MPU from ATC1take the following form: ATC1_IXXXXXXX.

At train level (multiple units of two vehicle), the two VOBC shall communicate together to determine which one is master. Only the master VOBC shall produce these data.

4 VOBC INPUTS / OUTPUTS

This chapter defines preliminary lists of vital / non-vital inputs/outputs on VOBC.
All information contained in this chapter 4 is prone to variations in project phases according to safety analysis from ALSTOM and THALES. Segregation between vital and non vital inputs/outputs will be finalized in project phase.
Outputs from VOBC are used by TCMS in various other functions.

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4.1 Typical Discrete VOBC Outputs (Vital) – from THALES ICD table 3 rev2

Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
EBC	Emergency Brake Command	Vital Output	Command, relay contact, double cut circuit	EB Brake Pipe Solenoids Typical 1.5 A through EBR slave relay	PPU	**EBC1** VIM2A **EBC2** VIM2B	TL Energized = EB held off. Slave EB relay used to control vehicle circuitry. See check-back input. Two independent commands to drive the two EB relays (+28,5Vdc).	"1" Energized (EB not applied) "0" De-energized (EB applied) Typically implemented with shielded wires
VZC	Velocity Zero Command	Vital Output	Command, relay contact, double cut circuit	Typical 1.5A	PPU	**VZC1** VIM2A **VZC2** VIM2B	Velocity Zero Command – VOBC Command. Two independent commands to drive the two slave VZC relays (+28,5Vdc).	"1" Energized (VZC sent) "0" De-energized (VZC not available) Typically implemented with shielded wires
PEC	Propulsion Enable Command	Vital Output	Command, relay contact, double cut circuit	max.200 mA	PPU	**PEC1** VIM2A **PEC2** VIM2B	Two independent dry-contacts.	"1" Energized (Propulsion enable commanded) "0" De-energized (Propulsion enable command OFF) Typically implemented with shielded wires
DER	Door Enable Right	Vital Output	Command, relay contact, double cut circuit	max.200 mA	PPU	**DER1** VIM2A **DER2** VIM2B	Two independent dry-contacts.	"1" Energized (Door Enable Right commanded) "0" De-energized (Door Enable Right command OFF) Typically implemented with shielded wires

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
DEL	Door Enable Left	Vital Output	Command, relay contact, double cut circuit	max.200 mA	PPU	**DEL1** VIM2A **DEL2** VIM2B	Two independent dry-contacts.	"1" Energized (Door Enable Left commanded) "0" De-energized (Door Enable Left command OFF) Typically implemented with shielded wires
PWR	Motoring command	Output	Command, relay dry-contact,	max.200 mA	PPU	PWR VIM2A	Connection to Motoring trainline. Motoring command in ATO (to be interlocked to the circuitry Propulsion Enable). Dry-contact.	"1" Energized (Motoring commanded) "0" De-energized (Motoring command OFF)
BRK	Braking command	Output	Command, relay dry-contact,	max.200 mA	PPU	**BRK** VIM2B	Connection to Braking trainline. Braking command in ATO. Dry-contact.	"1" Energized (Braking command OFF) "0" De-energized (Braking commanded)

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4.2 Typical Discrete VOBC Outputs (Non-Vital) – from THALES ICD table 4 rev2

As non-vital outputs, this data can be managed either trough MVB interface or hardware (non vital LV outputs and trainlines).

Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
FSB	Full Service Brake Command	Output	MVB telegram	MVB protocol	MPU	MPU MVB port	VOBC Full Service Brake Command.	"1" Energized (Full Service Brake commanded) "0" De-energized (Full Service Brake command OFF)
SM	Vehicle Sleep Mode	Output	No more useful because deletion of DTO mode					
STDBY	Stand by Enable	Output	MVB telegram	MVB protocol	MPU	MPU MVB port	Enables Stand-by mode by the VOBC	
DMR	ATO Mode Reset	Output/ input	MVB telegram	MVB protocol	MPU	MPU MVB port	Output drives trainline connected to reset ATO mode relays in both Cabs.	
DME	ATO Mode Enable	Output	MVB telegram	MVB protocol	MPU	MPU MVB port	VOBC recognizes input on DMS and closes relay contact to select ATO mode relay in Cab	
Auto-DCR	Door Close Request	Output	Status	MVB telegram	MPU	MPU MVB port	Active high (Open doors are commanded to close).	Read "1" (Doors commanded to close) Read "0" (Doors not commanded to close)

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Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
Auto-DORR	Door Open Right Request	Output	Status	MVB telegram	MPU	MPU MVB port	Active high (Right doors commanded to open). Door open command is taken into account only if the doors were previously enabled.	Read "1" (Right doors commanded to open) Read "0" (Right doors not commanded to open)
Auto-DOLR	Driver Door Open Left Request	Output	Status	MVB telegram	MPU	MPU MVB port	Active high (Left doors commanded to open). Door open command is taken into account if the doors were previously enabled	Read "1" (Left doors commanded to open) Read "0" (Left doors not commanded to open)
FWD	Forward Direction Selection	Output	Status	MVB telegram	MPU	MPU MVB port	Train travel direction selection by VOBC When VOBC controls the travel direction, FWDS and REVS inputs will provide the status of VOBC commands: FWD, REV.	
REV	Reverse Direction Selection	Output	Status	MVB telegram	MPU	MPU MVB port	Train travel direction See description for FWDS.	

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4.3 Typical VOBC Inputs (Vital, Non-vital) – from THALES ICD rev2 table 5

Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
EBS1	Emergency Brake Status	Vital Input	Status, optically isolated input	15 mA	PPU	**EBS1,** RET1 VIM1A	Status line from vehicle EB loop. Input referenced to RET 1.	Read "1" EB not applied Read "0" EB applied
EBS2	Emergency Brake Status	Vital Input	Status, optically isolated input	15 mA	PPU	**EBS2,** RET1 VIM1A	Status line from vehicle EB loop. Input referenced to RET1.	Read "1" EB not applied Read "0" EB applied
EB_CB	Slave EB Relay Check-back	Vital Input	Status, optically isolated input	15 mA	PPU	**EB_CB,** RET1 VIM1B	Monitor the back contact(s) of the VOBC slave **EB** relay. Power to contact(s) provided from BAT+. Implementation with one independent normal close contact of each EBR relay, connected in series. Input referenced RET1	Read "1", Both EB Relays OFF (EB Applied) Read "0", Both EB Relays ON (EB Raised) Read Failure if EB Relays are in opposite states. VOBC becomes passive, EB loop un-energized and EBs applied.
MODE1	Operating Mode Selection	Vital Input	Status, optically isolated input	15 mA	PPU	**MODE1,** RET3 VIM1A	Input referenced to RET3.	
MODE2	Operating Mode Selection	Vital Input	Status, optically isolated input	15 mA	PPU	**MODE2,** RET3 VIM1B	Input referenced to RET3.	

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
DCLS	Doors Closed and Locked Status Left/Right	Vital Input	Status, optically isolated input	2x15 mA	PPU	**DCLS1,** RET2 VIM1A **DCLS2,** RET2 VIM1B	Two independent status lines from door close loop. Summary signal for all doors closed. Input referenced to RET2.	Read "1" (Door are closed and Locked) Read "0" (No Door closed and lock)
TIA	Train Integrity	Vital Input	Status, optically isolated input	15 mA	PPU	TIA, **RET1** VIM1A	Trainline for detection of a parted train. Cab circuits provide power to the coupler status and EB buttons loop. VOBC monitors status input. Inputs referenced to battery return.	Read "1" (Train Integrity acquired) Read "0" (Train Integrity broken) Train Integrity input shall always be maintained "1" logic as long the train cars are connected in the normal train configuration and not be dependant of any train level interlocking
TIB	Train Integrity	Vital Input	Status, optically isolated input	15mA	PPU	**TIB** VIM1B	Trainline for detection of a parted train. Tc2 cab circuit provides power to the coupler status loop. VOBC monitors status input. Inputs referenced to battery negative.	Read "1" Train integrity acquired Read "0" Train integrity broken See above
TI Test	Train Integrity Test	Non vital input	Status, optically isolated input	15mA	PPU	**TI test** VIM1B	Input acquired for the Train Integrity test of the train integrity interface relays	
ACA	Active cab	Vital Input	Status, optically isolated input	15 mA	PPU	**ACA,** RET1 VIM1A	Active Cab 1(A) is energized when local cab (T1) is active. Antivalent with ACB. Input referenced to RET 1	Read "1" (Active Cab A available) Read "0" (Active Cab A not available)

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
ACB	Active cab	Vital Input	Status, optically isolated input	15 mA	PPU	**ACB,** RET1 VIM1B	Active Cab 2(B) is energized when remote cab (T2) is active. Antivalent with ACA. Input referenced to RET 1.	Read "1" (Active Cab B available) Read "0" (Active Cab B not available)
VZS	Velocity Zero Status trainline	Vital Input	Status, optically isolated input	15 mA	PPU	**VZS,** RET2 VIM1A	Monitor the status of **VZS** trainline. Input referenced to RET3.	Read "1" (Velocity Zero) Read "0"(Velocity not Zero)
VZS_CB	Velocity Zero relay check-back	Vital Input	Status, optically isolated input	15 mA	PPU	**VZS_CB,** RET1 VIM1B	Monitor the back contact(s) of the slave **VZ** relays. Power to contact(s) provided from BAT+. Implementation with one independent normal close contact of each VZ relay, connected in series. Input referenced to RET1	Read "1", Both VZ Relays OFF Read "0", Both VZ Relays ON Read Failure if VZ Relays are in opposite states. VOBC becomes passive, EB loop un-energized and EBs applied.
CSA	Coupler Status A	Vital Input	Status	15mA	PPU		Status of Coupler A	
CSB	Coupler Status B	Vital Input	Status, optically isolated input	15mA	PPU		Status of Coupler B	

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4.4 Typical VOBC Inputs (Non-vital) – from THALES ICD rev2 Table 6

As non-vital inputs, this data can be managed either trough MVB interface or hardware (non vital LV outputs and trainlines).

Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
BRS	Brake release status	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Status of Brakes are released via MVB telegram)	Read "1" (Brakes are released) Read "0" (Brakes are not released)
DCR	Door Close Request	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Open doors are commanded to close).	Read "1" (Doors commanded to close) Read "0" (Doors not commanded to close)
DORR	Door Open Right Request	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Right doors commanded to open). Door open right status is available only if the doors were previously enabled.	Read "1" (Right doors commanded to open) Read "0" (Right doors not commanded to open)
DOLR	Driver Door Open Left Request	Input	Status	MVB telegram	MPU	MPU MVB port	Active high (Left doors commanded to open). Door open left status is available only if the doors were previously enabled	Read "1" (Left doors commanded to open) Read "0" (Left doors not commanded to open)

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Signal	Description	I/O	Interface Type	Signal Format	LRU	Connector Pin	Description of Operation	Signal Polarity ("1" logic HIGH/ "0" logic LOW)
FWDS	Forward Direction Selected	Input	Status	MVB telegram	MPU	MPU MVB port	Train travel direction When T1 cab is active (ACA='1', ACB='0'), - forward travel direction for T1 is equivalent to FWDS='1', REVS='0' - reverse travel direction for T1 is equivalent to FWDS='0', REVS='1' When VOBC controls the travel direction, FWDS and REVS inputs will provide the status of VOBC commands: FWD, REV.	
REVS	Reverse Direction Selected	Input	Status	MVB telegram	MPU	MPU MVB port	Train travel direction See description for FWDS.	
DEBR	Driver EB Reset Request	Input	Status	MVB telegram	MPU	MPU MVB port	Driver EB Reset requested. Active high. When the vehicle applies EB, the driver will activate the DEBR signal to request VOBC to raise the EB's. When all conditions are met, the VOBC will output EBC.	Read "1" Driver EB requested Read "0" Driver EB not requested
DMS	DTO Mode Select	Input	No more useful because deletion of DTO mode					

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4.5 Sensors, Antennas and Communication Links

Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
T1P1P	Speed Sensor 1	Input	Status, optically isolated input	2x50 mA	PPU	VIM3	Speed sensor power and signal. Shield connected at VOBC chassis.
T1P1S							
T1P2S							
T1P_Sh							
T2P1P	Speed Sensor 2	Input	Status, optically isolated input	2x50 mA	PPU	VIM3	Speed Sensor power and signal. Shield connected at VOBC chassis.
T2P1S							
T2P2S							
T2P_Sh							
T3P1P	Speed Sensor 3	Input	Status, optically isolated input	2x50 mA	PPU	VIM3	Speed Sensor power and signal. Shield connected at VOBC chassis.
T3P1S							
T3P2S							
T3P_Sh							
ACC1P	Accelerometer 1	Input	Status, analog input	< 40mA	PPU	VIM3	Accelerometer power and signal. Shield connected at VOBC chassis.
ACC1N							
ACC1S							
ACC1G							
ACC1_Sh							
ACC2P	Accelerometer 2	Input	Status, analog input	< 40mA	PPU	VIM3	Accelerometer power and signal. Shield connected at VOBC chassis.
ACC2N							
ACC2S							

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
ACC2G							
ACC2_Sh							
ACC3P	Accelerometer 3	Input	Status, analog input	< 40mA	PPU	VIM3	Accelerometer power and signal. Shield connected at VOBC chassis.
ACC3N							
ACC3S							
ACC3G							
ACC3_Sh							
PROX1P	Proximity Sensor 1	Input	Status, optically isolated input	15 mA	PPU	See inputs (VIM3)	Proximity Sensor power and signal. Based on proximity sensor model, the signal PRX1N is not used. Shield connected at VOBC chassis.
PROX1N							
PROX1S (PROX)							
PROX2_Sh							
PROX2P	Proximity Sensor 2	Input	Status, optically isolated input	15 mA	PPU	See inputs (VIM3)	Proximity Sensor power and signal. Based on proximity sensor model, the signal PRX2N is not used. Shield connected at VOBC chassis.
PROX2N							
PROX2S (PROX)							
PROX2_Sh							
RAD1A	Radio Antenna 1 – SDR 1	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.
RAD2A	Radio Antenna 2 – SDR 1	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.
RAD1A	Radio Antenna 1 – SDR 2	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
RAD2A	Radio Antenna 2 – SDR 2	Output	2.4 GHz Radio signal	< 500 Mw	SDR	-	N-type connection.
TI UNIT1	Transponder Interrogator Unit and Antenna	Output	RF signal		TI	-	CIR connection
TI UNIT2	Transponder Interrogator Unit and Antenna	Output	RF signal		TI	-	CIR connection
ETHERNET1	Network Communication Link	Output	ETHERNET Network		SDR 1 SDR2 Network switches TOD1 TOD2 MPU Diagnostic Computer	-	
ETHERNET2	Network Communication Link	Output	ETHERNET Network		SDR 1 SDR2 Network switches TOD1 TOD2 MPU Diagnostic Computer	-	

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Signal	Description	I/O	Interface Type	Load on TL @28,5VDC	LRU	Connector. Pin	Description of Operation
MVB1	Serial Communication Link	Input/ Output	MVB Network		MPU	-	Interface to: Vehicle TDMS Various Vehicle non-vital systems
MVB2	Serial Communication Link	Input/ Output	MVB Network		MPU	-	Interface to: Vehicle TDMS Various Vehicle non-vital systems

Traction and Braking effort are exchanged through MVB network from VOBC to Propulsion and Brake controller. Traction and Braking effort are taking into account only if they are validated by at least suitable status of PEC, PWR and BRK hardware logic trainlines (refer to associated description here above).

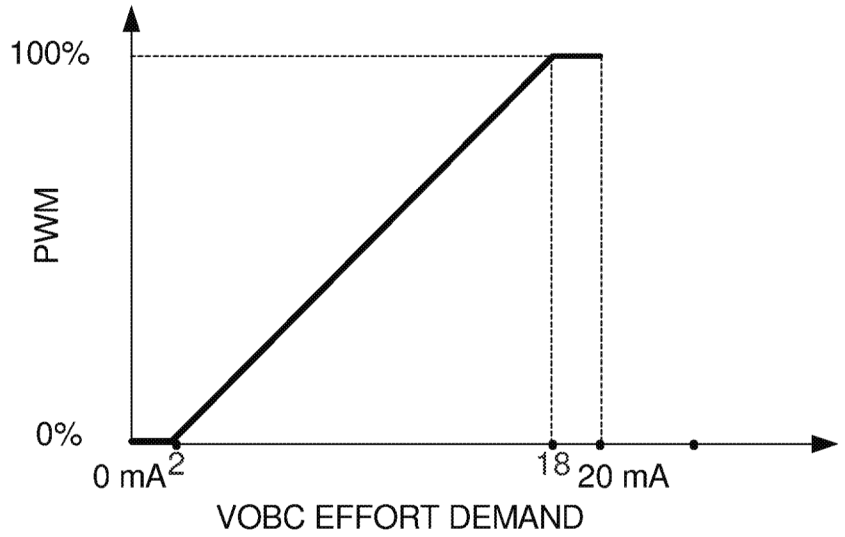
As option Traction and Braking effort can be managed through analogic signal between VOBC and Rolling Stock TCMS such as:

EFF1+ **EFF1-** EFF1_Sh	Motoring/Braking Effort Demand	Analog Output	Current output 0 – 20 mA	Max 20 mA	PPU	(PASC) VIM3	Current output 0-20 mA to vehicle propulsion controller. Interface load: 50Ω.
EFF2+ **EFF2-** EFF2_Sh	Motoring/Braking Effort Demand	Analog Output	Current output 0 – 20 mA	Max 20 mA	PPU	(PASC) VIM3	Current output 0-20 mA to vehicle propulsion controller. Interface load: 50Ω.

This effort is given through an analog 0-20 mA signal.

- 0-2 mA (0 mA) corresponds to a zero effort.
- 18-20 mA corresponds to the maximum brake effort / fast brake effort or full traction effort.

Braking/Motoring transfer characteristic will be finalized pending vehicle motor/braking characteristics, after vehicle submits this information for review during implementation phase (tolerance values for min and max will be determined based on this information).



5 ADDITIONAL DATA ON MVB INTERFACES

This chapter list minimal additional data used to fulfill the TCMS / VOBC interface. This data shall be exchanged on MVB interfaces as defined in chapter 3 here above.

5.1 From the Alstom TCMS (MPU) to the ATC

MPU_CUnitOper	BOOL	When functioning, the applicative software of TCMS shall set this variable to 1 (to be recorded in EVR) (to send to ATC)
MPU_CTrainOper	BOOL	As there is no M.U. service, this variable is the same as unit oper (=1 when application running).
MPU_CShutDownInP	BOOL	Flag to indicate that shutdown is in progress (= 1 during about 30s).(to be recorded in EVR)
MPU_CAuthorMaint	BOOL	Flag to indicate that software uploading of the device or other maintenance operations is authorized. (1 = authorized).
MPU_CMPU1Oper	BOOL	mastership management (to be recorded in EVR)
MPU_CMPU2Oper	BOOL	mastership management (to be recorded in EVR)
MPU_CMPU1Master	BOOL	mastership management (to be recorded in EVR)
MPU_CMPU2Master	BOOL	mastership management (to be recorded in EVR)
MPU_CTEffDmd	INT	Total effort demand in step of 0.1% (-100 to +100%) according to driver or ATC demand (for PCE, BCE, DDU)
MPU_CAutoMode	BOOL	Automatic driving mode done by ATC (ATO) (for BCE, PCE)
MPU_CDateTimeSec	DWORD	Date and time provided by the TCMS to all equipment.

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		(to be recorded in EVR)
MPU_CDateTimeTick	WORD	Date and time provided by the TCMS to all equipment. (to be recorded in EVR)
MPU_CTrainNumber	WORD	Number of the train or unit : A unit is a set of car whose configuration is not normally changed in normal operation. As far as possible, this should be recorded on the device as context to every fault. (to be recorded in EVR)
MPU_CSerialNumber	WORD	Device serial Number (to be recorded in EVR)
MPU_CNetwVersion0	USINT	Identification of the network revision : the equipment receives the network revision in order to check its consistency between its own network revision and the one of the TCMS. Should there be incompatibility between the TCMS network version and equipment version, the latter shall configure itself into a safety status (door positioning on safety) and remain in that state (no system change, no functional process). Divided in 3 "char8 variables" (to be recorded in EVR)
ATC_CDDU1Oper	BOOL	DDU operational in cabin Mc1 (E1) 0: Not operational 1: Operational
ATC_CDDU2Oper	BOOL	DDU operational in cabin Mc2 (E2) 0: Not operational 1: Operational
ATC_CHighVoltagePresence	BOOL	High voltage presence on the trainset 0: No High voltage presence 1: voltage presence
ATC_CFSDAlarm	BOOL	Fire or smoke detection on the train 0: No Fire and smoke detection 1: Fire or smoke detection
ATC_CFullServBrak	BOOL	Driving control handle position full service brake 0: No full service brake 1: Full service brake
OCC_CIOS1	BOOL	IOS1
OCC_CIOS2	BOOL	IOS2
OCC_CIOS...	BOOL	IOS...
OCC_CIOS142	BOOL	IOS142
OCC_CIOS143	BOOL	IOS143

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5.2 From the ATC to the Alstom TCMS (MPU)

<ATCi>_IDevIsAlive	WORD	Counter incremented by the ATC application software at each cycle
<ATCi>_IDevOper	BOOL	Bit indicating that the application of the device is running and OK. 0: Application not running 1: Application running
<ATCi>_IAutoTestInProg	BOOL	Device has its autotest in progress 0: Not running 1: Autotest running
<ATCi>_IAutoTestDone	BOOL	autotest finished on device 0: Autotest not finished 1: Autotest finished
<ATCi>_IAutoTestRes	BOOL	Result of auto test 0: Autotest OK 1: Autotest not OK
<ATCi>_IFaultxxx	BOOL	A bit by fault which can be send to the TCMS and to inform the driver
<ATCi>_IMedium1OK	BOOL	State of MVB network: 0: Medium 1 is not OK 1: Medium 1 is OK
<ATCi>_IMedium2OK	BOOL	State of MVB network 0: Medium 2 is not OK 1: Medium 2 is OK
<ATCi>_IAccelSp	INT	Acceleration setpoint in step of 0,1% (-100 to +100 %) from ATCi
<ATCi>_IFSBCmd	BOOL	ATC, ATPM mode enabled and maximum service brake ordered 0: No full Service Brake Command from ATCi (with i=1 or 2) 1: Full Service Brake Command from ATCi (with i=1 or 2)
<ATCi>_ITractionPowerGap	BOOL	Indicates the close presence of a non-bridgeable cut-out to the rolling stock 0: Area OK 1: Non-bridgeable cut-out area
<ATCi>_ITractionInhibition	BOOL	Traction inhibition 0: Traction is not inhibited 1: Traction is inhibited
<ATCi>_IEmyBrkATP	BOOL	Emergency brake ATP demand from ATCi 0: No emergency 1: Emergency
<ATCi>_ICoastCmd	BOOL	Coasting command from ATCi (with i=1 or 2)

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		0: No coasting command requested 1: Coasting command requested
<ATCi>_ITractCmd	BOOL	Traction command from ATCi (with i=1 or 2) 0: No traction command requested 1: Traction command requested
<ATCi>_IBrakCmd	BOOL	Braking command from ATCi (with i=1 or 2) 0: No braking command requested 1: Braking command requested
<ATCi>_ITrainWithMission	BOOL	Train mission status (L4) 0: No mission 1: Mission
<ATCi>_INetwVersion0	USINT	Network revision : The equipment sends its network Revision. Char 0
<ATCi>_INetwVersion1	USINT	Network revision : The equipment sends its network Revision. Char 1
<ATCi>_INetwVersion2	USINT	Network revision : The equipment sends its network Revision. Char 2
<ATCi>_ISoftwVersion0	USINT	Revision of the software loaded on the device. Char 0
<ATCi>_ISoftwVersion1	USINT	Revision of the software loaded on the device.Char 1
<ATCi>_ISoftwVersion2	USINT	Revision of the software loaded on the device. Char 2
<ATCi>_IHardwVersion0	USINT	Revision of the Hardware loaded on the device. Char 1
<ATCi>_IHardwVersion1	USINT	Revision of the Hardware loaded on the device. Char 2
<ATCi>_IHardwVersion2	USINT	Revision of the Hardware loaded on the device. Char 3
<ATCi>_ITrainNumber	WORD	Train number
<ATCi>_ITrainSpeed	INT	Train speed in step of 0,1 kph (-120 to +120 kph) from ATCi
<ATCi>_IDestStationIdx	BYTE	ATCi confirming the index of the destination station n=11 [0x01…0x0B] for line 2 n=14 [0x01…0x0E] for line 4
<ATCi>_INxtStationIdx	BYTE	ATCi confirming the index of the next station n=11 [0x01…0x0B] for line 2 n=14 [0x01…0x0E] for line 4
<ATCi>_ICurStationIdx	BYTE	ATCi confirming the index of the current station n=11[0x01…0x0B] for line 2 n=14 [0x01…0x0E] for line 4
<ATCi>_ILineNumbIdx	BYTE	ATCi confirming the index of the Line_Number [0x00] Not yet defined [0x02] For Line 2 [0x04] For Line 4
<ATCi>_ITrainLoc	BYTE	Train localisation [0x01,0x02,0x03] 1 : stopped in station

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		2 : out of tunnel 3 : in tunnel
<ATCi>_ILRUList	BYTE	List of the removable ATC component statuses at first maintenance level.(LRU:Line Replaceable Unit) For Line 2:Bit0: OBCU A Rack; Bit1: OBCU A Fan; Bit2: Odometer A; Bit3: Not applicable; Bit4: TIA antenna; Bit5: CIU A; Bit6: TOD end1; Bit7: TOD end2
<ATCi>_IIsMaster	BOOL	ATCi confirming it is the master (with i=1,2) 0: Not OK 1: OK
<ATCi>_ITrigArrival	BOOL	trigger of station arrival 0: No trigger 1: Trigger OK
<ATCi>_ITrigPreArrival	BOOL	trigger station pré-arrival 0: No trigger 1: Trigger OK

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6 MECHANICAL AND ELECTRICAL INTEGRATION

6.1 Mechanical Integration

ALSTOM proposed vehicle for OLRT project will include provisions to integrate THALES equipment within the scope of supply defined by THALES through ICD and according vehicle architecture presented in chapter 2.1. As represented on train architecture (chapter 2.1), the VOBC equipment is located as follows:

- In an electrical cabinet (VOBC enclosure),: MPU, PPU/VIM, Network Switched, Diagnostic Computer, relays and three accelerometers;
- Three speed sensors will be mounted on independent non-motorized, braked axles of the vehicle. None unbraked axle is available.
- Two proximity sensor is to be mounted on the bogie frames.
- Three accelerometers are to be installed on the floor inside the vehicle locker as close as possible to the centerline of the vehicle.
- Two Transponder Interrogator Unit is to be mounted on the bogie frame of the car.
- Four radio antennas (two at each end of the train) are to be mounted in the interior of the vehicle, near the ceiling at each end of the train.

The following equipment should be located in the driver's cabs or suitable lockable enclosure at each end of the train:

- Train Operator Display (TOD);
- Two SDRs (one at each end of the train) with power supplies, each with its own dedicated mounting bracket (to be supplied by vehicle supplier);
- Pushbuttons and switches required for the CBTC system.

Preliminary data taken into consideration on equipment to integrate are such as :

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Item	Description	Qty per VOBC	H (mm)	W (mm)	D (mm)	Maximum Weight (kg)
1	MPU Subrack	1	133	482	279	12
2	PPU/VIM Subrack	1	266	482	381	15
3	SDR unit	2	75	207	254	see(2)
4	Radio Antenna	4	101	95	32	0.11
5	Transponder Interrogator Subrack	2	133	482	233	5.4
6	TI antenna	2	50	560	200	3.5
7	Speed Sensor	3	See ref.[7]	See ref.[7]	See ref.[7]	0.2
8	Speed Sensor Gears	3	see(2)	see(2)	see(2)	2
9	Accelerometer Assembly, with mounting plate	3	43	135	80	0.4
10	Diagnostic Computer	1	152	255	59	2.5
11	Proximity Sensor	2	150	280	72	3.5
12	On board rack (s)	1	See ref.[7]	See ref.[7]	See ref.[7]	See ref.[7]
13	Network Switch	2	154	100	65	1.4
14	Connector Kit	1	N/A(3)	N/A(3)	N/A(3)	see(2)
15	Cable Kit	1	NA(3)	NA(3)	NA(3)	see(2)
16	Power Supply Unit (for SDR,TIU)	2	111.2	168.5	38.7	0.77
17	TOD	2	144	196	16.5	0.5

Detailed mechanical interfaces for each equipment will be consolidated in project phase. Contrains on antenas, speed sensors, accelerometers, proximity sensors localisation will be take into account to avoid any risk of interferences within feasibility constrains. Thales "design" scope in this regard has to specify

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their requirements pertaining to electrical, mechanical and performance characteristics of said equipment. With respect to cable lengths, Alstom and Thales will have to collaborate in defining solutions which will accommodate both Thales' maximum cable length requirements and Alstom's cable routing constraints.

6.2 Equipment Layout and Assembly

The following sections provide detailed preliminary information taken into consideration regarding mechanical layout and assembly data.

6.2.1 Rack Assembly VOBC

The clearances relative to the rack enclosure, including envelopes for installation/ withdrawal, orientation and cable routing criteria/connector location are covered by ALSTOM.

The rack assembly VOBC houses the following components:

- MPU, 19" subrack
- PPU/VIM, 19" subrack
- TI, 19" subrack

Where permitted, Diagnostic Computer, Network switches, and relays will be mounted in the rack.

6.2.2 CBTC Equipment Enclosure

The CBTC equipment enclosure (cabinet) is supplied by the ALSTOM (refer to Chapter 8).

The CBTC Equipment enclosure will be constructed to provide a dry, secure environment for the equipment that is suitable for the environmental conditions it is likely to encounter. The equipment cabinet must shelter the VOBC equipment from external contaminants (i.e. dust, metal filings and splashing liquids).

The equipment cabinet will prevent the accumulation of hot air as designed for other electronics installed on vehicle.

If the equipment cabinet houses non-VOBC equipment, the additional equipment will comply with the applicable EMI/EMC requirements.

The cabinets provide shielding and grounding to minimize external sources of electrical interference. The enclosure should be located away from sources of electrical noise (i.e. propulsion and HVAC equipment) and shall be connected to the vehicle earth with a heavy conductor.

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Equipment cabinets shall be furnished with the necessary features to permit service personnel to access the equipment from the front and back. Installation and removal of CBTC equipment is performed from the front of the rack mounted in the cabinet.

6.2.3 Radio Antennas

The radio antennas are mounted at the front of the front/rear cars, in a space behind the car body.

The antennas will be set at a height of at least 2000 mm from TOR. The separation between antennas shall be more than 250 mm.

The connections between SDR radio and the radio antennas are made through N-type connectors located at the front of the subrack to be specified by THALES.

6.2.4 Speed sensors

Speed sensors will be mounted on non-motorised, braked, independent axles. Mounting interfaces and mechanical envelope shall be clarified by THALES and discussed in project phase.

6.2.5 Gear Speed Sensor

Mounting interfaces and mechanical envelope shall be clarified by THALES and discussed in project phase.

6.2.6 Accelerometers

THALES shall provide the mechanical envelope and assembly drawing for the accelerometer.

The accelerometer assemblies are mounted onto a plate fixed to the vehicle's floor inside the electronic equipment cabinet, in close proximity to the electronic unit and as close as possible to the centre line of the vehicle.

The accelerometer assemblies are mounted longitudinal to the longitudinal axis of the vehicle and the forward direction of accelerometers is towards the cab in the front/rear car.

Three M4 studs are used to mount the Accelerometer assembly. The mounting plate must be leveled with respect to a level track at time of installation.

Mounting details for the assembly on the vehicle floor will be defined by ALSTOM.

6.2.7 Proximity Sensor

The Proximity sensor is intended to provide additional positional information to the VOBC during station docking. THALES shall detail the assembly drawing for this proximity sensor.

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The installation of the proximity sensor shall be detailed by THALES.

The wheel wear will be compensated through removable spacers with maximum height of 35 mm corresponding to maximum wheel diameter (840 mm) and the adjustment shall be part of scheduled maintenance of the vehicle. The adjustment shall be done in 7 mm steps. [5 mm steps are acceptable].

Installation requirements:

- The installation tolerance of the proximity sensor shall be +/- 3 mm
- The proximity plate is installed, on the trackside, at 15 mm above the TOR or as required by the application

6.2.8 Train Operator Display

The TOD is a self-contained LRU that is mounted with M5 fasteners to the Cab Console in the space provided by the vehicle manufacturer, as shown below.

The overall dimensions of the TOD shall be defined by THALES.

6.3 Electrical Interfaces

The supply circuits are distributed to supply power to the following equipment:

- MPU subrack
- PPU/VIM subrack
- TI unit
- SDR and TOD units

The Network Switched, Diagnostic Computer power supply scheme is to be defined.

Proposed vehicle for OLRT project will provide 28,5V DC (under battery charging – 24V DC (EN 50155) otherwise) for all VOBC equipment within the required power range such as :

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Item	Description	Rated voltage supply (VDC)	Rated Power consumption (W)	Equivalent current draw at 28,5V (A)
1	MPU Subrack	28,5	75	tbc
2	PPU/VIM Subrack	28,5	165	tbc
3	SDR unit	28,5	30	tbc
4	Transponder Interrogator unit	13,5	25	tbc
5	TOD	28,5	25	tbc
6	Diagnostic Computer	28,5	25	tbc

Cables and connectors shall be specified by THALES (see Chapter 8).

7 TRANSVERSE REQUIREMENTS

Rolling Stock / Signaling interfaces will take into account contrains from applicable standards defined through OLRT specification, Canadian Regulations and ALSTOM golden rules.

8 SCOPE OF SUPPLY

The here attached file defines scope of supply between both THALES and ALSTOM.



Thales-Alstom Scope of Supply Interface M

(see appendix THALES ALSTOM SCOEP OF SUPPLY INTERFACES MEETING 17 SEPT 12)

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APPENDIX L
PRELIMINARY PROJECT MANAGEMENT PLAN

PRRR0000120

PRRR0000120-00709

OTTAWA LRV

ANNEXE H

Preliminary Project Management Plan

REFERENCE OTT-RSO-00300 V27-09-2012

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PRRR0000120

PRRR0000120-00710

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1 PURPOSE, SCOPE AND USAGE RESPONSIBILITIES

The purpose of this Preliminary Project Management Plan is to describe the main processes and organizations planned by the Rolling Stock team to undertake in an efficient and proper manner, all Works required by the OTTAWA Project.

An updated Project Management Plan will be prepared at the beginning of the Project and submitted according the Project Program.

2 PROJECT OVERVIEW

2.1 Presentation of Rolling stock scope

The scope of activity includes Project management, Design development, industrialization, validation and homologation, transfer of technology, manufacturing and warranty for 34 vehicles.

2.2 Product Description

The OLRT proposed in this tender is derived from the ALSTOM CITADIS range as described in the contractual documentation refer to 000-RTG-OLRT-B2-Sect 5.0 Sept 10-2012

Section : 5.4.2 Compliance with Canadian content policy to 5.4.3.21 Approach to pushing/ towing ...

Section 5.4.5.1 Validation of operational capabilities ... to 5.4.5.2 Proposed consist arrangements

Section 5.4.5.8 Validations of operation scenarios 1 and 2 to 5.4.5.8 Approach to system expansion for operating scenario 3

And annexe A10 : compliance matrix to RFP 3-0 – Schedule 15-2 Part 4-Article 3 to Project Agreement

2.3 Project Schedule and Key Dates

In order to delivery 34 LRVs to the City of OTTAWA on 2018 May 17th for starting revenue service as required, we need to sign the Notice to Proceed in March 2013 according to the preliminary schedule reference OLR Planning 2012 Sept 25th.

In this planning some customer milestones are highlighted to show the deadlines which the different interfaces with Signaling, Radio , platform camera , Design & Style has to be frozen. The respect of these milestones will guaranty an optimum project management on time.

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Customer and EPC Interfaces Milestones :

Final Environmental interfaces specifications (Track, gauge , MSF):

EPC must confirm and freeze the following parameters in order to launch properly the OLRT development:

- Tracks parameters (curve , shape , . .) on service network and in the depot.
- Final static and dynamic gauge
- Final MSF layout and equipment (plugs , ...)
- Traction power characteristics (Sub-stations)
- Overhead catenary system parameters
- Winter operation assumptions (storage & service)
- ...

Signaling equipment (Thales) Final interfaces specifications

EPC must confirm and freeze the final interfaces with the signaling supplier:

- Electrical and Mechanical interfaces
- Functional specification
- Software protocol

Radio and platform camera Final interface specification

EPC must confirm and freeze final interfaces with the telecom supplier:

- Electrical and Mechanical interfaces
- Functional specification
- Software protocol
-

D&S Freeze meetings

After organization of freeze meetings with the end customer, EPC must confirm and freeze shape exterior and interior the colors and samples

MSF available for manufacturing

The MSF shall be available secured and energized in order to start tooling implantations in good and safe conditions.

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Ottawa track available for vehicle dynamic testing

A representative section (at least 5 km) of the actual Ottawa track is available, secured and energised for vehicle dynamic testing up to 100 km/h.

Deliverables associated to Milestones:

M3 : Supply of quality management plan and preliminary design package

- Quality management plan
- LRV Diagram
- Functional specification at vehicle level

M4 : Submittal and (d) Vehicle Design Submittals design package

All documents required by schedule 10 for the Final Design Development Submittals for the Vehicle listed in (d) Vehicle Design Submittals

From

(i) A Work breakdown structure (WBS) for vehicle and its associated subassemblies;

to

(iv) Tow Mode Performance Simulations.

M5 : Sourcing Orders of doors , HVAC Brake , Gangway , Pantograph

An order from our ERP system or a LOI

M6 : Carbodyshell

This milestone corresponds to the delivery in production site of the 4 underframes of the vehicles (without electrical wiring).

M7 : Sub assembly finished

This milestone corresponds to all sub-assemblies of the last section of the vehicle finished (= before assembly in the main tooling called "cathedral").

M8 : End of fitting

This milestone corresponds to a vehicle finished before the start of serial electrical tests.

3 PROJECT STRUCTURE AND ORGANISATION

3.1 Project industrial organisation

As explained in different document sent to the final customer:

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The 2 first vehicle are produced in Valenciennes (France) , center of Excellence for LRV

To fulfill the 25 % local Canadian requirement , the remaining fleet will be manufactured in the MSF after a transfer of technology.

3.2 Project Team Organisation chart

The project team will be located both in Valenciennes (France) and in Ottawa depending on the project phases.

3.3 RS main roles and responsibilities

The core-team in composed of different Key managers , their role is described hereunder :

3.3.1 Rolling Stock Project Manager – PM

Reporting to the Customer Director the RS Project Manager from ALSTOM, is in charge of:

- Managing and delivering the Contract from a technical and product point of view
- Ensure a smooth and efficient Technology transfer
- Taking appropriate measures to achieve contractual targets
- Setting the Work Packages to the Project Team according with Quality, Cost, delay and performance targets
- Managing the Project Team
- Managing and coordinating, with his Project Teams and his Deputies, activities and resources in all ALSTOM sites
- Driving internal project reporting and reviews
- Coordinate with the Customer Director for all issues involving Commercial and/or Contractual aspects, or having a possible impact on the Customer relationship.

3.3.2 Project Industrialization Manager – PrIM

The Project Industrialization Manager is in charge of all industrial engineering activities associated with the fabrication of the vehicle including:

- Defining the manufacturing processes including the design and fabrication and of the relevant tools and jigs, based on proven process used while transferring manufacturing lines in new sites
- Optimizing the work flow in all working areas

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- Setting the activities standard times and production organization
- Manage the technology transfer to Ottawa MSF

3.3.3 Project Engineering Manager PrEM

The Project Engineering Manager is in charge of:

- Managing and coordinating all technical activities and resources of the Project, including design, validation, configuration management and RAMS.
- Liaising with the Customer and partners and suppliers on all technical issues.
- Providing the RS Project Manager with the relevant reporting on technical activities.
- Ensuring compliance with all Contract technical requirements.
- Analyzing any additional technical requests from the Customer and proposing relevant technical solutions

3.3.4 Project Sourcing Manager - PrSM

The Project Sourcing Manager is in charge of:

- Defining the Project sourcing strategy in accordance with the local content commitment
- Conducting with his team the procurement activities, including preanalysis and inspection of major potential suppliers, issuance of RFQ, analysis of offers with the related technical staff, contract negotiation and follow-up
- managing all Purchasing activities along with the QCD principle and in cooperation with ALSTOM sourcing structure

3.3.5 Project Planning Manager - PrPM

The Project Planning Manager is in charge of managing the preparation and maintenance of Project schedules by:

- Setting up the overall Project Scheduling tools taking into account the Contract milestones
- Monitoring the Project actual progress against forecast
- Participate to the definition of recovery actions and plans with the required Team members
- Elaborate and issue the monthly Project Progress Report as required by the Client.

3.3.6 Project Validation Manager - PrVM

The Project Validation Manager is in charge of managing the validation and the certification of the train.

- Elaborating the validation and type testing Plan,
- Managing the Validation team

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3.3.7 Project Testing and Commissioning Manager - PrTCM

The Project Testing and Commissioning is in charge of :

- Elaborating the Serial testing and Commissioning Plan,
- Managing the Testing team
- Managing the Commissioning activities

3.3.8 Project Quality & Safety Manager -PrQSM

The Project Quality and Safety Manager (PsQSM) is in charge of:

- Coordinating the Quality and Safety activities within the Project and with the Customer.
- Organising and chairing the various Project Technical Gate Reviews, monitoring the pass/fail status of the Project development Plan
- Issuing the Project Quality Plan, the Project Inspection Plan and any other quality documents on an as required basis.
- Coordinating and organising the product inspections (First Article Inspection, Factory Acceptance Test).
- Reviewing and approving Supplier Quality and Inspection Plans.
- Collecting Test (type test, routine test) records and certificates of compliance.
- Ensuring the monitoring and follow-up of non-conformities, deviations and related corrective actions.
- Defining, organising and implementing a relevant Quality and Safety Audit program to check the actual compliance of the project with the defined quality process.

3.3.9 Project Warranty Manager - PrWM

The Project Warranty Manager is in charge of:

- Managing Resources during the Defects Liability Period.
- Support reliability growth of the trains

3.3.10 Project Finance Controller - PrFM

The Project Finance Controller is in charge of:

- Invoicing as per the process described in the Contract

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- Managing the Contract Bonds and Guarantees
- Managing the project cash flow
- Managing the cost controllers of the internal entities
- Managing the preparation of all the internal reports

3.3.11 Contract Manager -PrCM

The Contract Manager is in charge of:

- Standardising "contract" filing systems on all contractual areas, which appear to cause concern to the customer, and maintain this filing system. Prepare and ensure that appropriate contract documentation (letters, minutes of meetings, submittals) is available on demand.
- Monitoring the compliance with the contractual obligations.
- Ensuring a smooth and effective interface with the customer for contract matters

3.3.12 Localisation Project Manager -PrLM

The Localisation Project Manager is in charge of:

i

- Ensuring that 25 % targeted Canadian content is well achieved .
- Working in close cooperation with the various managers of the project who contribute to the Canadian localization of the project : Sourcing manager, Industrial manager, Enginnering manager, Human resources manager, etc ... and helping them to set up a localization strategy in order to satisfy and even of exceed the local part.
- Issuing regular internal reporting allowing RTG to check of the contractual conformity of the 25 % minimum of local share.

3.4 Language

English is the language of the Contract for this project. All the project documentation will be prepared in the Contract language.

3.5 Communication channels and documents format

The official communication channels between the RS Team and the Customer will be done by The RS Project Manager.

A specific process for the correspondence will have to be agreed during project phase for evolutive document and non-evolutive document (rev index , chronologic numbers ...)

3.6 Reporting

Regular progress meeting will take place with the Client according to the phases of the project.

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Monthly progress report will be sent to the Client (Planning update , photos if necessary , Design, main component , validation, manufacturing progress) - electronic format is required.

4 RESOURCE MANAGEMENT

4.1 Provision of resources

The "Demand Planning and Capacity Management" procedure defines the measures allowing to evaluate the workload planning confirmed and provisional, to manage the AT units workload and to insure the availability of the adequate human and material resources.

The resources are regularly revised during project reviews with the AT management, and the project manager guarantees their adequacy regarding the needs of his project.

4.2 Working environment

The site directors guarantee a working environment in accordance with the applicable legislation and compatible with the quality policy and the targets to realize a certified product.

The product safety and the means to minimize the employees' potential risks are foreseen in the entry data of the design, the development and in the production process activities.

The EHS (Environment, Hygiene and Safety) policy is available for consultation in every establishment.

The participating units usual measures apply to this project, they guarantee the respect of the hygiene, cleanliness and safety rules.

5 SCOPE MANAGEMENT

5.1 Principles and objective

The scope management consists of defining, structuring and allocating work in order to secure the delivery of the commitments made under the Contract. This activity ensures that all the work, and only the work required under the Contract, is identified and delivered.

5.2 Work breakdown structure

The scope and activities of the Project shall be managed through a Work Breakdown Structure (WBS), which, through the establishment of a coding system, shall identify both products and activities to be performed and how they are allocated to the organizations participating in the project. It is defined through the Product Breakdown Structure (PBS), the Activity Breakdown Structure (ABS) and the Organization Breakdown Structure (OBS).

5.3 WORK PACKAGES

The tasks within the scope of work are organized and referenced according to PBS and ABS, then assigned to the proper Project team or site, according to the OBS, and gathered into consistent Work Packages.

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This gathering of tasks into WP is the result of a trade-off between a detailed view for a close control (leading to high number of small WP) and the possibility for the Project Manager to manage efficiently a high number of WP.

Each WP is assigned to and managed by a WP Leader (WPL) and defined in a WP Sheet, including the commitments related to the WP in terms of Quality, Cost and Delivery schedule. These commitments as well as the progress with respect to these commitments constitute the basic data for the Project internal reporting.

6 DOCUMENT MANAGEMENT

The Document Management system covers the following activities:

- Document numbering.
- Document template.
- Document issuance and dispatch.
- Document archive.

The main principles are as follows:

All documents issued to the Customer should be issued through a unique channel, the project team. All activities related to the logging, distribution and filing of all the documents exchanged within the project and with the Customer will be managed by a dedicated person.

All official correspondence (incoming/outgoing) shall be dispatched to the relevant persons of the Project team.

Relevant document control tool shall be made available for the transmission, archive and share of project documents between all sites involved. In the meantime, this archive shall be done locally according to the above principles.

All technical documents (drawings , schematics , ...) will have an internal Alstom format with our own numeration. Other requirement on the format or numeration will be submit to a commercial agreement and will be transmit in an electronic format.

7 QUALITY MANAGEMENT

7.1 Principles

Quality Management is totally integrated in the Project Management activities.

Each entity shall further detail these rules and principles wherever and whenever necessary. In all cases, the implementation, control and management of the Quality Process shall conform to the requirements of ISO 9000 and the Contractual quality requirements.

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7.2 Quality processes

The Project Quality organization is in charge of the following quality processes:

- Project Quality Plan and Project Quality Inspection Plan issuing.
- Design Control (through the "Design for Quality" gate reviews process).
- Sourcing / Purchasing Monitoring.
- Manufacturing/Assembly Process Monitoring.
- Product Configuration Management / Product Identification and Traceability Management.
- Inspection and Test Monitoring.
- Special Processes Control.
- Non-Conformities Management.
- Quality Records Management (e.g. history book, certificates of conformity).
- Project Quality Audits (Internal & External).

8 RISK MANAGEMENT

Project risk management is required as a process to identify, assess and manage risks in a controlled and coordinated manner.

8.1 Organisation and responsibilities

The RS Project Manager is responsible for ensuring that effective procedures are implemented to manage risks, for approving risk mitigation plans and authorizing the necessary resources for their application.

The RS Project Manager is responsible for maintaining the Risk Management System, for providing assistance to the Work Package Managers in their risk management tasks, for conducting relevant risk analysis.

The procedure requires that a risk owner be identified for each risk. The nominated risk owner evaluates the risk with the support of the Project Director. He also proposes and implements appropriate risk mitigation actions.

Each risk owner is then responsible for monitoring the progress of his risks in collaboration with the Project Risk Manager.

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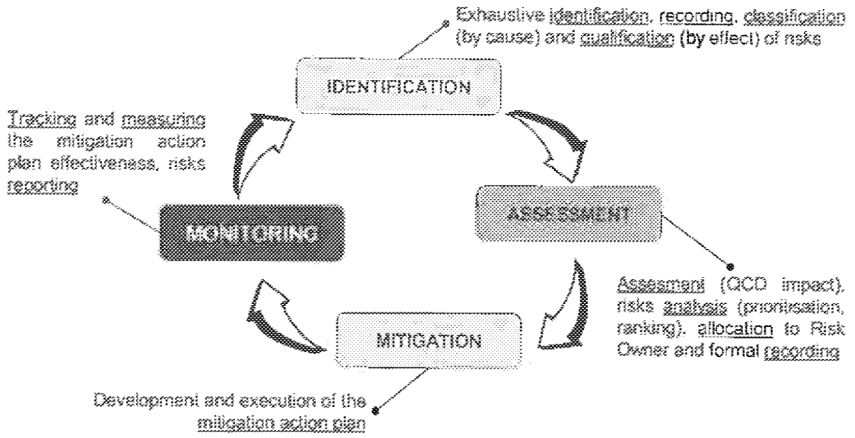
8.2 Risk management process overview

Risk Management is a systematic and structured approach to identify, assess, mitigate and monitor risks in a four step iterative cycle:



9 TIME MANAGEMENT

9.1 Project planning

Planning management for this project will be applied using ALSTOM Transport management guidelines: management by work package and also taking into consideration the particular requirement of the Contract.

Each activity of the project (design, manufacturing etc - see chart below) is managed through a Work Package management approach: each Work Package owner is responsible for the QCD (Quality, cost and delivery) of the activity he is responsible for.

9.2 Major project milestones

Base on the preliminary planning , an updated and detailed planning will be provided at the beginning of the Project.

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10 ENGINEERING MANAGEMENT

10.1 Definition of the Technical Specification

In this phase the Product Configuration, the required performances and the Standards to be met are stated. The Technical Specification represents the origin of the Engineering Process Flow.

10.2 Definition of the PBS.

Starting from the T.T.S., the PBS is elaborated; it represents the Product View by means of a systems/subsystems/components tree structure organized in increasing levels of details.

The specific Project PBS elaboration for the Project is the result of the cross-correlation between the Technical Product Specification and a Standard PBS, which is part of the Company Data Base and refers to a Generic ALSTOM's CITADIS DUALIS.

The specific PBS, so obtained, is transferred to the CAD where it used as the basic representation of the product and as a reference for the design activities with the DMA GS methodology.

The specific PBS, is also transferred to SAP to be used as a basic view of the product for the ERP purposes, mainly to build a data base of the costs of each main system/subsystem/component

10.3 WBS definition

The WBS is the road map which defines:

- Job Planning including Milestones, Design Reviews and Gates Reviews.
- Tasks assignment to the different specialist Engineering Centres
- The commitment of the team leaders (task owner) on the estimated costs/hours and time schedule
- Work Loads & Resources allocation in order to decide how to share the activities between internal and external resources in case of overload of the internal ones.

10.4 The DFQ (Design for Quality) process

The DFQ process follows a V-cycle moving from the system definition and concceptual design through to validation in phases with increasing levels of detail. Each phase is subject to internal design reviews and a Gate Review (GR) at both Train level and at the Sub-systems levels.

Gate Reviews are designed to assess the maturity status of the project. Each Gate Review has a specific checklist with questions to address the requirements to be met and including risk assessment and mitigation strategies. Gate Reviews are performed both at train level and at main sub-systems level.

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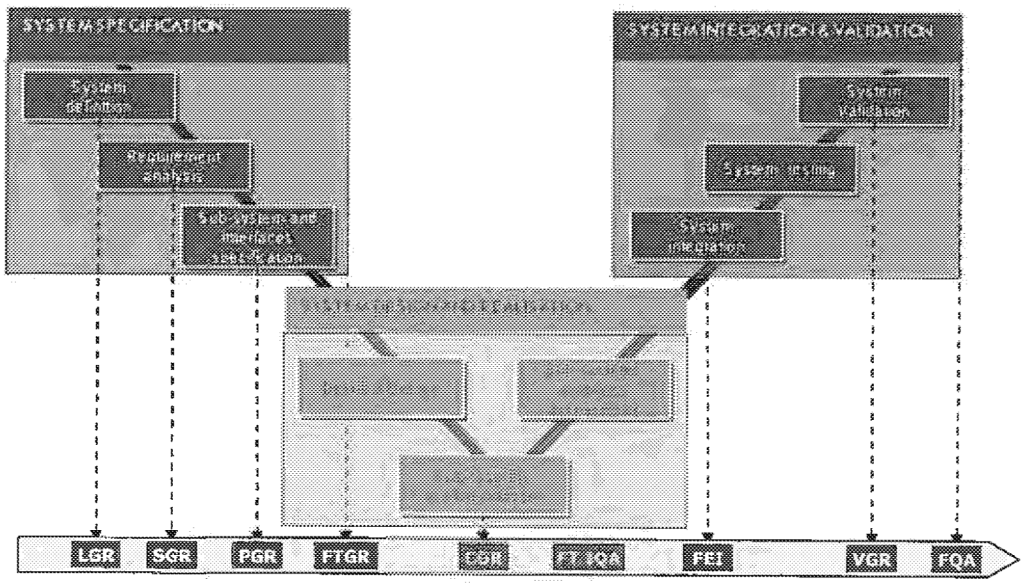

Figure3: Stages of Project Development and associated Gate Reviews

Definition of the different gates reviews :

Gate Review		Key Questions	Maturity Status
Launch Gate Review	LGR	- Is Project organized and does it have the ability to perform? - Are Project scope planning, resources clear?	- Client requirements identified and assigned - Project organization completed - Project ready to perform.
Specification Gate Review	SGR	- Are the train concepts and architecture principles defined? - Is a requirement baseline agreed and committed with Customer? - Are all external interfaces clarified and committed with Customer? - Are the train requirements allocated to subsystems?	- Train specifications completed - Requirement baseline released (agreed with client and acceptable level of risks) - External interfaces completed and committed - Ready for preliminary design
Preliminary Gate Review	PGR	- Are the train analysis and specifications completed? - Are Sub-system interfaces defined and committed?	- Train and sub-systems specifications completed and committed - Sub-systems interfaces with train completed and committed

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Gate Review		Key Questions	Maturity Status
		- Have all the sub-systems and key modules successfully held their SGR?	- Ready for detailed design
First Train Gate Review	FTGR	- Is product and process definition mature enough to launch First train? - Have all "Made" sub-systems successfully held their PGR?	- First train ready to be launched (FT baseline) - All sub-systems PGR GO
Critical Gate Review	CGR	- Is design finalized and first assemblies validated on FT to launch pre-serial production? - Have all the sub-systems and key modules successfully held their CGR? - Are integration tests performed on FT? (static tests)	- Design completed and released - Pre-serial trains ready to be launched (Pre-serial baseline) - First assemblies validated on FT - First train ready for dynamic tests
Validation GO First Train Initial Quality Approval	FT IQA	- Are FT tests completed (Static + dynamic)? - Is Manufacturing completed and validated on pre-serial trains?	- Full tests completed (static + dynamic) on FT - FT validated and ready for delivery - Design freeze (Configuration updated)
Serial GO First Equipment Inspection	FEI	- Is First Train fully validated? - Are static tests performed on pre-serial trains? - Are manufacturing and integration tests finalized on Serial train?	- Integration tests performed - Pre-Serial Trains ready for dynamic tests - Serial trains ready to be launched for production (Serial baseline)

11 SOURCING MANAGEMENT

In order to verify the suitability of the suppliers to provide materials with the Quality needed by the nature of the products, the RS team will perform the qualification of the suppliers according to the contractual requirements.

Within the ALSTOM Transport Sector, the evaluations performed by one of the Sector sites are deemed valid for purposes of the allocation of the supplies.

The activities of evaluation and qualification of the suppliers are planned and programmed by each Site.

The period of validity of the evaluation/qualification is 3 years.

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The certification processes performed by an independent certifying organization carried out in accordance with standards EN ISO 9000 or equivalent standards are deemed valid.

The documentation regarding the qualification activities is available at the various sector sites and can be consulted by the Buyer during audits.

12 INDUSTRIALISATION & MANUFACTURING MANAGEMENT

The Industrial Management Plan will be defined at the beginning of the Project. It defines the Processes and tools that are needed for the Production of the trams.

The objective of the industrialization department is to:

- Define the manufacturing tools and process, and optimise the related investments.
- Build the Product Bill of Material (PBOM) from the PBS defined by the Technical team.

The objective of the manufacturing department is to:

- Manufacture the components and integrate the vehicle according to the manufacturing file, with the right targeted quality, cost and delivery time.
- Perform routine tests on components and trams.
- Implement and follow up the design changes and the related configuration on each vehicle up to Ex-works.

13 VALIDATION PROCESS

As described in the 000-RTG-OLRT-B2-Sect 5.0 Sept 10-2012 document paragraph 5.4.3.5 Testing , we will use our standard process to validate the OLRT .

13.1 Purpose and Scope

The validation activities will be conducted following bottom up approach:

- Equipment type testing.
- Initial Integration and tuning testing
- Train level type testing on completed train.
- Train Static Type Testing
- Train Dynamic Type Testing
- Train Dynamic Testing At the Customers

If the tests were already performed on a different project using the same equipment under the same conditions, a waiver can be requested and the previous test report will be made available.

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13.2 Validation plan

A validation plan is edited by the Validation Manager on the beginning of the project. It is refined during the progress of the project. During the course of the project a status report on the completion of the validation tasks will be prepared and forwarded.

- For each verification and validation activity the shall be as applicable:
- Identification of contractual requirements.
- Identification of applicable standard.
- Summarized main performance to be validated.
- Identification of Gap versus the reference solution. (functional, component or integration of a component, performance).
- Identification if the verification is to be completed by testing.
- Identification of test location (Supplier, Contractor test track, Climate chamber, TTC, ...)
- Reference of Test specification
- reference of Test Procedure
- reference of Test Report
- Specific resources required for the validation
- Specific Instrumentation requirements
- Duration of the test

A preliminary validation plan has already been sent to EPC

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14 CONFIGURATION MANAGEMENT

The objective is to establish the overall plan for the Configuration Management requirement of all the Configuration Items during the complete Product life-cycle and therefore to ensure that these items are defined both functionally and physically by parts, specifications and related documentation identifying and managing the configuration at the lowest level of detail required to satisfy all Project needs.

15 ENVIRONMENTAL MANAGEMENT

ALSTOM is committed to including environmental factors in the design of its products, with the aim of controlling and minimizing environmental impact throughout the product's life cycle, from manufacture to recycling.

16 HEALTH AND SAFETY

ALSTOM require that all Businesses establish a Safety and Health Policy to ensure that their operations do not expose their workforce or the local community to any risk of injury, illness or damage to property. This commitment recognizes our moral and legal responsibility to provide a safe and healthy work environment for employees, subcontractors, vendors and visitors at all ALSTOM workplaces.

Our safety and health objectives are:

- To work on the basis that injuries and industry related diseases are preventable.
- To verify that our activities comply with all relevant occupational health and safety and related legislation.
- To eliminate or reduce hazards and risks through control measures that prevents injury or damage.
- To consult with our employees, subcontractors and third parties impacted by our business.
- To achieve measurable and continuous improvement in safety and health performance.
- To integrate safety management into every aspect of our operations as a priority business function.

This requirement is also applicable to all activities held in the MSF and on the customer tracks.

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APPENDIX M
PROJECT AGREEMENT AND CONSTRUCTION CONTRACT EXTRACTS

1. Back-to-back documents:

Project Agreement Document	Description
Main body	Main body
Schedule 1	Definitions and Interpretation
Schedule 8	Energy Matters
Schedule 10	Review Procedure
Schedule 11	Quality Management (only ss. 2.3, 2.4(a)(i), (ii) and (iv), and 2.5(c) and (d)(i)(E), Part 4, ss. 5.3, 5.4, 5.5, 5.6, and 5.7, and Parts 6 and 7)
Schedule 14	Commissioning (only ss. 1.1, 1.3 (other than 1.3(p)(v) and (p)(vi)), 1.4, 1.5, 1.6, 1.7 and 1.8(ii))

Schedule 15	Output Specifications
	
	Only the following:
	• Schedule 15-1: TECHNICAL DEFINITIONS AND REFERENCE DOCUMENTS
	• Schedule 15-2: DESIGN AND CONSTRUCTION
	  • Part 1: GENERAL REQUIREMENTS
	  • Part 4: DESIGN AND CONSTRUCTION REQUIREMENTS – VEHICLES AND SYSTEMS
	  • Part 6: DESIGN AND CONSTRUCTION REQUIREMENTS - MSF
	• Schedule 15-4: REGULATORY STANDARDS
	• Appendix D: Wayfinding and Signage – OLRT Sign Design

Schedule 22	Variation Procedure
Schedule 27	Dispute Resolution Procedure
Schedule 33	Works Reports
Schedule 35	Additional Vehicles
Schedule 39	Operations Matters

Construction Contract Document	Description
Main body	Main body
Attachment 1	CC Definitions and Interpretation
Attachment 22	CC Variation Procedure
Attachment 26	CC Record Provisions
Attachment 27	CC Dispute Resolution Procedure
Attachment 35	CC Additional Vehicles
Attachment 39	CC Operations Matters
Attachment 41	CC Intellectual Property

2. Acknowledged documents:

Project Agreement Document	**Description**
Schedule 5	Direct Agreements
Schedule 6	Independent Certifier Agreement
Schedule 11	Quality Management (except ss. 2.3, 2.4(a)(i), (ii) and (iv), and 2.5(c) and (d)(i)(E), Part 4, ss. 5.3, 5.4, 5.5, 5.6, and 5.7, and Parts 6 and 7)
Schedule 14	Commissioning (except ss. 1.1, 1.3 (other than 1.3(p)(v) and (p)(vi)), 1.4, 1.5, 1.6, 1.7 and 1.8(ii))
Schedule 15	Output Specifications (except the those parts listed as "Back-to-back documents")
Schedule 16	Title Encumbrances
Schedule 17	Environmental Obligations
Schedule 18	Communications and Public Consultation Protocol
Schedule 23	Compensation on Termination
Schedule 30	Insurance Trust Agreement
Schedule 38	Extension and Additional Phases
Schedule 41	Intellectual Property

Construction Contract Document	**Description**
Attachment 17	CC Environmental Obligations
Attachment 18	CC Communications and Consultation Protocol
Attachment 38	CC Extension and Additional Phases

APPENDIX N
DESIGN AND STYLE MANAGEMENT

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OTTAWA LIGHT RAILTRANSIT PROJECT

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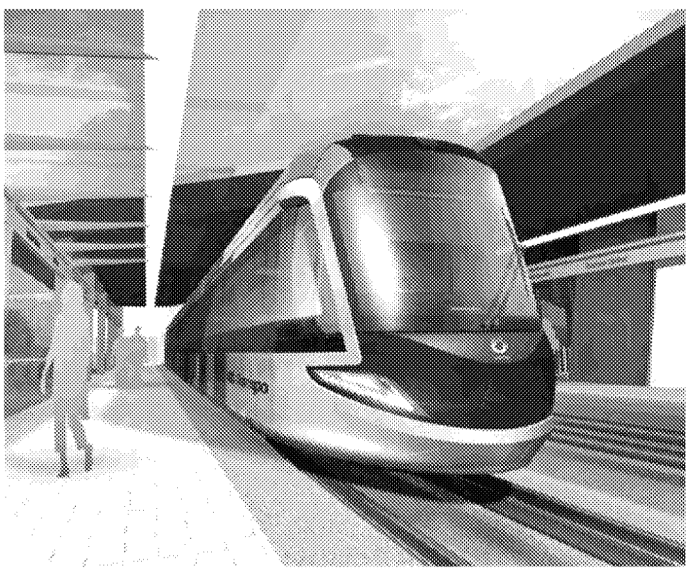
1 TENDER STAGE: REMINDER OF THE 3 DIFFERENT STYLES PROPOSED

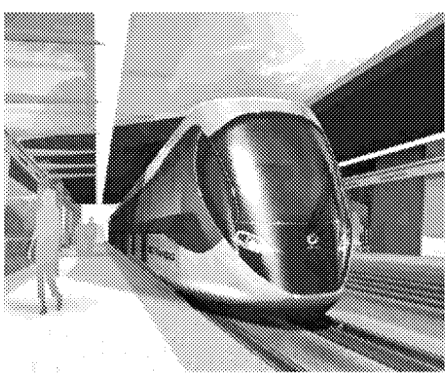
During Tender Stage Our Design & Styling department proposed to the City of Ottawa, three different exterior and interior designs. Here under you can find the different aesthetic views proposed at tender stage.

3 exterior designs :

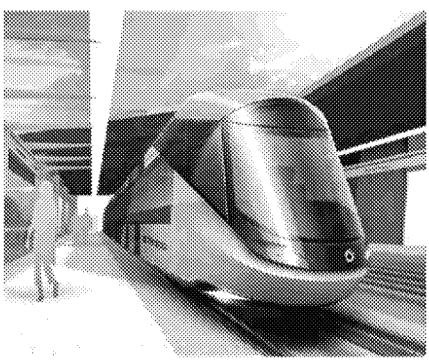
MAPPEL



TULIP



VISION



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3 different interior Designs

GEOMETRY



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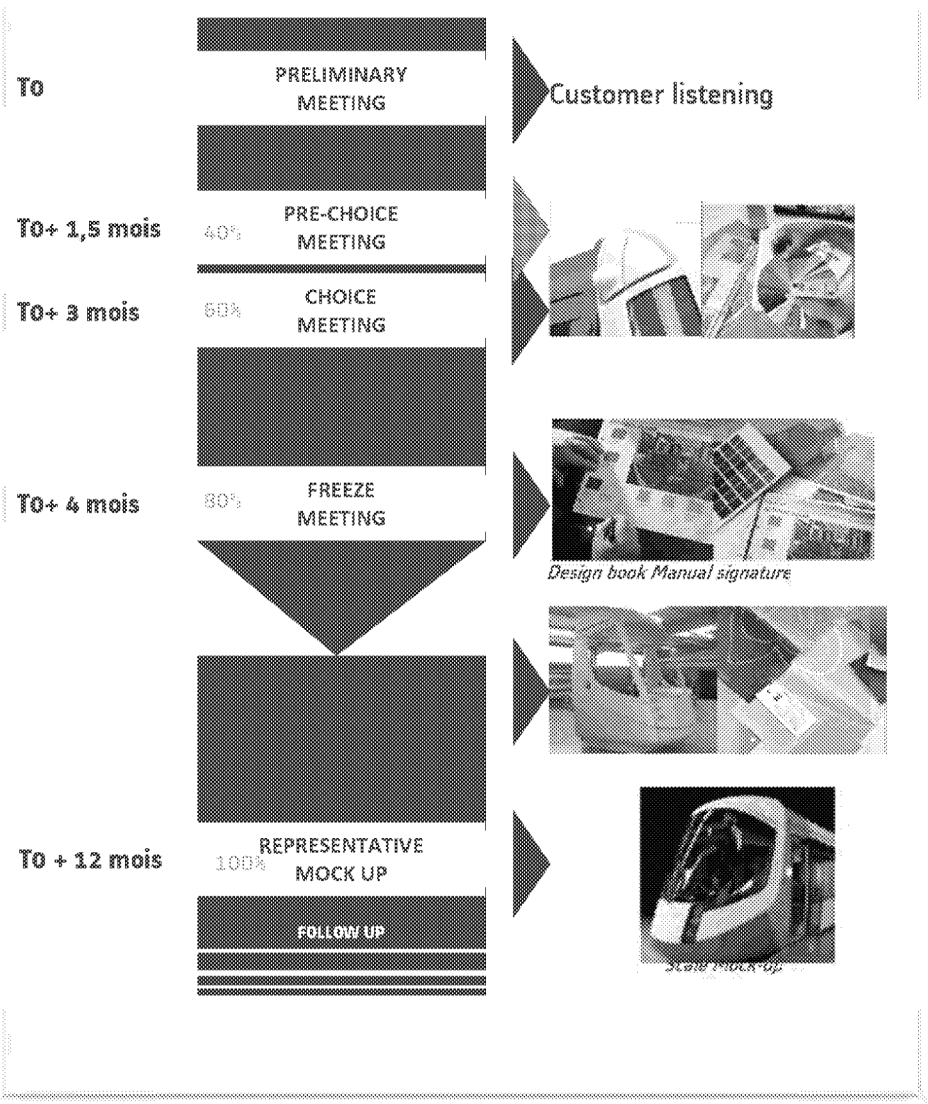
2 DESIGN & STYLING PROCESS FOR PROJECT PHASE :

In order to arrive at a railway product that fully satisfies customer expectations, ALSTOM has laid out a collaborative design process that guarantees quality results.



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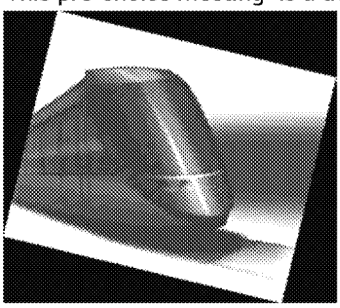
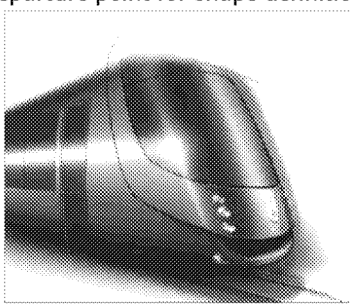
2.1.1.1 Preliminary Meeting [T0]

The aim of this preliminary meeting is for our Design & Styling team to collect all information from customer to adjust and converge on a single pre-final Design regarding the 3 design exterior and interior Alstom proposed during tender phase.

2.1.1.2 Pre-choice meeting [T0 + 1,5 month]

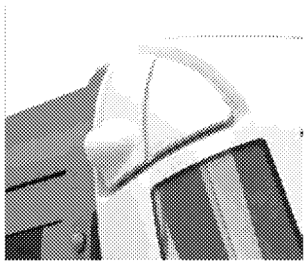
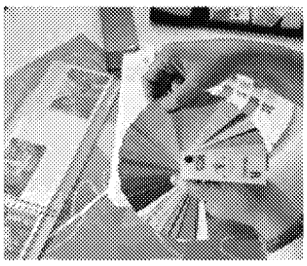
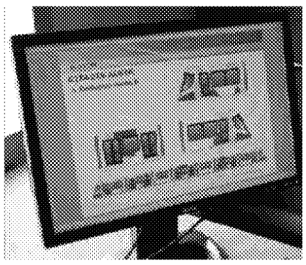
Refering to the information collected during the preliminary meeting , a new single proposal is presented .
Some non-major modification can still be adjusted at this stage.
This pre-choice meeting is a departure point for shape definition, colour schemes, graphic lines and materials.


2.1.1.3 Choice meeting [T0 + 3 month]

Shape and colour options

The shape, colour and graphic line of a train car is further determined with 3D software. Virtual images allow customers to get a feel of the object from different angles.

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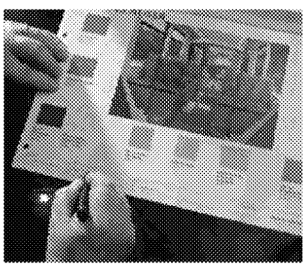
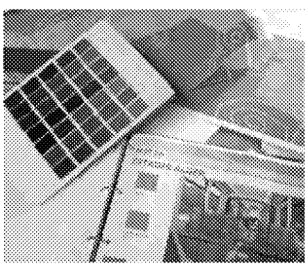
2.1.1.4 Freeze meeting [T0 + 4 months]

Final approval of the Design & Styling of the LRV

The City of OTTAWA signs off to 80% of its preferences. This marks the beginning of the manufacturing phase for products related to styling and design. The shapes, colours and materials chosen are specified at this stage. ALSTOM then submits a life-size impression of the graphic line for approval by the customer.

Design book and Samples

In order to validate this phase and freeze the Styling , a Final Design book will be sent to the Customer for final approbation. Some samples for Colors and textile will be attached to obtain a final validation .

2.1.1.5 Representative mock-up [T0 + 9 months]

The Customer can see the mock-up scale 1:1 currently manufactured included the front-end cab , seating, roofs , side walls among others in the manufacturing facility. All associated components and specifications are reflected in the mock-up, from the front-end cab design to the colours and trimmings inside.




A final acceptation of the mock-up is required by the Customer before sending it to OTTAWA .

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2 MOCK-UP SPECIFICATION

3.1 Object

The mock-up will be compliant as required in the Schedule _15-2_Part_4 of the PA.

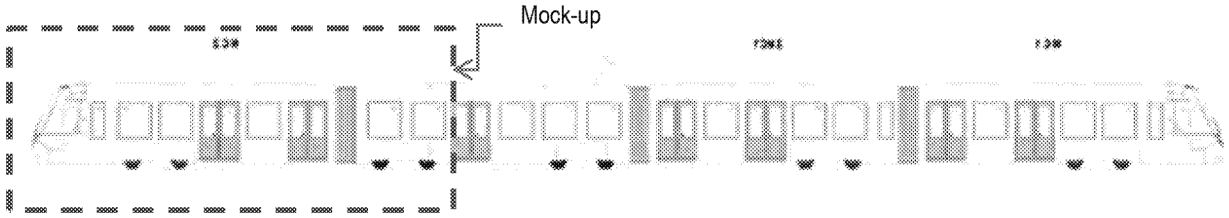
the mock-up (internal, external) will include, to the greatest extent practicable, all components in the interior, cab and exterior that will form part of the final vehicle design. Actual components will be used where available.

3.2 Description of the mock-up

The 1:1 scale mock-up will be manufactured and supplied in accordance with the requirements of the tender document.

This mock-up won't be equipped with bogies but can be transportable by truck (refer to the chapter 3.7) . This mock-up will be accessible by the public from the outside . During the exhibit du the public , the doors will be opened and a barrier will allow the public to see interior arrangement without entering in the mock-up .

The mock-up proposed for OLRT will consist on a section as shown below. It will be equivalent to a half LRV 30 meter consist.



3.3 Saloon Exterior

All constructions, surfaces and finishes will be as close as practicably possible to the final product specification. The following items will be fitted on the mock-up :

- Lateral windows;
- Lateral displays;
- Passenger doors;
- External lights.

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3.4 Saloon Interior

All constructions, surfaces and finishes will be as close as practicably possible to the final product specification. Volume and location of the interior components will be representative to the serial product in order to ensure representative spacing between the components.
Material, texture and colour will be as close as possible to the contractual design

The following items will be fitted on on the mock-up :

- Ceiling including Roof arches and Lighting
- Lateral garnishing
- Passenger information displays;
- Gangway;
- Floor covering;
- Seats (fixed, folding)
- Wheel chairs location
- grab bars
- Interior and exterior signage
- Lateral Windows (nota : emergency window is not applicable in this contract)

3.5 Cabin

The followings item will be fitted on the mock-up:

- Windscreens;
- Lateral windows;
- External lights;
- Internal lights;
- Windscreen wipers;
- Master controller;
- Front display;
- Driver seat;
- Cab partition ;
- Pushbuttons,
- Driver display
- Instrumentation, gauge

All CBTC , Telecom and Communication equipment fitted in the cab shall be delivered free of charge to ALSTOM by the relative supplier as shown in the appendix D – milestone "First need of CBTC, TELECOM and Radio to equip the mock up driver desk ".

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The driver desk will not be functional except for the commands described in the chapter §3.6.

3.6 Functional equipment

The following electrical equipment will be functional and controlled from the driver cabin. This list only concerns the equipment listed below:

- External lights;
- External displays;
- Internal displays;
- Internal cab lights;
- Internal saloon lights (normal and emergency lights);

The mock-up will be connected to the 110V, 60Hz network to provide energy to the functional equipment.
Adaptors will be mounted for the equipment working under Low voltage.
The bi-position commutators to control equipment won't be accessible to the public.

3.7 Other topic

The aim of the mock-up is to freeze on time the interior & exterior styling of the LRV and the cab ergonomics.
All external equipment not related to styling as pantograph, wiring , electrical cubicles , snow plough , trucks... will not be fitted on the mock-up.
Nevertheless, as part of the design review process, for the mock-up, Alstom will also provide general arrangement drawings for the exterior front and side elevations of the vehicle showing elements which will not fitted on the mock-up such as snow plough, pantograph, horn location, communication antennas , wiring ... This will ensure that the impact on the vehicle aesthetics of the future integration of those items can be understood.

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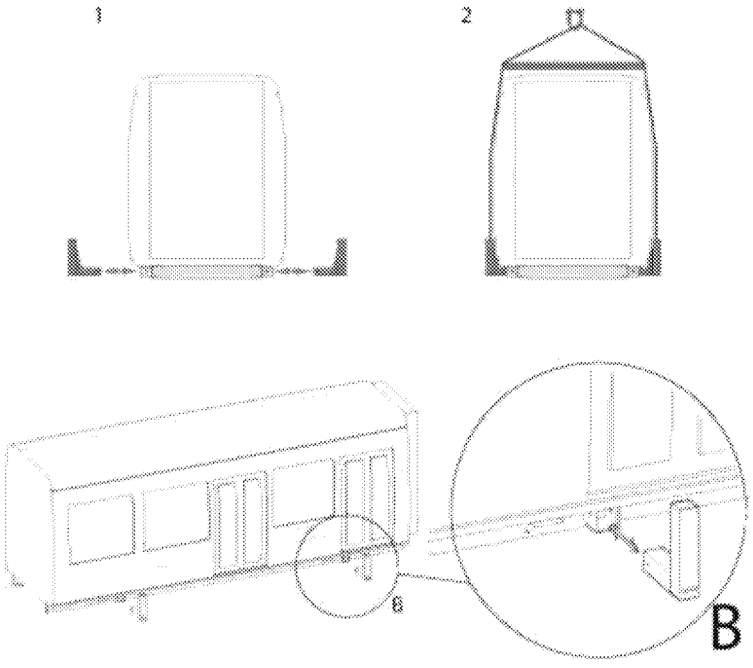
3.8 Transportation and handling

The mock-up needs to be moved and installed in places around OTTAWA for public display and customer review. In order to facilitate the transportation requirements, a lifting/haulage system has been proposed that provides points at which slings could be used for lifting and haulage.

The system incorporates removable brackets which can be attached to the mock-up's permanent sub frame. The removable brackets would provide lifting and sling points external to the vertical walls of the mock-up segments. See Figure for an illustration of the system.





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3.9 INTERFACES DELAY

3.9.1 Delay to freeze the Design & Styling

ALSTOM price and conditions are based on the fact that only a single Design shall be proposed at pre-choice meeting and that the final choices shall be validated at the milestones named "D&S Freeze meeting (shape for exterior , driver cabs and interior)" and D&S Freeze meeting working mock-up (colors , samples)"stated in the planning included in the appendix D .

If the Construction Contractor delays the approval of Design & Styling as stated in the planning included in appendix D Construction Contractor will have to issue a variation to cover the extra cost of the subcontractor, to grant an extension of time, to modify the delay's LDs calculation, and to adapt the payment milestone..

3.9.2 Late delivery for Telecom ,CBTC and Radio equipment

If there is delay to receive Telecom CBTC and radio equipment for the mock-up as stated in the planning included in appendix D regarding the milestone named "First need of CBTC, TELECOM and Radio to equip the mock up driver desk ", Construction Contractor will have to issue a variation to cover the extra cost of the subcontractor, to grant an extension of time, to modify the delay's LDs calculation, and to adapt the payment milestone..

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