

Appendix G Systems General Requirements

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 2 -

Table of Contents

1	APPENDIX G – Systems GENERAL REQUIREMENTS	7
1.1	Introduction.....	7
1.2	Requirements Delivery	7
1.3	Standards.....	8
1.4	Systems Plan	8
1.5	Design Life of the Systems	9
1.6	Systems Design Management.....	9
1.6.1	Requirements Specification Overview.....	10
1.6.2	Requirements Analysis Overview.....	10
1.6.2.1	Requirements Specification and Analysis Process	11
1.6.2.2	Requirements Verification Categorization.....	12
1.6.2.3	Requirements Verification Plan	13
1.6.2.4	Requirements Verification Reports.....	13
1.6.3	Systems Management Plan	14
1.6.4	Systems Design Reviews	15
1.6.4.1	Systems Concept Design Review (SCDR)	16
1.6.4.2	Systems Preliminary Design Review (SPDR)	16
1.6.4.3	Systems Final Design Review (SFDR).....	16
1.6.5	Configuration Management Plan	17
1.6.6	Interface Management Plan	17
1.6.6.1	Interface Document Guidance to Project Co.	17
1.6.6.2	Coordination Documentation.....	18
1.6.6.2.1	Systems and Station Infrastructure Coordination	19
1.6.6.2.2	Systems and Guideway Infrastructure Coordination	19
1.6.6.2.3	Systems and OMC Infrastructure Coordination.....	19
1.6.6.2.4	System to System Coordination Inclusive of TransLink’s Parallel Projects.	20
1.6.6.2.5	Coordination of Configuration Data	23

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 3 -

1.6.6.3	Systems Cut-Over Plan	24
1.6.6.4	Cut-Over Hazard Assessment	24
1.6.7	Systems Software Design.....	24
1.6.8	Systems Software Design Management Plan.....	25
1.6.9	Systems Design Considerations	25
1.7	Systems Assurance.....	26
1.7.1	Systems Assurance Plan.....	26
1.7.1.1	ATC System.....	27
1.7.1.2	Fire Life Safety System (FLSS).....	27
1.7.1.3	Tunnel Ventilation System (TVS)	29
1.7.1.4	Trainway Intrusion Detection System (TIDS)	30
1.7.1.5	Safety-Relevant Systems.....	31
1.7.2	RAM Program Plan.....	32
1.7.3	RAM Analysis Report.....	33
1.8	Systems Safety	33
1.8.1	Systems Safety Program Plan	33
1.8.2	Systems Safety Certification Plan.....	35
1.8.3	Systems Hazard and Safety Analyses	35
1.8.3.1	Hazard Analysis	35
1.8.3.2	Operational and Support Hazard Analysis.....	36
1.8.3.3	System Fault Tree Analysis	36
1.8.3.4	Subsystem Failure Modes, Effects and Criticality Analysis.....	36
1.8.3.5	Systems Safety Reports.....	36
1.8.3.5.1	Preliminary Safety Report.....	36
1.8.3.5.2	Design Safety Case	37
1.8.3.5.3	Final Safety Case	37
1.8.4	Independent Safety Assessor	38
1.9	Systems Risk Management	41

1.9.1	Systems Risk Management Plan	41
1.10	Electromagnetic Compatibility	42
1.10.1	General	42
1.10.2	Electromagnetic Compatibility Study Report	42
1.10.3	Electromagnetic Compatibility Control Plan	43
1.10.4	Electromagnetic Compatibility Control Report	44
1.11	Cyber Security	44
1.12	Maintainability	45
1.12.1	Preventative Maintenance	46
1.12.2	Corrective Maintenance	46
1.12.3	Predictive Maintenance	47
1.12.4	Service Data Tools	47
1.12.5	Equipment Maintainability Guidelines	47
1.12.6	Room Access Guidelines	49
1.12.7	Wayside Access Guidelines	49
1.12.8	Station Access Guidelines	50
1.13	Verification and Validation Testing	50
1.13.1	Test and Commissioning Strategy and Plans	51
1.13.2	Verification and Validation Deliverables	51
1.13.3	Systems Commissioning Plan	52
1.13.4	Commissioning Safety Plan	54
1.13.5	Test and Commissioning Rules and Procedures	54
1.14	Systems Test Documentation	54
1.14.1	Validation, Inspection, and Test Plan	54
1.14.2	Systems and Subsystem Test Plans	55
1.14.3	Safety Commissioning Test Plan	56
1.14.4	Test Procedures	57
1.14.5	Test Reports	57

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 5 -

1.14.6	Failure Reporting, Analysis, and Corrective Action System	58
1.14.7	Authorization to Move Trains and Commissioning.....	59
1.15	End-Product Audits.....	59
1.16	Systems Field Test Readiness Reviews	59
1.17	Verification Testing	60
1.17.1	Systems Equipment Tests	60
1.17.2	First Article Inspection	60
1.17.3	Factory Acceptance Tests	61
1.17.4	Post Installation Checkout (PICO) Tests	61
1.17.5	Site Acceptance Tests	62
1.17.6	Integrated System Testing.....	62
1.17.6.1	System Integration Tests.....	62
1.17.6.2	Trial Running	63
1.17.6.2.1	Trial Running Committee	63
1.17.6.2.2	Trial Running Stage 1	64
1.17.6.2.3	Trial Running Stage 2	64
1.17.6.2.4	Trial Running Stage 3	64
1.17.6.2.5	Trial Running Test Report	65
1.17.7	Test Suspension	65
1.18	Systems Certification	65
1.19	Systems Documentation Deliverables	65
1.19.1	Systems Plan Deliverables	66
1.19.2	Systems Concept Design Review (SCDR) Deliverables	68
1.19.3	Systems Preliminary Design Review (SPDR) Deliverables	69
1.19.4	Systems Final Design Review (SFDR) Deliverables.....	73
1.19.5	Construction Deliverables.....	79
1.19.6	Testing and Verification Readiness Deliverables	79
1.19.7	Testing and Verification Results Deliverables.....	82

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 6 -

1.19.8 Operation and Maintenance Deliverables	83
Table 1.19-1 Systems Plan Deliverables.....	67
Table 1.19-2 Systems Concept Design Review (SCDR) Deliverables.....	68
Table 1.19-3 Systems Preliminary Design Review (SPDR) Deliverables.....	70
Table 1.19-4 Systems Final Design Review (SFDR) Deliverables	73
Table 1.19-5 Construction Deliverables	79
Table 1.19-6 Testing and Verification Readiness Deliverables.....	79
Table 1.19-7 Testing and Verification Results Deliverables	82
Table 1.19-8 Operation and Maintenance Deliverables.....	84

Table of Figures

No table of figures entries found.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 7 -

1 APPENDIX G – SYSTEMS GENERAL REQUIREMENTS

1.1 Introduction

- (a) This Appendix G [Systems General Requirements]:
- (i) sets out the requirements and processes to be employed by Project Co to confirm and validate that the Systems achieve the requirements of this Agreement, including Part 2 Schedule 4 Article 13 [Systems] and Article 21 [Tunnel Ventilation System] and that the BSP is ready for Service Commencement; and
 - (ii) describes the deliverables required of Project Co.
- (b) In DOORS Next Generation (provided as Disclosed Data), unless otherwise specified or the context otherwise requires, the following terms have the following meanings:
- (i) the Authority means the Province.
 - (ii) the Responsible Party means Project Co.
- (c) Section 1.19 [Systems Documentation Deliverables] of this Appendix G sets out the required timing for deliverables under this Appendix. Unless otherwise noted in this Appendix G, Project Co shall submit all deliverables in this Appendix G to the Province's Representative for review in accordance with the Review Procedure.
- (d) Section 1.19 [Systems Documentation Deliverables] lists the minimum set of deliverables required by the Province under this Appendix G. Project Co shall identify additional deliverables as required to demonstrate that their process and product meets the requirements of this Agreement and are fit for purpose. The Province at its sole discretion may require additional deliverables.
- (e) “Systems Deliverable” numbers refer to the deliverable numbers identified in the tables set out in Section 1.19 of this Appendix G.
- (f) The requirements of this Appendix G apply to all Systems, including those whose implementation is unchanged from previous SkyTrain projects.
- (g) Project Co shall only submit documents submitted for previous SkyTrain projects, including RAMS analyses, safety reports and safety cases, to satisfy a System Documentation Deliverable, if Project Co can demonstrate that the documents were prepared in accordance with the requirements of this Agreement, to the satisfaction of the Province, acting reasonably; and,
- (h) As per Schedule 4 Appendix D [Form of Independent Certifier Contract], Section 1.1 [Definitions], “Functions, Duties and Obligations,” the Independent Certifier is not responsible for Systems safety certification. Project Co is solely responsible for the safety assurance and safety certification of the Systems in accordance with the requirements of this Agreement.

1.2 Requirements Delivery

- (a) The Province has provided Project Co an output from DOORS Next Generation, as Disclosed Data.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 8 -

- (b) At the end of the Project, Project Co shall deliver to the Province the Requirements Verification Report [Systems Deliverable 053, Systems Deliverable 099] in DOORS Next Generation REQIF format.
- (c) Within DOORS Next Generation, Project Co shall preserve the Province's originally provided DOORS Next Generation identification numbers (IDs).
- (d) At the end of the Project, Project Co shall return to the Province a REQIF file of Project Co's developed and completed requirements and verification information, including the Province's originally provided IDs.
- (e) Project Co shall create a baseline in DOORS Next Generation at each Design Review and provide REQIF file to the Province.

1.3 Standards

- (a) Project Co shall undertake the Design and Construction of the Systems in accordance with:
 - (i) APTA - American Public Transportation Association
 - (ii) CENELEC - European Committee for Electrotechnical Standardization
 - (iii) EN 50126 Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
 - (iv) EN 50128 Railway applications. Communication, signalling and processing systems. Software for railway control and protection systems
 - (v) EN 50129 Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling
 - (vi) FCC Part 15 – Federal Communications Commission, Radio Frequency Devices
 - (vii) IEEE 15288 - Institute of Electrical and Electronics Engineers, "Systems and software engineering - System life cycle processes"
 - (viii) IEEE 16326 - Institute of Electrical and Electronics Engineers, "Systems and software engineering - Life cycle processes - Project management"
 - (ix) NIST - National Institute of Standards and Technology
 - (x) NFPA 130 - National Fire Protection Association, "Standard for Fixed Guideway Transit and Passenger Rail Systems"

1.4 Systems Plan

- (a) Project Co shall prepare and submit a Systems Plan [Systems Deliverable 008] for the Project Work and the Equipment in respect of the Systems, which describes the organisation and process by which Project Co proposes to do the following:
 - (i) transform all applicable Systems technical requirements specified or implied by this Agreement, including the requirements and recommendations of the engineering standards specified herein,

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 9 -

into a working rail transit system while ensuring that the functionality of the Existing SkyTrain System is maintained, through the use of an iterative process of definition, analysis, categorisation, design, testing, evaluation, and verification and validation;

- (ii) integrate related technical parameters and provide compatibility of physical, functional, and operational interfaces in a manner that optimises the design of the Systems Equipment;
 - (iii) integrate availability, reliability, maintainability, safety, quality assurance, testing, competency management and human factors into the total engineering effort;
 - (iv) show how the risks identified in the Systems Risk Management Plan [Systems Deliverable 009, Systems Deliverable 026, Systems Deliverable 060, Systems Deliverable 103] are being mitigated at each stage of development; and
 - (v) show how existing functionality and operational capability of the Existing SkyTrain System will be maintained within the Integrated SkyTrain System.
- (b) The Systems Plan [Systems Deliverable 008] shall comply with the outcomes specified in IEEE 15288.
 - (c) The Systems Plan [Systems Deliverable 008] shall define a Systems and software engineering project management process that complies with IEEE 16326.
 - (d) In the Systems Plan [Systems Deliverable 008] Project Co shall provide a line by line requirements analysis to demonstrate compliance to these two standards: IEEE 15288 and IEEE 16326.

1.5 Design Life of the Systems

- (a) All Systems supplied by Project Co shall be designed for an operating life of at least 30 years, with appropriate maintenance as defined by Existing SkyTrain System maintenance manuals or by Project Co, with the exception of the following designed for an operating life for the periods indicated:
 - (i) PC type computer equipment - at least 10 years;
 - (ii) communications equipment (excluding PC type computer equipment) - at least 20 years; and
 - (iii) batteries for UPS systems or substation control power - at least 10 years.
- (b) Project Co shall provide components that are generally available and shall not provide components that are obsolete or that Project Co ought reasonably to have been aware would become obsolete before Service Commencement. Should any components change status before Service Commencement and no longer be generally available, Project Co shall notify the Province promptly, and present options such as last-time buy and alternative components to the Province.

1.6 Systems Design Management

- (a) The design management requirements for the Systems portion of the Project include:
 - (i) Requirements Specification Process;
 - (ii) Requirements Analysis Process;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 10 -

- (iii) Systems Management Plan [Systems Deliverable 007];
- (iv) Systems Design Reviews;
- (v) Configuration Management Plan [Systems Deliverable 013];
- (vi) Interface Management Plan [Systems Deliverable 001, Systems Deliverable 018, Systems Deliverable 034, Systems Deliverable 080]; and
- (vii) Systems Software Design Management Plan [Systems Deliverable 027].

1.6.1 Requirements Specification Overview

- (a) The requirements referred to herein apply to the Systems and their integration into the Existing SkyTrain System as well as the BSP to provide a fully operational railway that is fit for purpose.
- (b) Project Co's requirements process shall comply with IEEE 15288.
- (c) Project Co shall manage requirements using the electronic requirements database DOORS Next Generation associated software, processes and procedures.
- (d) Project Co shall provide to the Province six licences for DOORS Next Generation.
- (e) Project Co shall provide to the Province training for six users on DOORS Next Generation.
- (f) Project Co shall provide to the Province full access to the BSP portions of DOORS Next Generation.

1.6.2 Requirements Analysis Overview

- (a) Project Co shall proceed with the requirements analysis in the following four major stages:
 - (i) Requirements Verification Plan;
 - (ii) Requirements Specification;
 - (iii) Requirements Verification Categorization Report; and
 - (iv) Requirements Verification Report.
- (b) Project Co shall prepare and submit a Requirements Verification Plan [Systems Deliverable 118] to define the overall requirements management and requirements analysis processes to be employed by Project Co to:
 - (i) iteratively specify and analyze Systems requirements to decompose higher level requirements, document derived requirements, and identify safety requirements;
 - (ii) validate that the requirements are correctly stated and that the specification is complete;
 - (iii) identify the verification and validation methods required to ensure that each requirement is properly implemented; and
 - (iv) track the verification and validation activities to their successful completion.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 11 -

- (c) Project Co shall apply the requirements analysis processes at each project stage to ensure that requirements which are newly identified at a given project stage are properly documented and verified, including:
 - (i) detailed design stage – ensuring the Systems are designed to meet the specific System requirements, and that the requirements from other disciplines interacting with the Systems are accommodated;
 - (ii) implementation stage – ensuring the installation meets the requirements; and
 - (iii) testing and commissioning – ensuring the products, subsystems and Systems, working together, satisfy the Systems requirements.

1.6.2.1 Requirements Specification and Analysis Process

- (a) Project Co shall clearly define and analyze all Systems technical requirements specified or implied in this Agreement and these Systems General Requirements.
- (b) Project Co shall analyze existing stakeholder documentation (provided as Disclosed Data) including operating and maintenance plans and procedures to identify stakeholder requirements.
- (c) DOORS Next Generation shall be used to track the status of each requirement throughout the lifecycle of the Systems Work.
- (d) The definition and analysis of all Systems technical requirements shall include decomposition of the Systems technical requirements into more detailed, derived requirements, further clarifying performance and behaviour.
- (e) The requirements analysis shall produce a necessary and sufficient set of requirements for the Systems and subsystems, which Project Co shall trace to the validation and verification products to demonstrate to the satisfaction of the Province that the delivered Systems comply with this Agreement and are fit for their intended purpose.
- (f) The definition of system Technical Requirements shall include the identification of safety requirements, the successful fulfillment of which are necessary for providing a system that is safe to operate and maintain.
- (g) All identified safety requirements shall be linked to one or more hazards in the Hazard Log [Systems Deliverable 016, Systems Deliverable 032, Systems Deliverable 079, Systems Deliverable 136] and all hazards in the Hazard Log shall be linked to one or more safety requirements.
- (h) DOORS Next Generation shall provide a listing of all explicit requirements, ensuring that all requirements are:
 - (i) unambiguous;
 - (ii) complete;
 - (iii) verifiable;
 - (iv) understandable;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 12 -

- (v) consistent;
 - (vi) traceable;
 - (vii) usable; and
 - (viii) necessary.
- (i) Project Co shall organise DOORS Next Generation by:
- (i) source (e.g., document and specific section reference);
 - (ii) type (e.g., information only, functional, operational);
 - (iii) discipline (e.g., ATC, communications, power supply and distribution);
 - (iv) verification method (e.g., analysis, demonstration, test, inspection);
 - (v) supporting document identification (e.g. traceable references); and
 - (vi) status, as open or closed.
- (j) DOORS Next Generation shall include a category to identify whether each requirement is a safety requirement.
- (k) DOORS Next Generation shall clearly separate safety requirements from all other requirements.
- (l) Project Co shall produce reports from DOORS Next Generation that include:
- (i) the Requirements Specifications [Systems Deliverable 050, Systems Deliverable 088]; and/or
 - (ii) Safety Requirements Specifications [Systems Deliverable 052, Systems Deliverable 092] for the Systems.
- (m) Project Co shall submit electronic versions the following:
- (i) Requirements Specifications [Systems Deliverable 050] and the Safety Requirements Specifications [Systems Deliverable 052] at the SPDR;
 - (ii) a final version of each of the Requirements Specifications [Systems Deliverable 088] and the Safety Requirements Specifications [Systems Deliverable 092] at the SFDR; and
 - (iii) the Requirements Specifications [Systems Deliverable 050, Systems Deliverable 088] and the Safety Requirements Specifications [Systems Deliverable 052, Systems Deliverable 092] every 6 months after the SPDR, up to the time of submitting the final versions at the SFDR.

1.6.2.2 Requirements Verification Categorization

- (a) Project Co shall assign one or more of the following verification methods to each requirement:
- (i) analysis;
 - (ii) demonstration;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 13 -

- (iii) test; and
- (iv) inspection.

- (b) Project Co shall verify each requirement by test wherever performance of a test is practicable.
- (c) Project Co shall submit a Requirements Verification Categorization Report [Systems Deliverable 089, Systems Deliverable 138] that describes Project Co's proposed verification method for each of the requirements, and a Safety Requirements Verification Categorization Report [Systems Deliverable 168, Systems Deliverable 022] that describes Project Co's proposed verification method for each of the safety requirements for the system.

1.6.2.3 Requirements Verification Plan

- (a) Project Co shall prepare and submit a Requirements Verification Plan [Systems Deliverable 118] and a Safety Requirements Verification Plan [Systems Deliverable 120] that defines the overall requirements management and requirements analysis processes to be employed by Project Co on the BSP, as outlined in Section 1.6.2 of this Appendix G [Systems General Requirements], and to specify the verification evidence for each requirement, as further defined herein.
- (b) Project Co shall ensure that requirements verification by analysis shall have a traceable reference to a specific document (including a specific section reference relevant to the analysis), discussion paper or notes which are archivable and retrievable (including being retrievable by the Province) and verify compliance with the applicable requirement.
- (c) Project Co shall ensure that requirements verification by demonstration shall have a traceable reference to a specific observation report which is archivable and retrievable (including being retrievable by the Province) and verifies compliance with the applicable requirement.
- (d) Project Co shall ensure that requirements verification by test shall have a traceable reference to one or more specific test procedures, complete with test identification and test objectives, and successful test results, which are archivable and retrievable (including being retrievable by the Province) and verify compliance with the applicable requirement.
- (e) Project Co shall ensure that requirements verification by inspection shall have a traceable reference to a specific supporting document (including a specific section reference relevant to the inspection), which is archivable and retrievable (including being retrievable by the Province) and verifies compliance with the applicable requirement.
- (f) Any requirements which cannot be verified by Project Co prior to Service Commencement because of the specific nature of the applicable requirement, such as the On-Time Performance Demonstration, will be identified specifically within the applicable plan as verifiable only after Service Commencement.

1.6.2.4 Requirements Verification Reports

- (a) At the SFDR, Project Co shall submit a Requirements Verification Report [Systems Deliverable 053] verifying Systems design compliance with all applicable Systems technical requirements of this Agreement, and a Safety Requirements Verification Report [Systems Deliverable 093] verifying Systems design compliance with all safety requirements of this Agreement.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 14 -

- (b) Project Co shall submit a final Requirements Verification Report [Systems Deliverable 099] verifying compliance with all applicable Systems technical requirements of this Agreement, and a final Safety Requirements Verification Report [Systems Deliverable 140] verifying compliance with all safety requirements of this Agreement.
- (c) Project Co shall ensure that the final Requirements Verification Report [Systems Deliverable 099] and the final Safety Requirements Verification Report [Systems Deliverable 140] include any requirements that were newly identified after the submittal of the final Requirements Specifications [Systems Deliverable 088] or the final Safety Requirements Specifications [Systems Deliverable 092], respectively.
- (d) As part of the Requirements Verification Report [Systems Deliverable 053, Systems Deliverable 099], Project Co shall, as applicable, confirm that all documentation defined in each of the Requirements Verification Plan [Systems Deliverable 118] and the Safety Requirements Verification Plan [Systems Deliverable 120] as being complete and archived, the exception being those requirements flagged as verifiable only after Service Commencement.
- (e) The completion test of this stage is that Project Co demonstrates that all requirements have traceable and retrievable verification and validation supporting documentation (e.g. test reports, analysis reports, drawings).

1.6.3 Systems Management Plan

- (a) Project Co shall submit a Systems Management Plan [Systems Deliverable 007].
- (b) The Systems Management Plan [Systems Deliverable 007] shall include:
 - (i) a Systems Design Review and audit schedule;
 - (ii) for each Systems deliverable, the content, format and deadline for submission;
 - (iii) a drawing submission schedule; and
 - (iv) a drawing tree illustrating Project Co's drawing hierarchy.
- (c) Design liaison sessions and their content shall be identified in the Systems Management Plan [Systems Deliverable 007] and Works Schedule.
- (d) Site specific configuration schemes, methods, approaches and anything new to the Existing SkyTrain System shall be presented to and reviewed by the Province at design liaison sessions during the Project. These points may be outside the formal Design Review sequences, as necessary to support timely delivery and de-risking of the Project, while allowing for adequately focused review and comment by the Province. The items to be reviewed include:
 - (i) naming, numbering, labeling and other identification schemes;
 - (ii) locations and quantities of equipment;
 - (iii) speed profiles, considering catch-up and ride quality;
 - (iv) train stopping locations;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 15 -

- (v) display layouts;
 - (vi) commands, alarms and messages;
 - (vii) maintenance interfaces;
 - (viii) other configuration data that is not easily changed; and
 - (ix) components and designs not previously used in the Existing SkyTrain System.
- (e) As part of the Systems Management Plan [Systems Deliverable 007] Project Co shall propose appropriate metrics to measure the progress of the design within each subsystem.
- (f) Project Co shall report progress against these metrics in monthly progress reports.
- (g) The Systems Management Plan [Systems Deliverable 007] shall comply with the requirements of the Systems Plan [Systems Deliverable 008].

1.6.4 Systems Design Reviews

- (a) The design review of the Systems shall consist of three types of formal design reviews, the SCDR, the SPDR, and the SFDRs.
- (b) Project Co shall submit a design review package for each Design Review, including all related documentation.
- (c) The Province's Representative shall provide its comments on the applicable design review package to Project Co within 15 Business Days after the Province's Representative has received the design review package.
- (d) A formal design review meeting between Project Co and the Province's Representative shall be held no more than 30 Business Days after the Province's Representative has received the applicable design review package. At a minimum, the meeting will include the following:
- (i) an overview presentation of the design by Project Co to the Province's Representative;
 - (ii) a review of the comments made by the Province's Representative and Project Co's response to the comments; and
 - (iii) additional comments presented by the Province's Representative.
- (e) Project Co shall submit a follow up report (listed below), documenting all comments made by the Province's Representative raised during the Design Review in accordance with this Appendix G [Systems General Requirements] and Project Co's responses to those comments within 15 Business Days of the formal Design Review meeting. The follow-up reports include the:
- (i) Systems Concept Design Review Report [Systems Deliverable 025];
 - (ii) Systems Preliminary Design Review Report [Systems Deliverable 059]; and
 - (iii) Systems Final Design Review Report [Systems Deliverable 102].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 16 -

- (f) Project Co shall, as a result of each of the Design Reviews, refine the plans and issues identified in the Systems Plan [Systems Deliverable 008], as applicable.
- (g) Refinements of the plans and issues identified in the Systems Plan [Systems Deliverable 008] shall include, risk mitigation, maintenance of functionality commensurate with that of the Existing SkyTrain System and requirements analysis.
- (h) The Province's Representative may, in its discretion, require additional design reviews, audits or inspections, in particular to minimise schedule or technical risks.
- (i) Project Co shall perform any additional design reviews, audits or inspections required by the Province's Representative.

1.6.4.1 Systems Concept Design Review (SCDR)

- (a) The SCDR for the Systems Work shall, at a conceptual level, establish the definition, internal and external interfaces and operations of each of the Systems and subsystems included in the Systems Work.
- (b) The documents listed in Section 1.19.2 [Systems Concept Design Review (SCDR) Submissions] of this Appendix G [Systems General Requirements] shall be submitted by Project Co as part of the Systems Concept Design Review Package [Systems Deliverable 024].

1.6.4.2 Systems Preliminary Design Review (SPDR)

- (a) The SPDR shall include a functional description of each Systems component, including drawings, schematics and renderings as appropriate.
- (b) Project Co shall, as part of the SPDR, finalise all interface specifications.
- (c) Project Co shall, as part of the SPDR, demonstrate compliance with all applicable Systems requirements of this Agreement.
- (d) As part of the Systems Preliminary Design Review Package [Systems Deliverable 058], Project Co shall demonstrate that all comments and open issues from the SCDR have been resolved by Project Co.
- (e) The Systems Preliminary Design Review Package [Systems Deliverable 058] shall include a Risk Assessment [Systems Deliverable 051] of all technical and program risks.
- (f) The Systems Preliminary Design Review Package [Systems Deliverable 058] shall present the proposed mitigation for such risks.
- (g) The documents listed in Section 1.19.3 [Systems Preliminary Design Review (SPDR) Submissions] of this Appendix G [Systems General Requirements] shall be submitted by Project Co as part of the Systems Preliminary Design Review Package [Systems Deliverable 058].

1.6.4.3 Systems Final Design Review (SFDR)

- (a) The SFDR shall confirm that the design of all Systems components is complete and that the Construction and the Systems Equipment manufacturing can proceed.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 17 -

- (b) As part of its submissions at the SFDR, Project Co shall demonstrate that all comments and open issues from the SPDR have been resolved by Project Co.
- (c) As part of the Systems Final Design Review Package [Systems Deliverable 101], Project Co shall provide all Contractual Technical Specifications [Systems Deliverable 107] for each of the Systems.
- (d) The Systems Final Design Review Package [Systems Deliverable 101] shall include a Risk Assessment [Systems Deliverable 090] of all technical and program risks.
- (e) The Systems Final Design Review Package [Systems Deliverable 101] shall present the proposed mitigation for such risks.
- (f) The documents listed in Section 1.19.4 [Systems Final Design Review (SFDR) Submissions] of this Appendix G [Systems General Requirements] shall be submitted by Project Co as part of the Systems Final Design Review Package [Systems Deliverable 101].
- (g) Project Co shall demonstrate that all comments and open issues from the SFDR and any additional design reviews, audits and inspections have been resolved by Project Co.
- (h) The Systems Final Design Review Package [Systems Deliverable 101], shall be signed and sealed by the responsible Professional Engineer.

1.6.5 Configuration Management Plan

- (a) Project Co shall, as part of the Systems Concept Design Review Package [Systems Deliverable 024], submit a Configuration Management Plan [Systems Deliverable 013] which describes how the configuration of the BSP and the Existing SkyTrain System and Canada Line system affected by the Systems Work will be controlled and documented, from the existing configuration through the design phases to as-built or as-delivered hardware and software.
- (b) The Configuration Management Plan [Systems Deliverable 013] shall comply with ISO 10007:2017 Guidelines for Configuration Management.

1.6.6 Interface Management Plan

1.6.6.1 Interface Document Guidance to Project Co.

- (a) As part of the Design Review package at each design review, Project Co shall submit an Interface Management Plan [Systems Deliverable 001, Systems Deliverable 018, Systems Deliverable 034, Systems Deliverable 080], which identifies all internal and external systems interfaces, describes the process for managing these interfaces, and includes an organizational structure, procedures and activities that will ensure the coordination of interface data and interface implementation among the disciplines.
- (b) As part of the Interface Management Plan [Systems Deliverable 001, Systems Deliverable 018, Systems Deliverable 034, Systems Deliverable 080], Project Co shall provide design criteria that clearly define the interface requirements among all aspects of the BSP.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 18 -

- (c) The initial Interface Management Plan [Systems Deliverable 001] shall be updated as necessary and resubmitted by Project Co in the design review packages for SCDR, SPDR, and SFDR [Systems Deliverable 018, Systems Deliverable 034, Systems Deliverable 080].

1.6.6.2 Coordination Documentation

- (a) Project Co shall manage and control the exchange of information required to allow successful interface coordination throughout the Design and Construction, including installation, testing and commissioning of the BSP. Coordination activities shall concentrate in the following areas:
 - (i) Systems and Station infrastructure;
 - (ii) Systems and Guideway infrastructure;
 - (iii) Systems and OMC infrastructure;
 - (iv) Systems and Canada Line;
 - (v) system to system, inclusive of the TransLink parallel projects (upgrade projects TransLink is currently working on in parallel with the BSP); and
 - (vi) configuration data.
- (b) Throughout the Project, Project Co shall keep the Interface Management Plan [Systems Deliverable 001, Systems Deliverable 018, Systems Deliverable 034, Systems Deliverable 080] up to date and resubmit. The Interface Management Plan [Systems Deliverable 001, Systems Deliverable 018, Systems Deliverable 034, Systems Deliverable 080] shall include:
 - (i) identification of individuals responsible for coordination of each interface;
 - (ii) identification of parties responsible for leading and supporting the preparation of interface documentation;
 - (iii) processes and procedures used to approve, coordinate, change and control interfaces;
 - (iv) title, definition and content of each interface documentation or configuration data deliverable; and
 - (v) milestones for approval and submission of interface documentation and configuration data.
- (c) Project Co shall ensure all interface documentation is signed and acknowledged by all coordinating parties and Project Co.
- (d) Project Co shall ensure all interface milestones are included in the Works Schedule and progressed by the project management team.
- (e) Interface documentation shall include:
 - (i) design documentation relating to the physical, functional, logical, operational;
 - (ii) performance, safety, reliability and maintainability attributes of the interface;
 - (iii) data configuration documentation;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 19 -

- (iv) installation documentation relating to the specific physical and electrical/optical configuration attributes of the interface; and
- (v) testing documentation relating to the verification and validation of all attributes required to support successful interface coordination.
- (f) TransLink will provide SkyTrain systems-level safety and systems engineering plans and analyses to govern their work and to document operational and functional characteristics of the Existing SkyTrain System.

1.6.6.2.1 Systems and Station Infrastructure Coordination

- (a) Project Co shall prepare and submit interface documentation defining the relationship between Systems and Station infrastructure. This documentation is intended to ensure a consistent and cohesive approach to integration of Systems Equipment with the Station architectural, structural, electrical and mechanical design and shall include:
 - (i) layouts for equipment rooms;
 - (ii) TVS shafts and rooms;
 - (iii) conduits, cableways and blockouts required to interconnect equipment;
 - (iv) equipment details including size, weight, heating, cooling, ventilation, power, mounting, delivery route requirements, and cabling; and
 - (v) layouts for Station public and non-public areas.

1.6.6.2.2 Systems and Guideway Infrastructure Coordination

- (a) Project Co shall prepare and submit interface documentation defining the relationship between Systems and Guideway infrastructure. This documentation is intended to ensure a consistent and cohesive approach to integration of Systems Equipment with the elevated and Subway Infrastructure, electrical and mechanical design and shall include:
 - (i) layouts for all Systems Equipment;
 - (ii) conduits, cableways and blockouts required to interconnect equipment;
 - (iii) walkway, trackwork, power rail, LIM rail and ATC loop; and
 - (iv) equipment details including size, weight, power, mounting, delivery route requirements, and cabling.

1.6.6.2.3 Systems and OMC Infrastructure Coordination

- (a) Project Co shall prepare and submit interface documentation defining the relationship between Systems and OMC (new OCC) infrastructure. This documentation is intended to ensure a consistent and cohesive approach to integration of Systems Equipment with the existing (new OCC) structural, electrical and mechanical design and shall include:
 - (i) layouts for equipment and control rooms;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 20 -

- (ii) conduits, cableways and blockouts required to interconnect equipment; and
- (iii) equipment details including size, weight, power, mounting, delivery route requirements, and cabling.

1.6.6.2.4 System to System Coordination Inclusive of TransLink's Parallel Projects.

- (a) Project Co shall define the relationship between Systems, and between Systems and the TransLink parallel projects. These TransLink parallel projects replace technology, change interfaces and ultimately improve SkyTrain's infrastructure and are scheduled to be underway in parallel with the Project. These projects include:
 - (i) SCOT (SkyTrain communications and operational telecommunications);
 - (ii) STARS (SkyTrain advanced radio system);
 - (iii) TVS SkyTrain head-end Replacement;
 - (iv) new OCC; and
 - (v) Reference Future Train
- (b) The STARS project will replace the existing SkyTrain voice and data radio system.
- (c) The SCOT project will replace the existing TRIMS, PABX and public address head-end.
- (d) The TVS head-end project will replace the existing Subway Infrastructure ventilation related FLSS user interface.
- (e) The new OCC project will replace the existing SkyTrain OMC.
- (f) Project Co shall prepare and submit interface documentation to demonstrate and ensure successful system integration including:
 - (i) ATC System coordination relating to:
 - (A) TRIMS (SCOT);
 - (B) TIDS;
 - (C) special trackwork; and
 - (D) FOCS network and cables.
- (g) FOCS and master clock coordination relating to:
 - (i) TRIMS (SCOT);
 - (ii) radio (STARS);
 - (iii) telephone/PABX (SCOT);
 - (iv) CCTV;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 21 -

- (v) PIDS;
 - (vi) FLSS;
 - (vii) SCADA;
 - (viii) WMS;
 - (ix) DDC;
 - (x) controlled access;
 - (xi) ethernet;
 - (xii) OTN head-end;
 - (xiii) Canada Line FOCS; and
 - (xiv) FOCS cables.
- (h) Low voltage power distribution coordination relating to:
- (i) Stations;
 - (ii) Guideway infrastructure; and
 - (iii) OMC.
- (i) WMS coordination relating to:
- (i) radio;
 - (ii) telephone;
 - (iii) CCTV;
 - (iv) TIMS;
 - (v) TIDS;
 - (vi) Station infrastructure;
 - (vii) Guideway infrastructure;
 - (viii) WMS head-end; and
 - (ix) Canada Line SCADA.
- (j) Radio (STARS) coordination relating to:
- (i) SkyTrain radio head-end;
 - (ii) ECOMM radio;
 - (iii) Canada Line radio;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 22 -

- (iv) PABX; and
- (v) FOCS.
- (k) TRIMS (SCOT) coordination relating to:
 - (i) radio;
 - (ii) PABX;
 - (iii) PA;
 - (iv) SkyTrain's information management system, and
 - (v) PIDS.
- (l) CCTV coordination relating to:
 - (i) telephone;
 - (ii) WMS;
 - (iii) TIDS;
 - (iv) FLSS;
 - (v) CCTV head-end, and
 - (vi) Canada Line CCTV.
- (m) FLSS coordination relating to:
 - (i) Station infrastructure;
 - (ii) Guideway infrastructure;
 - (iii) FLSS head-end; and
 - (iv) Canada Line fire alarm system.
- (n) PIDS coordination relating to:
 - (i) PIDS head-end.
- (o) HVAC DDC coordination relating to:
 - (i) DDC head-end.
- (p) SCADA coordination relating to:
 - (i) SCADA head-end; and
 - (ii) propulsion equipment.
- (q) Power distribution and back-up power coordination relating to:

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 23 -

- (i) BC-Hydro.
- (r) TVS coordination relating to:
 - (i) Canada Line tunnel ventilation system;
 - (ii) FLSS head-end (TVS SkyTrain head-end replacement); and
 - (iii) TVS equipment.

1.6.6.2.5 Coordination of Configuration Data

- (a) Project Co shall manage and control the exchange of configuration data between each System and between Systems and users. Configuration data includes items such as Station identification, track locations, and equipment names.
- (b) Project Co shall exchange information using version controlled data configuration files.
- (c) These files shall contain human readable, ASCII, comma-delimited, structured, well normalised records with no data redundancy present.
- (d) Project Co shall prepare and submit project wide configuration data guidelines that shall include:
 - (i) types of data configuration files;
 - (ii) exact data format and structure;
 - (iii) project wide identifiers such as station names and abbreviations;
 - (iv) data descriptions and intended use; and
 - (v) examples of each file type.
- (e) Project Co shall prepare and submit data configuration files to define the following interfaces including:
 - (i) alignment and ATC and operator;
 - (ii) TVS and ATC;
 - (iii) propulsion power and ATC;
 - (iv) ATC and TRIMS and operator;
 - (v) Station layout and telephone and operator;
 - (vi) Station layout and CCTV and operator;
 - (vii) WMS and Station equipment and operator;
 - (viii) DDC and HVAC equipment and operator;
 - (ix) Station layout and fire and life Systems and operator;
 - (x) SCADA and propulsion equipment and operator;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 24 -

- (xi) Station layout and controlled access and operator;
- (xii) TVS modes, TVS control system, TVS equipment, FLSS, FCP and operator; and
- (xiii) TVS modes and Canada Line TVS and operator.

1.6.6.3 Systems Cut-Over Plan

- (a) Project Co shall develop and submit a Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] to show how Project Co will:
 - (i) design, construct, install, verify, and test changes to the Existing SkyTrain System without disrupting the safe, uninterrupted public use of the Existing SkyTrain System;
 - (ii) design, construct, install, verify, and test changes to the existing Canada Line system without disrupting the safe, uninterrupted public use of the existing Canada Line system;
 - (iii) minimise changes to existing interfaces; and
 - (iv) manage the implementation of unavoidable changes to existing interfaces.
- (b) The Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] shall identify strategies to fall back to redundant subsystems or previous software versions in case of a failure of newly cut-over Systems Equipment.
- (c) The Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] shall describe how the Systems will be demonstrated to be in a state of operational readiness, to the satisfaction of TransLink.
- (d) The Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] shall include a schedule of specific access requirements, including dates, activities, and specific room access.
- (e) The Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] shall provide that all software changes are to be delivered in a staged manner to reduce any risk.
- (f) The Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] shall make full use of the simulation system.

1.6.6.4 Cut-Over Hazard Assessment

- (a) Project Co shall carry out and submit a Cut-Over Hazard Assessment [Systems Deliverable 064], to demonstrate that all cut-over hazards, or other hazards that could manifest themselves during the cut-over stage are controlled to an acceptable risk level, as defined in the Systems Safety Program Plan [Systems Deliverable 011].

1.6.7 Systems Software Design

- (a) Project Co shall ensure that all Systems software implemented on the Project is designed in accordance with international standards.
- (b) All software shall be fully integrated by Project Co with the Existing SkyTrain System.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 25 -

1.6.8 Systems Software Design Management Plan

- (a) Project Co shall, as part of the Systems Concept Design Review Package [Systems Deliverable 024], submit a Systems Software Design Management Plan [Systems Deliverable 027].
- (b) The Systems Software Design Management Plan [Systems Deliverable 027] shall, at a minimum, identify:
 - (i) the personnel responsible for software design and their lines of communication;
 - (ii) the managerial and technical processes to be used in software design and development, documenting, testing, regression testing, and revision control;
 - (iii) the managerial and technical processes to be used in software quality assurance;
 - (iv) the managerial and technical processes to be used in the integration of off-the-shelf software with software developed by Project Co for the BSP; and
 - (v) the managerial and technical processes to be used in the integration of all software with the Existing SkyTrain System and the Canada Line system.

1.6.9 Systems Design Considerations

- (a) Project Co shall apply a design philosophy that addresses continued performance, responsiveness and ease of operation and maintenance.
- (b) The detailed design philosophy shall adhere to the following principles in a manner that is consistent and permits integration with the Existing SkyTrain System:
 - (i) minimizing changes to the design of the Existing SkyTrain System; and
 - (ii) maximizing compatibility with the design of the Existing SkyTrain System, with respect to:
 - (A) interchangeability;
 - (B) modular design;
 - (C) maximizing use of standard off-the-shelf components;
 - (D) design for maintainability (access, diagnostics);
 - (E) design for availability and reliability;
 - (F) applicable wiring standards;
 - (G) wire identification;
 - (H) spare wires, cable and fibres; and
 - (I) suitable outdoor enclosures.
 - (iii) The following techniques shall be applied in a manner that is consistent with, and permits integration with, the Existing SkyTrain System:

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 26 -

- (A) application of selected redundancy;
- (B) minimization of single point failures which interrupt service;
- (C) minimization of Systems Equipment operation stresses;
- (D) provision of operate-around-failure capabilities;
- (E) use of components that meet or exceed the design and implementation criteria of the comparable Existing SkyTrain System components;
- (F) use of components that have proven reliability in similar service;
- (G) components are applied according to recognised methods and Good Industry Practice; and
- (H) components are configured in an arrangement that has been demonstrated to provide the required performance.

1.7 Systems Assurance

1.7.1 Systems Assurance Plan

- (a) Project Co shall develop and implement a Systems Assurance Plan [Systems Deliverable 006] in accordance with IEC 61508, EN 50126, EN 50128, and EN 50129.
- (b) The Systems Assurance Plan [Systems Deliverable 006] shall demonstrate compliance with IEC 61508, EN 50126, EN 50128, and EN 50129 for all aspects of the Systems Work included in systems requirements management, top level systems design, systems interface management, systems integration and subsystem design.
- (c) The Systems Assurance Plan [Systems Deliverable 006] shall define the preliminary list of safety-relevant Systems and define the process by which the list will be finalised.
- (d) The Systems Assurance Plan [Systems Deliverable 006] shall define how the requirements of IEC 61508, EN 50126, EN 50128, and EN 50129 will be tailored for each subsystem as appropriate for the Safety Integrity Level of that subsystem.
- (e) The Systems Assurance Plan [Systems Deliverable 006] shall define how single point failures and dormant failures will be identified and minimised.
- (f) The Systems Assurance Plan [Systems Deliverable 006] shall identify, to the satisfaction of the Province, how Project Co will demonstrate that no single point failure can create an unacceptable hazard.
- (g) The Systems Assurance Plan [Systems Deliverable 006] shall identify, to the satisfaction of the Province, how Project Co will demonstrate that no dormant failure can create an unacceptable hazard.
- (h) The Systems Assurance Plan [Systems Deliverable 006] shall discuss at a high level how Project Co will execute the safety and reliability, availability and maintainability programs.
- (i) The Systems Assurance Plan [Systems Deliverable 006] shall describe how the execution of the safety and RAM programs is apportioned between the Systems Safety Program Plan [Systems

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 27 -

Deliverable 011], RAM Program Plan [Systems Deliverable 004] and Systems Safety Certification Plan [Systems Deliverable 010].

- (j) Project Co shall execute its assurance program (Safety and RAM) following the requirements presented in this Appendix G [Systems General Requirements].
- (k) Project Co shall include in its assurance program any additional assurance-related activities deemed appropriate by Project Co for the systems being delivered.
- (l) The Systems Assurance Plan [Systems Deliverable 006] shall identify Project Co's personnel responsible for Systems assurance, their lines of communication and reporting hierarchy.
- (m) Project Co shall assure the design, Construction, installation and commissioning of safety certifiable elements of the Integrated SkyTrain system.
- (n) Safety certifiable elements include all project elements that can affect the safety or security of transit agency passengers, employees, contractors, emergency responders or the general public.

1.7.1.1 ATC System

- (a) The BSP ATC System shall be supplied and assured in compliance with IEC 61508, EN 50126, EN 50128, and EN 50129.
- (b) Project Co shall describe, in the Systems Safety Program Plan [Systems Deliverable 011], how the BSP ATC System will be assured in compliance with IEC 61508, EN 50126, EN 50128, and EN 50129.
- (c) Project Co shall describe, in the Systems Safety Certification Plan [Systems Deliverable 010], how the BSP ATC System will be safety certified in compliance with IEC 61508, EN 50126, EN 50128, and EN 50129.
- (d) Project Co shall identify to the Province any deviation in tasks or outcomes, or any non-compliance with these standards, at the outset of the Project Work in the Systems Safety Program Plan [Systems Deliverable 011].
- (e) Project Co shall explain the impacts of the deviations and/or non-compliances on system design, certification, operation and maintenance.
- (f) The Province will assess if the deviations and/or non-compliances are acceptable in its review of the Systems Safety Program Plan.

1.7.1.2 Fire Life Safety System (FLSS)

- (a) In addition to the requirements of Section 1.7.1 [Systems Assurance Plan], the FLSS shall be supplied and assured in compliance with NFPA and ULC standards applicable to the installation, operation and maintenance environments for which the FLSS is intended.
- (b) Project Co shall describe, in the Systems Safety Program Plan [Systems Deliverable 011], how the FLSS will be assured in compliance with these applicable NFPA and ULC standards and the requirements of Section 1.7.1 [Systems Assurance Plan].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 28 -

- (c) Project Co shall describe, in the Systems Safety Certification Plan [Systems Deliverable 010], how the FLSS will be safety certified in compliance with these applicable NFPA and ULC standards and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (d) Project Co shall identify to the Province any deviation in tasks or outcomes, or any non-compliance with these standards, at the outset of the Project Work in the Systems Safety Program Plan [Systems Deliverable 011].
- (e) Project Co shall explain the impacts of the deviations and/or non-compliances on system design, certification, operation and maintenance.
- (f) The Province will assess if the deviations and/or non-compliances are acceptable in its review of the Systems Safety Program Plan.
- (g) Project Co shall describe, in the RAM Program Plan [Systems Deliverable 004], how the FLSS' availability will be demonstrated to have been achieved.
- (h) The FLSS shall be designed to adhere to the following design principles as a minimum:
 - (i) there shall be no single points of failure that will render the FLSS unavailable;
 - (ii) any FLSS failure shall result in the system going to a more restrictive state;
 - (iii) no single FLSS failure shall cause the system to become unsafe;
 - (iv) there shall be no dormant FLSS failures that will remain undetected for a period of time that may cause an unacceptable hazard;
 - (v) the FLSS shall use regularly scheduled self-check routines to detect existing dormant failures; and
 - (vi) dormant failures not detected by the FLSS self-check routines shall be detected during periodic maintenance.
- (i) Project Co shall demonstrate, to the satisfaction of the Province, that no dormant FLSS failures can create an unacceptable hazard.
- (j) Periodic maintenance shall be carried out on the FLSS within the time span prescribed for dormant failures remaining undetected.
- (k) Project Co shall determine the allowable time span for a dormant FLSS failure to remain undetected, based on the safety relevance and reliability of the failure mode and components involved.
- (l) Project Co shall demonstrate that the FLSS design incorporates these minimum design principles, by carrying out the hazard and safety analyses prescribed in the Systems Safety Program Plan [Systems Deliverable 011].
- (m) Any interfaces between the FLSS and other Systems with safety responsibility shall be analyzed in an Interface Hazard Analysis [Systems Deliverable 017, Systems Deliverable 033].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 29 -

1.7.1.3 Tunnel Ventilation System (TVS)

- (a) In addition to the requirements of Section 1.7.1 [Systems Assurance Plan], the TVS shall be supplied and assured in compliance with the NFPA 130 standard and IEC 61508.
- (b) Project Co shall describe, in the Systems Safety Program Plan [Systems Deliverable 011], how the TVS will be assured in compliance with the NFPA 130 standard, IEC 61508 and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (c) Project Co shall describe, in the Systems Safety Certification Plan [Systems Deliverable 010], how the TVS will be safety certified in compliance with the NFPA 130 standard, IEC 61508 and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (d) Project Co shall identify to the Province any deviation in tasks or outcomes, or any non-compliance with these standards, at the outset of the Project Work in the Systems Safety Program Plan [Systems Deliverable 011].
- (e) Project Co shall explain the impacts of the deviations and/or non-compliances on system design, certification, operation and maintenance.
- (f) The Province will assess if the deviations and/or non-compliances are acceptable in its review of the Systems Safety Program Plan.
- (g) Project Co shall describe, in the RAM Program Plan [Systems Deliverable 004], how the TVS system availability will be demonstrated to have been achieved.
- (h) The TVS shall be designed to adhere to the following design principles as a minimum:
 - (i) there shall be no single points of failure that will render the TVS unavailable;
 - (ii) any TVS failure shall result in the system going to a more restrictive state;
 - (iii) no single TVS failure shall cause the system to become unsafe;
 - (iv) there shall be no dormant TVS failures that will remain undetected for a period of time that may cause an unacceptable hazard;
 - (v) the TVS shall use regularly scheduled self-check routines to detect existing dormant failures; and
 - (vi) dormant failures not detected by the TVS self-check routines shall be detected during periodic maintenance.
- (i) Project Co shall demonstrate, to the satisfaction of the Province, that no dormant TVS failures can create an unacceptable hazard.
- (j) Periodic maintenance shall be carried out on the TVS within the time span prescribed for dormant failures remaining undetected. Such periodic maintenance shall be no less than monthly.
- (k) Project Co shall determine the allowable time span for a dormant TVS failure to remain undetected, based on the safety relevance and reliability of the failure mode and components involved.

- (l) Project Co shall demonstrate that the TVS design incorporates these minimum design principles, by carrying out the hazard and safety analyses prescribed in the Systems Safety Program Plan [Systems Deliverable 011].
- (m) Any interfaces between the TVS and other systems with safety responsibility shall be analyzed in an Interface Hazard Analysis [Systems Deliverable 017, Systems Deliverable 033].

1.7.1.4 Trainway Intrusion Detection System (TIDS)

- (a) The TIDS shall be supplied and assured in compliance with the process described in the Systems Safety Program Plan [Systems Deliverable 011] and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (b) The TIDS shall be safety certified in compliance with the process described in the Systems Safety Certification Plan [Systems Deliverable 010] and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (c) The Province will assess if the assurance and safety certification processes are acceptable.
- (d) Project Co shall describe, in the RAM Program Plan [Systems Deliverable 004], how the TIDS' availability will be demonstrated to have been achieved.
- (e) The TIDS shall be designed to adhere to the following design principles as a minimum:
 - (i) there shall be no single points of failure that will render the TIDS unavailable;
 - (ii) any TIDS failure shall result in the system going to a more restrictive state;
 - (iii) no single TIDS failure shall cause the system to become unsafe;
 - (iv) there shall be no dormant TIDS failures that will remain undetected for a period of time that may cause an unacceptable hazard;
 - (v) the TIDS shall use regularly scheduled self-check routines to detect existing dormant failures; and
 - (vi) dormant failures not detected by the TIDS' self-check routines shall be detected during periodic maintenance.
- (f) Project Co shall demonstrate, to the satisfaction of the Province, that no dormant TIDS failures can create an unacceptable hazard.
- (g) Where periodic maintenance action is required to detect dormant failures, Project Co shall specify the proposed maintenance action and the maximum time period between instances of such maintenance action, and shall do so no later than at the relevant SPDR.
- (h) Project Co shall determine the allowable time span for a dormant TIDS failure to remain undetected, based on the safety relevance and reliability of the failure mode and components involved.
- (i) Project Co shall demonstrate that the TIDS design incorporates these minimum design principles, by carrying out the hazard and safety analyses prescribed in the Systems Safety Program Plan [Systems Deliverable 011].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 31 -

- (j) Any interfaces between the TIDS and other systems with safety responsibility shall be analyzed in an Interface Hazard Analysis [Systems Deliverable 017, Systems Deliverable 033].

1.7.1.5 Safety-Relevant Systems

- (a) Each safety-relevant system shall be supplied and assured in compliance with the process described in the Systems Safety Program Plan [Systems Deliverable 011] and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (b) Each safety-relevant system shall be safety certified in compliance with the process described in the Systems Safety Certification Plan [Systems Deliverable 010] and the requirements of Section 1.7.1 [Systems Assurance Plan].
- (c) The Province will assess if the assurance and safety certification processes are acceptable.
- (d) Each safety-relevant system shall be designed to adhere to the following design principles as a minimum:
 - (i) there shall be no single points of failure that will render the safety-relevant system unavailable;
 - (ii) any safety-relevant system failure shall result in the system going to a more restrictive state;
 - (iii) no single safety-relevant system failure shall cause the system to become unsafe;
 - (iv) there shall be no dormant safety-relevant system failures that will remain undetected for a period of time that may cause an unacceptable hazard;
 - (v) each safety-relevant system shall use regularly scheduled self-check routines to detect existing dormant failures; and
 - (vi) dormant failures not detected by the safety-relevant system's self-check routines shall be detected during periodic maintenance.
- (e) Project Co shall demonstrate, to the satisfaction of the Province, that no dormant safety-relevant system failures can create an unacceptable hazard.
- (f) Periodic maintenance shall be carried out on each safety-relevant system within the time span prescribed for dormant failures remaining undetected.
- (g) Project Co shall determine the allowable time span for a dormant safety-relevant system failure to remain undetected, based on the safety relevance and reliability of the failure mode and components involved.
- (h) Project Co shall demonstrate that the safety-relevant system design incorporates these minimum design principles, by carrying out the hazard and safety analyses prescribed in the Systems Safety Program Plan [Systems Deliverable 011].
- (i) Any interfaces between the safety-relevant system and other systems with safety responsibility shall be analyzed in an Interface Hazard Analysis [Systems Deliverable 017, Systems Deliverable 033].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 32 -

- (j) Project Co shall ensure that data sent from a safety-relevant system to a safety-critical system will be produced and transmitted using correct safety assurance concepts for designing and implementing fail-safe functions.
- (k) Safety assurance concepts used to design and implement fail-safe functions in processor-based systems include:
 - (i) checked redundancy;
 - (ii) numerical assurance;
 - (iii) N-version programming;
 - (iv) diversity;
 - (v) self-checking; and
 - (vi) data protection and error checking, such as check sums, cyclic redundancy checks, hash functions, or similar.
- (l) Project Co shall define the safety assurance concepts that are necessary for the design of safety-relevant systems' interfaces with the safety-critical BSP ATC System.

1.7.2 RAM Program Plan

- (a) Project Co shall develop and implement a RAM Program Plan [Systems Deliverable 004] in accordance with the applicable provisions of EN 50126-1 and 50126-2.
- (b) The RAM Program Plan [Systems Deliverable 004] shall define the management of all RAM activities for the BSP to ensure a systematic and documented process.
- (c) The RAM Program Plan [Systems Deliverable 004] shall include a documented set of time-scheduled activities, resources and events.
- (d) The RAM Program Plan [Systems Deliverable 004] shall establish the organizational structure, responsibilities, procedures, activities, capabilities and resources, which together ensure that the BSP will satisfy the RAM targets specified in the RAM Program Plan [Systems Deliverable 004].
- (e) The design of the Systems components of the BSP shall incorporate applicable RAM design features which reduce the likelihood that failures will impact system availability.
- (f) As part of the RAM Program Plan [Systems Deliverable 004], Project Co shall translate the foregoing criteria into:
 - (i) the allocated MTBF and MTBSAF requirements for the Systems and the subsystems;
 - (ii) maintainability features with MTTR requirements; and
 - (iii) SPFMA for efficient operation of the BSP.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 33 -

- (g) The System Performance Demonstration [Systems Deliverable 141] (see Article 13 [Systems]) shall confirm that the performance of the BSP will be equal to or exceed that of the Existing SkyTrain System.

1.7.3 RAM Analysis Report

- (a) To verify compliance of the BSP with the requirements of the RAM Program Plan [Systems Deliverable 004], Project Co shall undertake RAM analysis and submit a RAM Analysis Report [Systems Deliverable 086].
- (b) The RAM Analysis Report [Systems Deliverable 086] shall provide details of RAM calculations and allocations used to substantiate the design of the Systems Equipment.
- (c) The RAM Analysis Report [Systems Deliverable 086] shall estimate the Systems Equipment MTBF and MTBSAF based on the following inputs:
- (i) predicated or actual (field data) reliability of each LRU and LLRU;
 - (ii) reliability block diagram of each subsystem;
 - (iii) preventive and corrective maintenance activities;
 - (iv) MTTR of each subsystem;
 - (v) Systems FMEA based on operational reliability; and
 - (vi) Spare Parts Lists [Systems Deliverable 156].

1.8 Systems Safety

- (a) This section presents the minimum set of safety assurance requirements that must be followed by Project Co during the Term.
- (b) Project Co shall develop and present evidence of appropriate safety assurance activities, as defined in the Systems Safety Program Plan [Systems Deliverable 011] and Systems Safety Certification Plan [Systems Deliverable 010], over the duration of the Term.

1.8.1 Systems Safety Program Plan

- (a) Project Co shall prepare, submit and periodically update a Systems Safety Program Plan [Systems Deliverable 011]. The Systems Safety Program Plan [Systems Deliverable 011] shall be developed and implemented in accordance with the requirements and recommendations of IEC 61508, EN 50126, EN 50128, and EN 50129.
- (b) The Systems Safety Program Plan [Systems Deliverable 011] shall focus on requirements to safely transport the public and protect employees from operational hazards, such as derailment, collision, fire and smoke conditions after Substantial Completion.
- (c) The Systems Safety Program Plan [Systems Deliverable 011] shall explain how Project Co will execute the safety management, including as a minimum:
- (i) identify hazards related to the Systems;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 34 -

- (ii) identify hazards related to the interface between the Systems and other Project Work, and between the Systems and the Existing SkyTrain System;
 - (iii) generate appropriate mitigations to all identified hazards;
 - (iv) transfer hazards to the appropriate parties;
 - (v) ensure that all systems are identified and properly analyzed in accordance with their safety criticality;
 - (vi) identify a preliminary list of all safety reports;
 - (vii) verify and record correct implementation of all mitigations; and
 - (viii) identify the products to support system certification whether produced by Project Co or others.
- (d) The Systems Safety Program Plan [Systems Deliverable 011] shall identify Project Co's safety organization, including internal and external lines of communication, reporting hierarchy and procedures for interfacing with the Province and local emergency service organizations.
- (e) The Systems Safety Program Plan [Systems Deliverable 011] shall define the risk classification system to be used to characterise the frequency, severity and resulting risk level for each hazard identified.
- (f) The risk classification system shall define what is deemed to be acceptable, acceptable with the Province's review and agreement, and unacceptable risk levels for an identified hazard.
- (g) If the Province provides its risk classification system for use, then Project Co shall use this classification system in the Systems Safety Program Plan [Systems Deliverable 011].
- (h) The Systems Safety Program Plan [Systems Deliverable 011] shall, at a minimum, define Project Co's safety related activities and responsibilities for implementation, verification methods for safety requirements, and shall comply with requirements that are applicable to TSBC certification, licensing and permitting.
- (i) The Systems Safety Program Plan [Systems Deliverable 011] shall include a schedule and process for auditing compliance against safety requirements.
- (j) Protection from Construction and environmental hazards shall be covered in the Health and Safety Program.
- (k) Protection from Construction and environmental hazards shall not be included in the Systems Safety Program Plan [Systems Deliverable 011].
- (l) Project Co shall include in the Systems Safety Program Plan [Systems Deliverable 011] any additional safety assurance related activities deemed appropriate by Project Co or its subcontractor for the systems being delivered.

1.8.2 Systems Safety Certification Plan

- (a) Project Co shall prepare and submit a Systems Safety Certification Plan [Systems Deliverable 010]. The Systems Safety Certification Plan [Systems Deliverable 010] shall be developed and implemented in accordance with IEC 61508, EN 50126, EN 50128, and EN 50129.
- (b) The Systems Safety Certification Plan [Systems Deliverable 010] shall, at a minimum, describe Project Co's strategy, approach, plan, roadmap and methodology for safety certifying system components, as well as the Integrated SkyTrain System, for Passenger Service, and for applying for an Operating Permit.

1.8.3 Systems Hazard and Safety Analyses

- (a) Project Co shall carry out systems hazard analyses in the manner described in the Systems Safety Program Plan [Systems Deliverable 011], to identify hazards relevant to the execution of the Project.
- (b) Project Co shall carry out systems safety analyses in the manner described in the Systems Safety Program Plan [Systems Deliverable 011], to provide safety analysis evidence, where necessary as defined in the Systems Safety Program Plan [Systems Deliverable 011], that identified hazards are mitigated to an acceptable level.

1.8.3.1 Hazard Analysis

- (a) Project Co shall complete and submit a Preliminary Hazard Analysis [Systems Deliverable 021, Systems Deliverable 041] for the Systems Work to identify hazards, associated causal factors, level of risk and proposed design mitigation measures.
- (b) The proposed design mitigation measures shall reduce the final risk of each hazard As Low As Reasonably Practicable (see EN 50126), to the satisfaction of the Province and shall not be restricted by design mitigation measures accepted on the Existing SkyTrain System.
- (c) Project Co shall track all hazards identified in the PHA in a Hazard Log [Systems Deliverable 016, Systems Deliverable 032, Systems Deliverable 079, Systems Deliverable 136] until all mitigation measures have been verified by Project Co.
- (d) The Hazard Log [Systems Deliverable 016, Systems Deliverable 032, Systems Deliverable 079, Systems Deliverable 136] shall be kept up to date.
- (e) The Hazard Log [Systems Deliverable 016, Systems Deliverable 032, Systems Deliverable 079, Systems Deliverable 136] shall be submitted as part of the design review package at each design review stage.
- (f) The Hazard Log [Systems Deliverable 016, Systems Deliverable 032, Systems Deliverable 079, Systems Deliverable 136] shall be available for inspection at any time on request by the Province's Representative.
- (g) An updated Hazard Log [Systems Deliverable 016, Systems Deliverable 032, Systems Deliverable 079, Systems Deliverable 136] shall be submitted with the Final Safety Case [Systems Deliverable 135].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 36 -

1.8.3.2 Operational and Support Hazard Analysis

- (a) Project Co shall complete an Operational and Support Hazard Analysis [Systems Deliverable 019, Systems Deliverable 037, Systems Deliverable 084] for the Systems Project Work to identify operations hazards, associated causal factors, level of risk, and proposed mitigation measures.
- (b) The scope of the O&SHA shall include normal operations, testing, installation, maintenance, repair, training, storage, handling, transportation and emergency/rescue operations.

1.8.3.3 System Fault Tree Analysis

- (a) Project Co shall complete a System Fault Tree Analysis [Systems Deliverable 097], which will be presented in the form of a logic flow diagram for analyzing hazards that result from component failures, design weaknesses, or human errors.

1.8.3.4 Subsystem Failure Modes, Effects and Criticality Analysis

- (a) Project Co shall complete Subsystem Failure Modes, Effects & Criticality Analyses [Systems Deliverable 095] to evaluate the effects of potential failures of subsystems on the Integrated SkyTrain System to the extent within the scope of the Project Work, their likelihood of occurrence, methods of detection and related failure management, where required.
- (b) Project Co shall indicate in its Systems Safety Program Plan [Systems Deliverable 011] which approach will be used to perform the Subsystem Failure Modes, Effects & Criticality Analyses [Systems Deliverable 095] (i.e. hardware analyses, functional analyses, or both).

1.8.3.5 Systems Safety Reports

- (a) Project Co shall submit systems safety reports as defined by the submissions schedule in Section 1.19 of this Appendix, to provide the Province's Representative with assurance with respect to the safety of the Integrated SkyTrain System to the extent within the scope of the Project Work, and appropriate for the Project stage at which the report is submitted.

1.8.3.5.1 Preliminary Safety Report

- (a) The Preliminary Safety Report [Systems Deliverable 045] shall be submitted as part of the Systems Preliminary Design Review Package [Systems Deliverable 058].
- (b) The Preliminary Safety Report [Systems Deliverable 045] shall present the results of initial hazard assessment and analysis work carried out to the SPDR stage, as defined in the Systems Safety Program Plan [Systems Deliverable 011].
- (c) The Preliminary Safety Report [Systems Deliverable 045] shall demonstrate that safety requirements have been created to mitigate all hazards identified at the SPDR stage to an acceptable level, as defined in the Systems Safety Program Plan [Systems Deliverable 011].
- (d) The Preliminary Safety Report [Systems Deliverable 045] shall demonstrate that the system design under development will result in a system that is safe for operation, as defined in the Systems Safety Program Plan [Systems Deliverable 011].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 37 -

1.8.3.5.2 Design Safety Case

- (a) The Design Safety Case [Systems Deliverable 066] shall be submitted as part of the Systems Final Design Review Package [Systems Deliverable 101].
- (b) The Design Safety Case [Systems Deliverable 066] shall address all hazards or other safety concerns identified in the Preliminary Safety Report [Systems Deliverable 045] and demonstrate that they continue to be controlled acceptably, as defined in the Systems Safety Program Plan [Systems Deliverable 011].
- (c) The Design Safety Case [Systems Deliverable 066] shall present the results of hazard assessment and analysis work carried out to the SFDR stage, as defined in the Systems Safety Program Plan [Systems Deliverable 011].
- (d) The Design Safety Case [Systems Deliverable 066] shall demonstrate that safety requirements have been created to mitigate all hazards identified at the SFDR stage to an acceptable level, as defined in the Systems Safety Program Plan [Systems Deliverable 011].
- (e) The Design Safety Case [Systems Deliverable 066] shall demonstrate that the system design that has been developed will result in a system that is safe for operation, as defined in the Systems Safety Program Plan [Systems Deliverable 011], and can proceed to be manufactured and installed.
- (f) The Design Safety Case [Systems Deliverable 066] shall identify all verification activities that will need to be carried out, to demonstrate that the system being manufactured and installed will be safe for operation, as defined in the Systems Safety Program Plan [Systems Deliverable 011].

1.8.3.5.3 Final Safety Case

- (a) The Final Safety Case [Systems Deliverable 135] shall demonstrate that all hazards identified in the Design Safety Case [Systems Deliverable 066], as well as any hazards identified thereafter have been closed or controlled acceptably, as defined in the Systems Safety Program Plan [Systems Deliverable 011].
- (b) The Final Safety Case [Systems Deliverable 135] shall be submitted by Project Co after Project Co has successfully completed all testing and commissioning.
- (c) The Final Safety Case [Systems Deliverable 135] shall include the completed Safety Requirements Verification Report [Systems Deliverable 093, Systems Deliverable 140].
- (d) The Final Safety Case [Systems Deliverable 135] shall demonstrate that the safety and RAM programs defined in the Systems Assurance Plan [Systems Deliverable 006] have been successfully executed, as defined in the Systems Assurance Plan.
- (e) The Final Safety Case [Systems Deliverable 135] shall demonstrate that the system developed can be certified, as defined in the Systems Safety Certification Plan [Systems Deliverable 010], as being ready for Passenger Service.
- (f) Project Co shall demonstrate that the Final Safety Case [Systems Deliverable 135] complies with the requirements and recommendations of EN 50126.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 38 -

1.8.4 Independent Safety Assessor

- (a) Thales will utilize their own Independent Safety Assessor for the ATC Work. Project Co shall provide an Independent Safety Assessor to assess all Systems Work that is not part of the ATC Work.
- (b) Project Co shall cause the Independent Safety Assessor to assess and audit Project Co's safety management system and activities in accordance with the requirements and recommendations specified in standards IEC 61508, EN 50126, EN 50128 and EN 50129, to the satisfaction of the Province, acting reasonably.
- (c) Project Co's Independent Safety Assessor shall:
 - (i) be a Professional Engineer;
 - (ii) be suitably qualified and experienced in respect of projects of the nature and scope of the Project;
 - (iii) be able to demonstrate the competency, ability, and resources necessary to carry out services of the nature required of an independent safety assessment in accordance with the standards listed in this Section 1.8.4;
 - (iv) be able to demonstrate driverless rail transit domain knowledge and technical expertise within system safety, and key safety related activities deployed during the development life cycle, including requirements management, hazard identification, safety risk assessment, risk analysis, RAM analysis, verification and validation, and testing and commissioning; and
 - (v) be without bias or conflict of interest.
- (d) Project Co shall appoint the Independent Safety Assessor no later than 60 days prior to the scheduled date of the SCDR.
- (e) Project Co shall, at its own cost, rectify all findings and observations raised by Project Co's Independent Safety Assessor, in a timely manner.

1.8.4.1 Scope of Work

- (a) Project Co shall cause the Independent Safety Assessor to:
 - (i) assess the safety management, safety engineering and assurance arrangements employed by Project Co for the Systems, and provide observations as to the completeness and robustness of these safety management, quality management, safety engineering and assurance arrangements;
 - (ii) provide an independent judgement that the safety arguments presented for the Systems are appropriate and adequate for the Integrated SkyTrain System, and that the Systems satisfy those safety requirements, and that the Integrated SkyTrain System, to the extent within the scope of the Project Work, is fit for passenger service; and
 - (iii) provide an independent judgement of the Systems certification documentation submitted pursuant to Section 1.18 [Systems Certification] of this Appendix G, and the Safety Certificate Documentation [Systems Deliverable 139].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 39 -

- (b) The Independent Safety Assessor's scope of work does not include that portion of the Project Work that is certified in accordance with the Construction Approval Process, the ATC Work, and the Existing SkyTrain System, but shall include the interface between these works and the Systems, to the extent required to satisfy the safety requirements and support the safety arguments.
- (c) Project Co shall cause the Independent Safety Assessor to review and assess both the initial submittal and any subsequent re-submittals of all System engineering and safety plans, including those listed in Table 1.19-1 [System Plan Deliverables], the Configuration Management Plan [Systems Deliverable 013], the Interface Management Plan [Systems Deliverable 018], the Systems Software Design Management Plan [Systems Deliverable 027], and the Software Development Plan [Systems Deliverable 054].
- (d) Project Co shall cause the Independent Safety Assessor to audit and assess the safety related activities performed, and the products produced to satisfy the plans referenced in clause (c), above.
- (e) Project Co shall cause the Independent Safety Assessor to review and assess the safety-related products produced for each of the Systems Design Reviews as specified in Section 1.6.4 [Systems Design Reviews], Table 1.19-2 [Systems Concept Design Review (SCDR) Deliverables], Table 1.19-3 [Systems Preliminary Design Review (SPDR) Deliverables], and Table 1.19-4 [Systems Final Design Review (SFDR) Deliverables], all of this Appendix G, and to review and assess any subsequent modifications made to these safety products.
- (f) Project Co shall cause the Independent Safety Assessor to review and assess both the initial submittal and any subsequent re-submittals of all verification and validation submittals, including those listed in Table 1.19-6 [Testing and Verification Readiness Deliverables], and Table 1.19-7 [Testing and Verification Results Deliverables], both of this Appendix G.
- (g) Project Co shall cause the Independent Safety Assessor to audit and assess the safety-related activities performed, and the products produced to satisfy the verification and validation activities referenced in clause (f), above.
- (h) Project Co shall cause the Independent Safety Assessor to review and assess the Preliminary Safety Report [Systems Deliverable 045], the Design Safety Case [Systems Deliverable 066], and the Final Safety Case [Systems Deliverable 135] to ensure that the safety arguments presented for the Systems are appropriate and adequate for the Integrated SkyTrain System, and that the Systems satisfy these safety requirements, to the extent applicable to that stage of the project.
- (i) Project Co shall cause the Independent Safety Assessor to review, audit and assess Project Co's requirements managements process and products to ensure that all safety requirements, and in particular those arising from Systems design activities and Systems RAMS activities, are properly identified, recorded, tracked, and demonstrated through the verification and validation activities.
- (j) Project Co shall ensure that there is unencumbered direct communication between the Province and Project Co's Independent Safety Assessor, as well as between Project Co's Independent Safety Assessor and Project Co's senior staff in their Systems safety team, verification and validation team, and testing and commissioning team, to ensure that all safety issues are properly identified, analyzed, discussed and resolved in a transparent and cooperative manner.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 40 -

- (k) Project Co shall cause the Independent Safety Assessor to attend periodic safety review meetings with representatives of the Province, Project Co, TransLink and TSBC.

1.8.4.2 Deliverables

- (a) Project Co shall cause the Independent Safety Assessor to produce and deliver to the Province the following main deliverables:
- (i) the Independent Safety Assessment Plan [Systems Deliverable 184];
 - (ii) the record of the independent safety assessment findings through an Independent Safety Assessment Monthly Report [Systems Deliverable 185]; and
 - (iii) the Independent Safety Assessment Final Report [Systems Deliverable 186].
- (b) All independent safety assessment deliverables shall be provided directly to the Province, without modification by Project Co.
- (c) Project Co's Independent Safety Assessment Plan [Systems Deliverable 184] shall at a minimum:
- (i) demonstrate how the independent safety assessment will satisfy the requirements of this Section 1.8.4 [Independent Safety Assessor];
 - (ii) demonstrate how the independent safety assessment will satisfy the requirements and recommendations of IEC 61508, and EN 50126;
 - (iii) provide a detailed schedule of independent safety assessment activities, linked to the Project Schedule;
 - (iv) define the scope of the independent safety assessment, and in particular, describe in detail how the independent safety assessment will address the Project Works listed in Section 1.8.4.1 [Scope of Work] (b); and
 - (v) provide a detailed list of documentation deliverables, including a brief description of content and the scheduled delivery date.
- (d) Project Co shall cause the Independent Safety Assessor to submit an Independent Safety Assessment Monthly Report [Systems Deliverable 185].
- (e) Project Co's Independent Safety Assessment Plan [Systems Deliverable 184] shall define the format of this Independent Safety Assessment Monthly Report [Systems Deliverable 185], for review and acceptance by the Province, acting reasonably. As a minimum, the report shall:
- (i) document independent safety assessment activities performed during the relevant period;
 - (ii) record all findings and observations raised by Project Co's Independent Safety Assessor during the relevant period; and
 - (iii) track Project Co's progress of rectifying the findings and observations raised by Project Co's Independent Safety Assessor.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 41 -

- (f) Project Co shall cause the Independent Safety Assessor to submit an Independent Safety Assessment Final Report [Systems Deliverable 186].
- (g) Project Co's Independent Safety Assessment Plan [Systems Deliverable 184] shall define the format of the Independent Safety Assessment Final Report [Systems Deliverable 186], for review and acceptance by the Province, acting reasonably.

1.9 Systems Risk Management

- (a) Project Co shall incorporate risk management into its overall Design, Construction, and testing program for the Systems.
- (b) Risk management of the Systems shall be used by Project Co to identify all potential risks to successful completion of the Systems Work including technical risks, cost and schedule risks, and risks of integrating with the Existing SkyTrain System and the Canada Line system.

1.9.1 Systems Risk Management Plan

- (a) Project Co shall implement and maintain a Systems Risk Management Plan [Systems Deliverable 009, Systems Deliverable 026, Systems Deliverable 060, Systems Deliverable 103] which describes the personnel responsible for Systems risk management and their lines of communication, the processes and procedures to be used for risk identification, risk analysis, risk evaluation, risk mitigation, and risk monitoring, and which also describes how Project Co will record and track its risk management activities from commencement of the Systems Project Work through Substantial Completion.
- (b) The Systems Risk Management Plan [Systems Deliverable 009, Systems Deliverable 026, Systems Deliverable 060, Systems Deliverable 103] shall comply with the requirements of the Systems Management Plan [Systems Deliverable 007].
- (c) Project Co shall submit the Systems Risk Management Plan [Systems Deliverable 009, Systems Deliverable 026, Systems Deliverable 060, Systems Deliverable 103] in accordance with Section 1.19 [Systems Documentation Deliverables].
- (d) Project Co shall convene a formal risk management workshop approximately fifteen (15) Business Days after the initial submittal of the Systems Risk Management Plan [Systems Deliverable 009], to review the plan and to systematically identify additional risks and relevant control measures. Project Co will invite TransLink and BCRTC to attend the workshop, and the Province may invite other parties to attend the workshop.
- (e) The Systems Risk Management Plan [Systems Deliverable 009, Systems Deliverable 026, Systems Deliverable 060, Systems Deliverable 103] shall be updated and resubmitted by Project Co as part of the Systems Concept Design Review Package [Systems Deliverable 024], the Systems Preliminary Design Review Package [Systems Deliverable 058] and the Systems Final Design Review Package [Systems Deliverable 101].
- (f) Project Co shall provide status updates on Systems risks in monthly progress reports.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 42 -

1.10 Electromagnetic Compatibility

1.10.1 General

- (a) All equipment installed by Project Co shall be electromagnetically compatible with the Greater Vancouver environment.
- (b) Equipment shall not produce electromagnetic emissions, whether conducted, radiated, or induced, which in any way interferes with the normal operation of any other equipment, or with electromagnetic devices or equipment within or adjacent to the BSP.
- (c) All equipment installed by Project Co shall be correctly packaged, shielded and placed to minimise susceptibility to electromagnetic emissions, including radio frequency emissions, whether generated by device or equipment within the BSP system or within the surrounding environment.
- (d) Project Co shall ensure the Systems Equipment operates correctly and reliably within the BSP operating electromagnetic environment and shall not themselves adversely affect adjacent infrastructure or systems.
- (e) The operating electromagnetic environment, considering both emissions and immunity, of the BSP shall include the following:
 - (i) close proximity to high voltage electricity transmission cables and overhead transmission lines;
 - (ii) occurrences of lightning activity;
 - (iii) close proximity to commercial radio and television transmission and reception equipment;
 - (iv) close proximity of industrial radio transmission and communication equipment;
 - (v) operation adjacent to highway authority equipment;
 - (vi) fixed telecommunications equipment;
 - (vii) mobile communications equipment;
 - (viii) miscellaneous personal equipment such as portable electronics, heart pacemakers and medical devices;
 - (ix) close proximity to Vancouver General Hospital; and
 - (x) close proximity to Canada Line.

1.10.2 Electromagnetic Compatibility Study Report

- (a) Project Co shall define the standards appropriate to all equipment supplied to demonstrate compliance with Canadian electromagnetic compatibility legislation and interoperability with all other adjacent equipment.
- (b) Where such standards cannot be defined, Project Co shall as a minimum comply with EN 50121 Parts 1 to 4 and FCC Part 15 Class B.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 43 -

- (c) Project Co shall submit EMC compliance evidence, to the satisfaction of the Province, for all Systems Equipment that does not have a proven performance history on the Existing SkyTrain System.
- (d) Project Co shall prepare an EMC Study Report [Systems Deliverable 015] to demonstrate System compatibility with standards and compatibility at the interface with other parties, for example with Vancouver General Hospital, Canada Line or Utilities.
- (e) Where no EMC compliance information exists, Project Co shall conduct EMC tests on the individual items of equipment prior to its installation.
- (f) All EMC tests shall be performed in an accredited EMC testing laboratory, or on the Project Site by a qualified, independent EMC testing organization, unless otherwise agreed to by the Province in accordance with the Consent Procedure.
- (g) Project Co shall submit Test Reports [Systems Deliverable 142] for all EMC tests performed.
- (h) Project Co shall demonstrate using Test Reports [Systems Deliverable 142] and equipment compliance reports that the System as installed is compatible with the electromagnetic environment and meets the required standards.
- (i) Project Co shall prepare and submit an overall EMC Study Report [Systems Deliverable 015] summarising the electromagnetic compatibility work performed and evidence collected demonstrating formal electromagnetic compatibility compliance.

1.10.3 Electromagnetic Compatibility Control Plan

- (a) Project Co shall prepare and submit an EMC Control Plan [Systems Deliverable 014]. The plan shall contain the following, including:
 - (i) Project Co capabilities with handling EMC related matters on previous projects;
 - (ii) interference emissions and susceptibility requirements and rationale for selection, including applicable support computations;
 - (iii) design techniques to reduce interference coupling;
 - (iv) safe grounding protection requirements for personnel and equipment;
 - (v) electromagnetic compatibility evaluation and analysis;
 - (vi) problem area definition and correction recommendation, if applicable;
 - (vii) compliance verification requirements for operational components and associated testing equipment;
 - (viii) critical compatibility demonstration requirements including critical circuit definition and success criteria;
 - (ix) procedures for configuration control; and
 - (x) schedule for executing the EMC Control Plan [Systems Deliverable 014].

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 44 -

1.10.4 Electromagnetic Compatibility Control Report

- (a) Project Co shall prepare, submit and keep up to date an EMC Control Report [Systems Deliverable 031, Systems Deliverable 067, Systems Deliverable 149]. The report shall include:
 - (i) the known external systems and equipment, which exist within the BSP operating area that could pose a threat to the reliable and safe operation of the line;
 - (ii) the known external systems and equipment, which exist within the BSP operating area that could be threatened by the operation of the line;
 - (iii) the known electromagnetic threats and hazards between systems, sub-systems and equipment;
 - (iv) the standards, design and development criteria and design strategies that shall be used to manage the threats to and from the adjacent systems, sub-system and equipment;
 - (v) the tasks to verify that the standards, design criteria, and design strategies have been achieved at system, sub-system and equipment levels including verification of electromagnetic compatibility requirements;
 - (vi) the tasks to validate that actions taken have successfully resulted in an EMC compliant BSP, both from a system operability perspective and compatibility with external systems and equipment, including validation of electromagnetic compatibility requirements;
 - (vii) the need for an interface compatibility verification where compliance to standards may not completely provide the evidence of electromagnetic compatibility;
 - (viii) the EMC documentation produced;
 - (ix) the management organisation and resources to control, plan and implement the EMC activities, including control of external parties such as accredited test houses; and
 - (x) the liaison activities with third parties, such as Transit Operators and Vancouver General Hospital, to gather necessary information to gain agreement on the adequacy of the electromagnetic compatibility performance of the BSP.

1.11 Cyber Security

- (a) BCRTC has adopted and is currently implementing the APTA standard recommendations relating to "Cyber Security Consideration for Public Transit" and NIST guidance on "Framework for Improving Critical Infrastructure Cyber Security".
- (b) Project Co shall maintain existing levels of cyber security integrity in all Project Work associated with the BSP through coordination with TransLink and BCRTC and compliance with SkyTrain cyber security policies and procedures.
- (c) Project Co shall secure all Systems to minimise cyber security risks during installation, testing and commissioning by methods that include:
 - (i) locate equipment in secure rooms protected by security cards access allowing access only to authorised staff;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 45 -

- (ii) disable and lock down all communication ports and functionality not required for operations;
 - (iii) comply with SkyTrain usernames and passwords procedures;
 - (iv) do not connect to an internet service provider either wired or wireless unless authorised. Where remote access is authorised then comply with SkyTrain procedures;
 - (v) install and configure internet security and anti-virus protection software, keep up to date and deploy patches in a timely manner;
 - (vi) do not connect workstations unless authorised;
 - (vii) comply with SkyTrain network segmentation, firewall and DMZ rules;
 - (viii) do not set up wireless networks unless authorised;
 - (ix) actively monitor and report any intrusions detected;
 - (x) conduct training and awareness programs to increase vigilance of staff;
 - (xi) conduct an audit at least every month;
 - (xii) include cyber security considerations within change control management procedures; and
 - (xiii) establish a cyber security incident response plan.
- (d) This list of methods used to minimise security risks is not definitive and shall be added to by Project Co once the Cyber Security Risk Assessment [Systems Deliverable 065] has been completed.
- (e) Project Co shall submit, as a condition of Substantial Completion, a BSP Systems Cyber Security Baseline Report [Systems Deliverable 157] documenting all security features and precautions incorporated into the Project Work.
- (f) This BSP Systems Cyber Security Baseline Report [Systems Deliverable 157] shall be confidential and only made available to authorised cyber security staff as designated by the Province from time to time.

1.12 Maintainability

- (a) In this section 1.12 maintainability shall be defined as the ability to perform maintenance to restore Systems and Equipment to a condition suitable to perform its required function and performance under stated conditions of use using prescribed procedures and resources.
- (b) Project Co shall design and construct the Systems and the Equipment in accordance with the following maintainability principles:
- (i) ease of defect identification;
 - (ii) ease of defect repair, including cleaning, adjustment or replacement;
 - (iii) ease of verification activities, including inspection, testing, measuring or analysis;
 - (iv) ease of restoration through remote diagnostics, access and control;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 46 -

- (v) ease of safe equipment access, including space for equipment removal/replacement plus access for tools, hand, arm, head and body;
- (vi) maximising the equipment operational life;
- (vii) maximising the equipment reliability and availability;
- (viii) improving from lessons learnt by BCRTC and within the transit industry;
- (ix) minimising the time to repair;
- (x) optimising the spare part quantities;
- (xi) maximising the reuse of the same or better components than used on the Existing Millennium Line;
- (xii) optimising the maintenance staff resourcing; and
- (xiii) any electronic equipment such as ATC remote loop boxes and radio/cell bidirectional amplifiers that are required to be located in Underground Guideway sections between Stations shall be located in a cross-passage, where possible.

1.12.1 Preventative Maintenance

- (a) Project Co shall provide a Preventative Maintenance Plan [Systems Deliverable 085] that recommends preventative maintenance schedules, comparable to the Existing SkyTrain System, procedures and service data tools to ensure Equipment remains safe, available, functional and continues to maintain its performance criteria.
- (b) The Preventative Maintenance Plan [Systems Deliverable 085] and procedures shall be submitted at or before the appropriate Final Design Review.
- (c) The Preventative Maintenance Plan [Systems Deliverable 085] and procedures shall support and be coordinated with the MTBFs for the Systems and the Equipment outlined in the RAM Program Plan [Systems Deliverable 004].

1.12.2 Corrective Maintenance

- (a) Project Co shall provide a Corrective Maintenance Plan [Systems Deliverable 063] that recommends corrective maintenance procedures, methods and service data tools to repair or replace each of the potentially defective items of Equipment and restore the Systems to their performance criteria.
- (b) The Corrective Maintenance Plan [Systems Deliverable 063] and procedures shall be submitted at or before the appropriate Final Design Review.
- (c) The Corrective Maintenance Plan [Systems Deliverable 063] and procedures shall support and be coordinated with the MTTRs for the Systems and the Equipment outlined in the RAM Program Plan [Systems Deliverable 004].
- (d) The corrective maintenance procedure for each item of Equipment shall explain:

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 47 -

- (i) how defects will become apparent to the operator and maintainer;
 - (ii) how rectification of defects is achieved; and
 - (iii) where the equipment repair will be performed.
- (e) Locations where equipment repair will be performed are:
- (i) first line at site;
 - (ii) second line at OMC;
 - (iii) third line return to supplier; or
 - (iv) dispose and replace.
- (f) Project Co shall conduct a maintainability demonstration to show that each item of the Equipment can be diagnosed and repaired or replaced within the allocated repair time.
- (g) Where it would be unreasonable due to size, weight or criticality to show replacement of the item of equipment, the maintainability demonstration shall consist of a formal site-based workshop and evaluation of corrective maintenance procedures, methods and tools by knowledgeable design, construction and maintenance personnel.

1.12.3 Predictive Maintenance

- (a) Project Co shall provide service data tools for continuously monitoring Equipment performance to allow analysis of historical trends to support prediction of defects before they occur.

1.12.4 Service Data Tools

- (a) Project Co shall provide Equipment maintenance service data tools to:
- (i) provide real time indication of operational status;
 - (ii) provide ongoing diagnostic data to identify defects and support condition-based maintenance; and
 - (iii) provide continuous detailed diagnostic data to identify systematic defects and support predictive maintenance.
- (b) Project Co shall demonstrate that the service tools are capable of, and do collect and pass service tool data, to SkyTrain's data centre for analysis, maintenance action and asset management.

1.12.5 Equipment Maintainability Guidelines

- (a) Project Co shall incorporate the following requirements into the Equipment Design and Construction:
- (i) standardise design and selection of equipment;
 - (ii) modular approach;
 - (iii) repair before disposal;
 - (iv) second line repair preferred;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 48 -

- (v) keep it simple, testable and self-revealing;
- (vi) maximise reliability of equipment that is difficult to repair or replace;
- (vii) minimise maintenance frequency and scope consistent with equipment performance criteria;
- (viii) include labeling covering warnings, equipment identification and instructions;
- (ix) use isolation to ensure equipment can be safely maintained;
- (x) avoid use of special tools;
- (xi) removal of working equipment shall not be required to gain access to defective item;
- (xii) maintainable equipment shall not be permanently fixed in place;
- (xiii) minimise use of proprietary equipment;
- (xiv) minimise orientation confusion when replacing equipment;
- (xv) include self-test and diagnostics service tools;
- (xvi) minimise use of fixings or covers that can be lost easily, make use of brackets, hangers and clasps;
- (xvii) ideally locate repairable equipment between waist and chest height;
- (xviii) ensure access hatches and door may be fully opened through 180 degrees and secured in the open position;
- (xix) position frequently maintained items in easy to access locations;
- (xx) include task lighting in locations where ambient lighting is poor;
- (xxi) include hinges, slides, and runners with travel stops to support larger/heavier items of equipment, no lifting shall be required;
- (xxii) where heavy equipment may require replacement, lifting eyes, grab handles, hoisting points and guide-ways shall be incorporated into the surrounding building;
- (xxiii) identify a route for heavy and large equipment to be taken to street or track level for vehicular access;
- (xxiv) do not use “select of test”, “made to measure” or “pre-set” items;
- (xxv) ensure connectors and boards mate easily and accurately;
- (xxvi) ensure ease of access to cable terminations, disconnection points, and interface locations;
- (xxvii) provide minimum 10% spare capacity in all cables, termination equipment, ports, and I/O;
- (xxviii) ensure cable termination frames are similar in construction and layout to those used on the Evergreen Line; and

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 49 -

(xxix) keep processing and communications utilisation below 30% on average during normal operations.

1.12.6 Room Access Guidelines

(a) Project Co shall design and construct the following rooms and areas for ease of Equipment access for maintenance and repair:

- (i) SCR and EER;
- (ii) ACER, TR and UPS rooms;
- (iii) RR, ECOMM and CTRM;
- (iv) PPS;
- (v) AARU area;
- (vi) elevator and escalator rooms;
- (vii) MECH and sump rooms; and
- (viii) TVFR and TVCR.

(b) These rooms shall include the following access features:

- (i) sufficient space and appropriate access around equipment whether floor, wall or roof mounted to gain access for maintenance, repair and replacement;
- (ii) door size commensurate with the replacement of the largest/heaviest item of equipment (fire rated removable access panels may also be used);
- (iii) lifting, moving and jacking locations;
- (iv) clear route to street or track for equipment replacement;
- (v) there shall be no confined spaces;
- (vi) hoist beams shall be provided above equipment or components of equipment that are too large or are too heavy to lift; and
- (vii) access platform shall be provided where required.

(c) Project Co shall size any EER of the BSP to accommodate two future additional full size 19-inch racks.

1.12.7 Wayside Access Guidelines

(a) Project Co shall Design and Construct equipment located on the wayside for ease of maintenance, repair and replacement in accordance with the following:

- (i) Equipment shall be located adjacent to, but not obstruct walkways;
- (ii) inbound and outbound walkways shall connect at crossover locations;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 50 -

- (iii) steps and harness connection points shall be included to access high level equipment;
- (iv) equipment at track level shall be minimised;
- (v) track level equipment shall include working space, lighting, and hinged walkway where needed;
- (vi) power rail covers shall be provided adjacent to areas where maintenance access is necessary; and
- (vii) task lighting shall be provided.

1.12.8 Station Access Guidelines

- (a) Project Co shall design and construct equipment located in the station public and non-public area for ease of maintenance, repair and replacement in accordance with the following:
 - (i) high level, roof and ceiling mounted equipment shall only be located where maintenance staff lifting devices can be positioned and used safely;
 - (ii) removable panels shall be provided to access equipment located behind ceilings or cladding; and
 - (iii) external roof mounted equipment such as radio antennas shall include safe access routes, climbing and harness connection points.

1.13 Verification and Validation Testing

- (a) Project Co shall be responsible for undertaking and passing all necessary testing activities for the Systems, including all materials (including Spare Parts) furnished and all Project Work performed under these Systems General Requirements.
- (b) Project Co shall demonstrate to the satisfaction of TransLink that the Systems are in a state of operational readiness.
- (c) Project Co shall develop, organise, and implement test and commissioning plans that verify that the Systems meet all performance, safety, reliability, system assurance, and functional requirements set out in this Agreement.
- (d) Project Co shall ensure that factory inspections and tests are performed and deliverables are not shipped until all required factory inspections and tests have been successfully completed and all deficiencies corrected.
- (e) Project Co shall further ensure that Project Site testing confirms that the Systems have been properly installed, adjusted and satisfy all performance, safety, reliability, system assurance, and functional requirements set out in this Agreement.
- (f) All factory tests and Project Site tests shall be undertaken as part of the Project Work.
- (g) Prior to the start of a test, Project Co shall submit all test plans and procedures for the applicable test.
- (h) Prior to the start of a test, Project Co shall ensure that all relevant prerequisite testing has been completed.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 51 -

- (i) Project Co shall ensure all inspection and testing is undertaken in compliance with the requirements specified in ISO-9001, clauses 4.10 [Inspection and Testing] and 4.11 [Control of Inspection Measuring and Test Equipment].

1.13.1 Test and Commissioning Strategy and Plans

- (a) Project Co shall develop and implement a testing and commissioning strategy for the Systems and testing and commissioning plans.
- (b) Project Co shall support all applications to TSBC required for the movement of Trains on the BSP for inspection, testing, and operations purposes.
- (c) Project Co shall coordinate directly with the relevant applicant and with TSBC as required to satisfy this requirement.
- (d) Project Co shall ensure that each element of the Project Work shall be, wherever possible, thoroughly tested and commissioned as a standalone subsystem operating in simulated worst-case environments prior to being placed into service unless the Equipment or system is service-proven on the Existing SkyTrain System. Project Co shall demonstrate this through qualification testing, FAI, FAT or SAT, whichever is applicable.

1.13.2 Verification and Validation Deliverables

- (a) Project Co shall submit test documentation for the Systems, including the following:
 - (i) Validation, Inspection, and Test Plan [Systems Deliverable 105, Systems Deliverable 131];
 - (ii) Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121];
 - (iii) Safety Commissioning Test Plan [Systems Deliverable 119];
 - (iv) 90-Day Look Ahead Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 133];
 - (v) Test Procedures [Systems Deliverable 126];
 - (vi) Test Reports [Systems Deliverable 142];
 - (vii) Failure Reporting Analysis and Corrective Action System Report [Systems Deliverable 150];
 - (viii) 30-Day Look Ahead Test Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 132];
 - (ix) System Commissioning Plan [Systems Deliverable 122]
 - (x) Commissioning Safety Plan [Systems Deliverable 111]
 - (xi) Test and Commissioning Rules and Procedures [Systems Deliverable 125]
 - (xii) Commissioning Monthly Report [Systems Deliverable 129]; and,

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 52 -

- (xiii) two spare copies of the applicable Test Procedures [Systems Deliverable 126] upon request on the day of the test.
- (b) The 90-Day Look Ahead Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 133] shall detail all of the commissioning and safety test activities as well as the TransLink Resources and Vehicle requirements.
- (c) The first 90-Day Look Ahead Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 133] shall be submitted at least 60 Business Days prior to the first scheduled test.
- (d) A revised 90-Day Look Ahead Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 133] shall be submitted periodically to the Province's Representative as required by the Province's Representative.
- (e) 30-Day Look Ahead Test Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 132] for all commissioning and safety commissioning activities, with each day's activities and TransLink Resources and Vehicle requirements identified, shall be submitted no less than 20 Business Days prior to the start of commissioning of any Systems.
- (f) The 30-Day Look Ahead Test Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 132] shall be updated and submitted on a weekly basis under the Review Procedure.
- (g) Project Co shall develop a Look Ahead Schedules database that contains the deliverables and information listed in this Section 1.13.2 [Verification and Validation Deliverables] of Appendix G [Systems General Requirements].
- (h) Project Co shall provide the Province with access, via the Internet, to the look ahead schedules, test procedures and the associated databases to identify activities and resource needs, and provide the capability for the Province to identify the Province's requirements for witnessing the execution of specific tests. Project Co shall provide the Province with access for a minimum of six users, via the Internet, to Project Co's look ahead schedules, test procedures and the associated databases.
- (i) The 30-Day Look Ahead Test Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 132] shall include an attribute to allow the schedule to be filtered on safety test activities only.
- (j) The 90-Day Look Ahead Schedule Detailing Commissioning and Safety Test Activities [Systems Deliverable 133] shall include an attribute to allow the schedule to be filtered on safety test activities only.

1.13.3 Systems Commissioning Plan

- (a) Project Co shall plan, schedule, coordinate and execute the testing and commissioning of the Project Work to successfully demonstrate the performance of the BSP as part of the Integrated SkyTrain System, in accordance with this Agreement and to the satisfaction of the Province.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 53 -

- (b) The scope of Project Co's testing and commissioning phase shall include all testing on the Project Site and inspection of components, subsystems, and Systems from the completion of installation, through PICO, SAT, System Integration Test and Trial Running.
- (c) Project Co shall be responsible for all operations and maintenance activities on the Project Site throughout this testing and commissioning phase.
- (d) Project Co is solely responsible for all validation and verification activities relating to the Project Work. With the exception of the obligation to supply Vehicles, Train drivers and Control Operators, as reasonably required for Commissioning, the Province accepts no responsibility for Commissioning of the Project Work.
- (e) Project Co shall create a schedule of commissioning activities and shall incorporate these activities into the Project Schedule.
- (f) Project Co shall submit the Commissioning Monthly Report [Systems Deliverable 129] to document the progress of commissioning activities, in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].
- (g) The Commissioning Director shall chair monthly meetings to review progress of commissioning activities. These meetings shall commence no later than four calendar months prior to the first Systems field test readiness review as defined in Section 1.16 [Systems Field Test Readiness Reviews]. The meetings will be attended by representatives of Project Co, their subcontractors (as required), the Province, TransLink and BCRTC.
- (h) The Systems Commissioning Plan [Systems Deliverable 122] shall include the following:
 - (i) the relationship of Project Co's commissioning team to safety and security management and other related System safety and security requirements;
 - (ii) resumes of key personnel involved detailing years of relevant commissioning experience;
 - (iii) organization chart of the testing and commissioning team, including the operations and maintenance team, and their discipline responsibilities;
 - (iv) planned resources, including an estimate and schedule of TransLink Resources required to support the commissioning phase;
 - (v) specific requirements for interfaces and coordination with the Province and TransLink;
 - (vi) progress reporting strategy including metrics to be used to quantitatively demonstrate commissioning progress;
 - (vii) testing regime, test documentation and review procedures;
 - (viii) procedures for configuration control and documentation management during the commissioning phase;
 - (ix) schedule and format of planned test readiness reviews in accordance with Section 1.16 [Systems Field Test Readiness Reviews]; and

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 54 -

(x) scheduling of the testing and commissioning activities.

1.13.4 Commissioning Safety Plan

- (a) Project Co shall submit a Commissioning Safety Plan [Systems Deliverable 111] which identifies the roles, responsibilities, procedures and processes to manage site safety during the commissioning phase.
- (b) The Commissioning Safety Plan [Systems Deliverable 111] shall include, but not be limited to, the following:
 - (i) the safety organization of the commissioning team;
 - (ii) the plan to identify and mitigate site safety hazards introduced during the commissioning phase, such as Train movements and traction power energization;
 - (iii) the plan to identify and mitigate system safety hazards introduced during the commissioning phase, such as during the staged testing of safety systems;
 - (iv) site access procedures;
 - (v) test and commissioning safety training;
 - (vi) emergency response plan;
 - (vii) incident notification and investigation; and
 - (viii) the process to coordinate operational safety rules and procedures with TransLink.
- (c) Project Co shall submit the Commissioning Safety Plan [Systems Deliverable 111] in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].

1.13.5 Test and Commissioning Rules and Procedures

- (a) Project Co shall submit operational rules and procedures to be employed during the commissioning phase.
- (b) The Test and Commissioning Rules and Procedures [Systems Deliverable 125] shall be based on Existing SkyTrain System operational rules and procedures as adapted for the commissioning phase.
- (c) Project Co shall submit the Test and Commissioning Rules and Procedures [Systems Deliverable 125] in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].

1.14 Systems Test Documentation

1.14.1 Validation, Inspection, and Test Plan

- (a) Project Co shall develop and implement a Validation, Inspection, and Test Plan [Systems Deliverable 105, Systems Deliverable 131].
- (b) The Validation, Inspection, and Test Plan [Systems Deliverable 105, Systems Deliverable 131] shall describe Project Co's overall strategy for the verification, validation, inspection, and test

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 55 -

processes for the Systems, including the responsibilities of individuals and the documentation of the verification and validation test results.

- (c) The Validation, Inspection, and Test Plan [Systems Deliverable 105, Systems Deliverable 131] shall include the following items:
- (i) a flow diagram, indicating the logical sequence of verification, validation, inspections and tests, starting with requirements verification, progressing through design verification, material receiving tests and inspections, testing on the Project Site, and concluding with the System Performance Demonstration [Systems Deliverable 141] (See Article 13 [Systems]);
 - (ii) verification, validation, inspection, and test schedule;
 - (iii) responsibilities of Project Co;
 - (iv) record-keeping assignments, procedures, and forms;
 - (v) procedures for performing verification and validation;
 - (vi) procedures for monitoring, correcting, and re-testing deficiencies;
 - (vii) minimum qualifications of persons authorised to certify Test Reports [Systems Deliverable 142];
 - (viii) procedures for controlling and documenting all changes made to the Systems and software after the start of testing; and
 - (ix) description of approach to managing the required TransLink Resources and Vehicles.
- (d) The Validation, Inspection, and Test Plan [Systems Deliverable 105, Systems Deliverable 131] shall be submitted in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].
- (e) The Validation, Inspection, and Test Plan [Systems Deliverable 105, Systems Deliverable 131] shall demonstrate that Project Co has considered all of the testing requirements in the Agreement and has made adequate provisions for testing in the Works Schedule.

1.14.2 Systems and Subsystem Test Plans

- (a) Project Co shall develop and implement Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121] for the overall BSP as well as each discipline and element of the Systems.
- (b) The Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121] shall include the relevant test processes and documentation for each test.
- (c) The Systems and Subsystems Tests shall demonstrate that Project Co has supplied complete, safe and operable Systems for the BSP.
- (d) The Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121] shall include the following:
 - (i) list of tests to be performed and the test schedule;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 56 -

- (ii) responsibilities of Project Co;
 - (iii) block diagrams of the hardware test configuration including external data transmission interfaces, and detailed descriptions of any and all test and / or simulation equipment;
 - (iv) estimated duration of each test;
 - (v) the required TransLink Resources and Vehicles, including the type and length of Train;
 - (vi) relevant prerequisites for the tests; and
 - (vii) calibration and its traceability to known standards of hardware, software, simulation tools and test equipment to be used for testing.
- (e) Project Co shall incorporate any additional tests to demonstrate specific requirements that the Province may identify.
- (f) The Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121] for each subsystem shall be submitted in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].
- (g) The Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121] shall include a listing of the tests required demonstrating compliance that the Systems meet all functional, safety, and performance requirements under this Agreement.

1.14.3 Safety Commissioning Test Plan

- (a) Project Co shall develop and implement a Safety Commissioning Test Plan [Systems Deliverable 119].
- (b) The Safety Commissioning Test Plan [Systems Deliverable 119] shall demonstrate how the safety requirements will be verified as compliant.
- (c) The Safety Commissioning Test Plan [Systems Deliverable 119] shall describe Project Co's overall commissioning test process for the Systems and documentation of the commissioning test results.
- (d) The Safety Commissioning Test Plan [Systems Deliverable 119] shall include the following:
- (i) commissioning test schedule;
 - (ii) safety test schedule;
 - (iii) responsibilities of Project Co;
 - (iv) record-keeping assignments, procedures, and forms;
 - (v) procedures for monitoring, correcting, and re-testing deficiencies;
 - (vi) procedures for controlling and documenting all changes made to the hardware and software after the start of testing; and
 - (vii) the required TransLink Resources and Vehicles, including the type and length of Train.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 57 -

- (e) The safety test schedule shall also be delivered by Project Co to TSBC.
- (f) The Safety Commissioning Test Plan [Systems Deliverable 119] shall include a listing of the tests required to fully demonstrate that the BSP satisfies the safety requirements while operating under actual service conditions.
- (g) The Safety Commissioning Test Plan [Systems Deliverable 119] shall be submitted by Project Co to both TSBC and to the Province's Representative in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].

1.14.4 Test Procedures

- (a) Project Co shall develop and implement Test Procedures [Systems Deliverable 126] which describe individual test cases and the steps comprising each case.
- (b) The Test Procedures [Systems Deliverable 126] shall include:
 - (i) the objective of the test;
 - (ii) for each test case, the requirement(s) to be demonstrated and verified;
 - (iii) whether the test demonstrates a safety requirement;
 - (iv) the required setup and conditions for each test case, including descriptions of the test equipment and data to be supplied by Project Co;
 - (v) descriptions, listings, and instructions, for all test software tools and displays;
 - (vi) step-by-step descriptions of each test case, including the inputs and user actions for each test step;
 - (vii) the expected results for each test case including the pass/fail criteria; and
 - (viii) descriptions of the techniques and scenarios to be used to simulate system field inputs and controlled equipment.
- (c) Test Procedures [Systems Deliverable 126] shall be submitted in accordance with the submission schedule in Section 1.19.6 [Testing and Verification Readiness Submissions].

1.14.5 Test Reports

- (a) Project Co shall prepare, maintain and submit complete Test Reports [Systems Deliverable 142] of all factory and Project Site test results obtained during performance of test procedures.
- (b) Any Test Reports [Systems Deliverable 142] that demonstrate safety requirements shall be delivered to both TSBC and the Province's Representative.
- (c) The Test Reports [Systems Deliverable 142] shall include the following:
 - (i) reference to the corresponding test procedure;
 - (ii) date the test procedure was performed;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 58 -

- (iii) description of any test conditions, input data, or user actions differing from that described in the test procedure;
 - (iv) results for each test case including a passed/failed indication;
 - (v) identification of Project Co's tester;
 - (vi) reference to any test results requiring action as stated in this document;
 - (vii) copies of reports, display copies, and any other hard or soft copy generated as a result of the execution of the test procedure; and
 - (viii) configuration data that fully describes the equipment and software that was tested, including software version and build numbers / identifiers for every software module.
- (d) Test Reports [Systems Deliverable 142] shall contain the results of all tests conducted at any factory or field location.
- (e) All verification and validation Test Reports [Systems Deliverable 142] shall be certified and signed by an approved member of Project Co's staff.

1.14.6 Failure Reporting, Analysis, and Corrective Action System

- (a) Project Co shall, during the periods of field testing, demonstration, and warranty, establish and maintain a closed-loop Failure Reporting, Analysis, and Corrective Action System to determine the cause of all test failures, unscheduled part removals, and other deficiencies related to the Systems.
- (b) Project Co shall, on a monthly basis, prepare and submit, in a searchable PDF format, a Failure Reporting Analysis and Corrective Action System Report [Systems Deliverable 150] which documents the results of the Failure Reporting, Analysis and Corrective Action System.
- (c) The Failure Reporting Analysis and Corrective Action System Report [Systems Deliverable 150] shall include the following:
 - (i) failure reports for any items that fail any test conducted under this Agreement or which are otherwise determined to have failed;
 - (ii) deficiency reports;
 - (iii) identification of the extent of required regression testing; and
 - (iv) Project Co's systematic evaluation of the failure reporting data to identify and monitor failure trends, such as no-trouble-found incidents and new failure effects.
- (d) The Province's Representative shall also have access, via the Internet, to the failure reporting system and its databases to both review and comment upon deficiency reports.
- (e) Project Co shall provide the Province with access for a minimum of six users, via the Internet, to Project Co's Failure Reporting, Analysis, and Corrective Action database.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 59 -

- (f) The Failure Reporting, Analysis and Corrective Action System shall be closed and all outstanding items consolidated onto the Final Deficiency List [Systems Deliverable 134] prior to Substantial Completion.

1.14.7 Authorization to Move Trains and Commissioning

- (a) Project Co shall provide to TSBC and the Province's Representative all documentation, records, test results or other material directly related to the Design and Construction of the Project that is required to allow:
 - (i) the movement of Trains on the BSP;
 - (ii) the testing of Train operation between the BSP and the Existing SkyTrain System;
 - (iii) Trial Running involving the movement of Trains on the Operational Millennium Line. During Trial Running, passengers will exit all inbound Trains arriving at VC and will not be permitted to travel on the BSP; and
 - (iv) TransLink to make application for the modification to the existing Operating Permit to allow Service Commencement and the carrying of passengers on the Operational Millennium Line.
- (b) Project Co shall ensure that the documentation, records, test results and all other related material are included as part of the following deliverables:
 - (i) Documentation Package to Allow the Movement of Trains on the BSP [Systems Deliverable 113]; and the
 - (ii) Documentation Package to Allow for Testing of Train Operation Between the BSP and the Existing SkyTrain System [Systems Deliverable 112].

1.15 End-Product Audits

- (a) The Province's Representative may, at its discretion with at least 3 weeks notice to Project Co, require that Project Co undertake end-product audits of the Systems components, including new upgrades to equipment on the Existing SkyTrain System during the integration and test phase of the Project, to demonstrate and confirm that:
 - (i) end product verification is compliant with all requirements and that product verification outcomes compare favourably against configuration documentation (including drawings, test procedures, authorised changes, software development files, as-built/as-coded documentation); and
 - (ii) the as-built/as-coded configuration has been favourably examined against its configuration documentation (including drawings, bills of material, specifications, code lists, manuals, compliance test and compliance data).

1.16 Systems Field Test Readiness Reviews

- (a) Project Co shall provide Systems Field Test Readiness Review Packages [Systems Deliverable 123] prior to the activation of any Systems Equipment in the field.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 60 -

- (b) The readiness reviews shall, during the commissioning phase of the Project, demonstrate that delivered end products from lower level systems have been validated, that validation tests are adequately planned, and that each set of integrated products forming a composite end product is ready for end product verification and validation.
- (c) Project Co shall support readiness reviews with the appropriate personnel, documentation, and other resources.
- (d) The readiness reviews shall demonstrate that the prerequisite installation activities are complete and the relevant completion evidence, including but not limited to relevant PICO test results, have been accepted by the Province.
- (e) Project Co shall submit a review package for the first of the Systems Field Test Readiness Review Packages [Systems Deliverable 123] at least 30 Business Days prior to the first Systems field test readiness review to demonstrate that all the prerequisites of the commissioning phase have been addressed to the satisfaction of the Province. This first Systems Field Test Readiness Review Package [Systems Deliverable 123] shall include the relevant PICO test procedures, but may exclude the related PICO test results.
- (f) Project Co shall submit the second and subsequent Systems Field Test Readiness Review Packages [Systems Deliverable 123] at least 10 Business Days prior to the readiness review, and shall include both the relevant PICO test procedures, and PICO test results in the package.

1.17 Verification Testing

1.17.1 Systems Equipment Tests

- (a) Sample units of Systems Equipment and associated software from production shall be subjected to routine quality control inspections and testing by Project Co.
- (b) The Province's Representative shall be allowed access to witness testing at any facility where Systems Equipment or software is manufactured or developed.

1.17.2 First Article Inspection

- (a) A FAI shall be conducted by Project Co on the first production unit of any Systems Equipment prior to the first shipment from the factory to ensure the units are suitable in all respects for the purpose intended by Project Co.
- (b) The FAI testing undertaken by Project Co shall include the following, where applicable:
 - (i) electrical and mechanical construction testing;
 - (ii) vibration and impact resistance testing;
 - (iii) temperature and humidity testing;
 - (iv) functionality, performance, and timing testing;
 - (v) accelerated life testing; and
 - (vi) EMC testing.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 61 -

- (c) Any Systems Equipment that does not have a proven history on the Existing SkyTrain System shall be subject to qualification testing by Project Co.
- (d) The Province's Representative shall be allowed to monitor and review all qualification testing.
- (e) Project Co shall notify the Province's Representative in writing a minimum of 30 Business Days in advance of each test/inspection and include a detailed schedule of the applicable test.
- (f) Project Co shall list the planned qualification tests for all Systems Equipment in the appropriate subsystem test plan and provide evidence of pre-qualification for any Systems Equipment for which qualification tests are not planned.

1.17.3 Factory Acceptance Tests

- (a) Project Co shall undertake or cause to be undertaken factory acceptance tests (FAT) on all Systems Equipment, where appropriate and reasonably practicable, in a factory environment that is generally representative of the actual operating environment.
- (b) The FAT shall demonstrate that the items of the System under test are capable of performing in accordance with the technical requirements, prior to installation.
- (c) The Province's Representative shall be allowed to review and verify the functional implementation of the system software informally in conjunction with scheduled project meetings at Project Co's facilities.
- (d) Project Co shall notify the Province's Representative in writing a minimum of 30 Business Days in advance of each test/inspection and include a detailed schedule of the applicable test.
- (e) Upon completion of the testing, a FAT review shall be undertaken by Project Co and the Province's Representative to confirm that the System or subsystem under test is fit to be deployed and installed.

1.17.4 Post Installation Checkout (PICO) Tests

- (a) PICO testing shall be undertaken by Project Co on all Systems Equipment and software after it has been installed at the site where it will function after Service Commencement.
- (b) PICO testing shall be performed to demonstrate that all Systems Equipment and software functions properly in the installed environment.
- (c) All Systems Equipment shall be verified by Project Co against the installation drawings to verify correct installation and that the Systems Equipment has not been damaged subsequent to shipment from the factory.
- (d) The PICO testing undertaken by Project Co shall include a complete system inspection including but not limited to verification of proper installation, grounding, cabling, conformance to plans and drawings, and all local codes and standards, neatness, accessibility and confirmation of installed versions of the equipment and software comprising and related to the Systems.
- (e) All cables shall be tested for opens, shorts, grounds and high resistance.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 62 -

1.17.5 Site Acceptance Tests

- (a) Following the PICO testing, site acceptance tests shall be performed by Project Co on the installed Systems Equipment.
- (b) The site acceptance test procedures may include tests performed during the FAT, but shall also focus on those requirements which could not be verified during the FAT.
- (c) Site acceptance tests (SAT) shall be performed by Project Co to verify that the Systems Equipment and software has been properly installed and to demonstrate that the Systems Equipment satisfies all performance, safety, reliability, and functional requirements while communicating with a full complement of devices under actual operating conditions.
- (d) The proper operation and performance of all features and functions as documented in the Systems Test Plans [Systems Deliverable 124] and Subsystem Test Plans [Systems Deliverable 121] shall be verified by Project Co during performance of the site acceptance tests.
- (e) Test cases shall include variation of component configuration where necessary to confirm proper behaviour. Such variations shall include inductive loop crossover detection for the various VOBCs in the system (odd and even numbered VOBCs have different antenna arrangements and MK I and MK II detection algorithms differ).

1.17.6 Integrated System Testing

1.17.6.1 System Integration Tests

- (a) Upon successful completion of the site acceptance tests on two or more related subsystems, these subsystems shall be integrated together by Project Co to commence integrated system testing.
- (b) The System integration tests shall demonstrate inter-subsystem functionality and performance under normal, abnormal, and emergency scenarios.
- (c) System integration tests shall include evaluation of remediation options by Project Co and the Province in relation to aspects that include those of automatic train operation (ATO).
- (d) Remedial efforts include proposals for change, outlining associated impacts (e.g. travel time) and subsequent trial and implementation. Any remedial efforts that affect the automatic speed control shall include ensuring there is no regression in other areas of the Existing SkyTrain System.
- (e) Project Co shall prepare a Systems Cut-Over Plan [Systems Deliverable 057, Systems Deliverable 100] to document the steps by which subsystems and/or geographical areas of the Project Work will be sequentially incorporated into the System integration test program, ultimately building up to the full operational BSP.
- (f) Project Co shall demonstrate the functionality and performance of the BSP, including the interface with the Existing SkyTrain System, under normal, abnormal, and emergency scenarios.

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 63 -

1.17.6.2 Trial Running

- (a) Project Co shall conduct a Trial Running test to demonstrate that the BSP functions as part of the Integrated SkyTrain System, is capable of operating in accordance with the service plans and the Project Requirements, and is ready for Service Commencement.
- (b) Prior to the start of Trial Running, Project Co shall:
 - (i) prepare and submit to the Province's Representative and TSBC the Trial Running Test Plan and Procedure [Systems Deliverable 146];
 - (ii) successfully complete all construction and testing including system integration tests;
 - (iii) prepare and submit to the Province's Representative and TSBC the Trial Running Safety Memorandum [Systems Deliverable 145], which demonstrates that all identified hazards, including hazards only related to Trial Running, are controlled acceptably as defined in the Systems Safety Program Plan [Systems Deliverable 011] such that Trial Running can be safely carried out;
 - (iv) successfully complete a pre-Trial Running test readiness review with the Province's Representative, and any others specified by the Province's Representative, to confirm that the BSP is fit to commence Trial Running; and
 - (v) prepare and submit to the Province's Representative the Final Deficiency List [Systems Deliverable 134] in accordance with Part 3 of Schedule 4.
- (c) Trial Running will occur in three stages over a minimum period of 20 days.
- (d) Passengers shall not be carried on the BSP during Trial Running.
- (e) Project Co shall plan Trial Running activity so as to minimise the potential for delays or disruption to passengers on the Existing SkyTrain System.
- (f) Trial Running shall be carried out under BCRTC operating and access rules, policies and procedures.

1.17.6.2.1 Trial Running Committee

- (a) A trial running committee will be established for purposes of:
 - (i) conducting a test readiness review to determine when the Systems are ready to commence Trial Running;
 - (ii) evaluating the impact of residual deficiencies on the effectiveness of Trial Running;
 - (iii) monitoring Trial Running to ensure that objectives of the Trial Running Test Plan and Procedure [Systems Deliverable 146] are being met;
 - (iv) assisting the resolution of open issues and emergent problems;
 - (v) suspending or modifying Trial Running where warranted by the quantity or severity of deficiencies or safety issues, including determining whether Trial Running or any stage of Trial Running must be repeated;

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 64 -

- (vi) to conclude whether and when Trial Running objectives have been met, including any extension or repeat of Trial Running activities.
- (b) The trial running committee will consist of a representative from each of:
 - (i) Project Co;
 - (ii) the Province; and
 - (iii) BCRTC.
- (c) As appropriate, the trial running committee representatives may bring in additional technical or administrative personnel, but final trial running committee decisions will be made by the three designated representatives.

1.17.6.2.2 Trial Running Stage 1

- (a) Trial Running Stage 1 shall take place entirely within the BSP.
- (b) The scope of Trial Running Stage 1 is the exercise of systems and facilities on the BSP, representative of Normal Operation, with Trains operating between AR and the GN pocket track, stopping at all Stations in both directions.
- (c) Trial Running Stage 1 shall comprise a minimum of 80 hours of Train operation, over 5 days.

1.17.6.2.3 Trial Running Stage 2

- (a) Trial Running Stage 2 shall take place entirely within the BSP.
- (b) The scope of Trial Running Stage 2 is the exercise of systems and facilities of the BSP under a range of exceptional and failure operating conditions.
- (c) Trial Running Stage 2 shall comprise a minimum of 80 hours of Train operation, over 5 days, following successful completion of Trial Running Stage 1.

1.17.6.2.4 Trial Running Stage 3

- (a) Trial Running Stage 3 shall take place on the Operational Millennium Line over a minimum of 10 days following the successful completion of Trial Running Stage 2.
- (b) The scope of Trial Running Stage 3 is verification and demonstration of the readiness of the operational BSP for full operation within the Integrated SkyTrain System.
- (c) Trial Running Stage 3 shall comprise the operation of Trains extended from the Existing Millennium Line, as planned upon Service Commencement, with Trains normally operating on timetable between Lafarge Lake station and AR.
- (d) Trial Running Stage 3 shall operate for the full service day of the Existing SkyTrain System, for 10 days, including a minimum of 6 weekdays, one Saturday, and one Sunday/Holiday schedule.
- (e) During Trial Running Stage 3, the Project Co shall demonstrate either three consecutive days of operation using a regular weekday schedule, or four consecutive days of operation using two regular weekday schedule days and two weekend/holiday schedule days, with no more than 20 cumulative

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 65 -

Delay Minutes attributable to the BSP, calculated in accordance with the BCRTC Service Delay Allocation Methodology.

1.17.6.2.5 Trial Running Test Report

- (a) Once Trial Running has been completed, Project Co shall prepare and submit a Trial Running Test Report [Systems Deliverable 147] outlining the significant events of Trial Running, the data captured and the conclusions made.
- (b) For the purposes of this Section 1.17.6.2 [Trial Running Test Report], the 15 Business Day period referred to in Section 2.1(b) of Schedule 2 [Representatives, Review Procedure and Consent Procedure] shall be reduced to five calendar days.
- (c) Without limiting the generality of Article 4.1.1(a)(i) [Required Activities], Part 3 of Schedule 4, the documentation, records, test results and other material to be provided by Project Co under the said Article 4.1.1(a)(i) shall include the Trial Running Test Report [Systems Deliverable 147] to which there has been no objection by the Province's Representative, acting reasonably, under the Review Procedure.
- (d) Notwithstanding Article 4.1.2.5(a) [Inspection for Substantial Completion], Part 3 of Schedule 4, Project Co shall not be required to deliver the Trial Running Test Report [Systems Deliverable 147] as part of the documents to be provided to the Independent Certifier and the Province's Representative under the said Section 4.1.2.5.

1.17.7 Test Suspension

- (a) If, at any time during performance of any site acceptance tests or System integration tests, the Province's Representative believes that the quantity or severity of deficiencies or the inefficient usage of TransLink Resources warrants suspension of any or all testing, the test(s) shall be halted, remedial work performed, and the relevant test(s) repeated.
- (b) The repeat of a test shall be scheduled for a date and time agreed upon by both the Province's Representative and Project Co.

1.18 Systems Certification

- (a) Following Trial Running and prior to applying for Substantial Completion, Project Co shall submit the following to the Province's Representative:
 - (i) certification that each System is ready for the BSP to carry passengers, signed and sealed by the responsible Professional Engineers for each System; and
 - (ii) Systems Engineer of Record certification that the Integrated SkyTrain System to the extent within the scope of the Project Work is ready to carry passengers.

1.19 Systems Documentation Deliverables

- (a) The submissions required by this Appendix G have been summarised in the tables below. The tables in this Section 1.19 are not intended to be exhaustive of the submission requirements, including those set out in the technical requirements of Article 13 [Systems], Part 2 of Schedule 4, the requirements in

Schedule 4 Part 2 Article 21 [Guideway and Station Ventilation System] and this Appendix G [Systems General Requirements]. The tables identify submissions that Project Co is required to provide to TSBC, where applicable.

1.19.1 Systems Plan Deliverables

Table 1.19-1 Systems Plan Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Interface Management Plan	Systems Deliverable 001	Appendix G	At SCDR	N/A	Consent Procedure
O&M Training Plan	Systems Deliverable 002	Part 3, Article 3	In accordance with Part 3, Article 3	N/A	Consent Procedure
Preliminary Qualification and Test Plan Methodology	Systems Deliverable 003	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
RAM Program Plan	Systems Deliverable 004	Appendix G	In accordance with the Systems Assurance Plan	N/A	Consent Procedure
Requirements Verification Plan	Systems Deliverable 118	Appendix G	60 Business Days after the Effective Date	N/A	Consent Procedure
Safety Requirements Verification Plan	Systems Deliverable 120	Appendix G	In accordance with the Systems Management Plan	I	Consent Procedure
Spare Parts Plan	Systems Deliverable 005	Part 3, Article 3	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Assurance Plan	Systems Deliverable 006	Appendix G	60 Business Days after the Effective Date	N/A	Consent Procedure
Systems Management Plan	Systems Deliverable 007	Appendix G	60 Business Days after the Effective Date	N/A	Consent Procedure
Systems Plan	Systems Deliverable 008	Appendix G	30 Business Days after the Effective Date	N/A	Consent Procedure
Systems Risk Management Plan	Systems Deliverable 009	Appendix G	60 Business Days after the Effective Date	N/A	Consent Procedure
Systems Safety Certification Plan	Systems Deliverable 010	Appendix G	In accordance with the Systems Assurance Plan	I	Consent Procedure
Systems Safety Program Plan	Systems Deliverable 011	Appendix G	In accordance with the Systems Assurance Plan	I	Consent Procedure

Notes:

“T” – to Technical Safety BC for information

“N/A” – Not applicable

1.19.2 Systems Concept Design Review (SCDR) Deliverables

Table 1.19-2 Systems Concept Design Review (SCDR) Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Configuration Management Plan	Systems Deliverable 013	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
EMC Control Plan	Systems Deliverable 014	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
EMC Study Report	Systems Deliverable 015	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure
Hazard Log	Systems Deliverable 016	Appendix G, Part 2, Article 13	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Interface Hazard Analysis	Systems Deliverable 017	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Interface Management Plan	Systems Deliverable 018	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
One-Dimensional and Special Trackwork Design Basis Report	Systems Deliverable 028	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Consent Procedure
Operational and Support Hazard Analysis	Systems Deliverable 019	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Plan for Signage	Systems Deliverable 020	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Preliminary Hazard Analysis	Systems Deliverable 021	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Smoke Re-Circulation Design Basis Report	Systems Deliverable 029	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Consent Procedure
Station CFD Design Basis Report	Systems Deliverable 160	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Consent Procedure
System Performance and Failure Management Analysis Report	Systems Deliverable 023	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Concept Design Review Package	Systems Deliverable 024	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Concept Design Review Report	Systems Deliverable 025	Appendix G	Within 15 Business Days of the formal design review meeting	N/A	Review Procedure
Systems Risk Management Plan	Systems Deliverable 026	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Systems Software Design Management Plan	Systems Deliverable 027	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Overall TVS Description	Systems Deliverable 170	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Independent Safety Assessment Plan	Systems Deliverable 184	Appendix G	In accordance with the Systems Safety Program Plan	I	Consent Procedure

Notes:

“FR” – upon formal request by Technical Safety BC

“I” – to Technical Safety BC for information

“N/A” – Not applicable

1.19.3 Systems Preliminary Design Review (SPDR) Deliverables

BROADWAY SUBWAY PROJECT
PROJECT AGREEMENT
SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Commercial in Confidence
EXECUTION COPY

Table 1.19-3 Systems Preliminary Design Review (SPDR) Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Diamond Crossover Impact Report	Systems Deliverable 030	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
EMC Control Report	Systems Deliverable 031	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure
Hazard Log	Systems Deliverable 032	Appendix G, Part 2, Article 13	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Preliminary Integrated CH Station CFD Analysis Report	Systems Deliverable 061	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Interface Hazard Analysis	Systems Deliverable 033	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Interface Management Plan	Systems Deliverable 034	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Intermodulation Analysis	Systems Deliverable 035	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Not used	Systems Deliverable 036	Not used	Not used	Not used	Not used
Operational and Support Hazard Analysis	Systems Deliverable 037	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Preliminary Communications Software Documentation	Systems Deliverable 038	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Computer Room Layout	Systems Deliverable 039	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Control Room and Engineer Maintenance Duty Manager Layouts	Systems Deliverable 040	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Hazard Analysis	Systems Deliverable 041	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Preliminary Human Factors Report	Systems Deliverable 042	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Power System Load Flow Analysis	Systems Deliverable 043	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Power System Short Circuit, Protection, Grounding, Harmonic and Power Factor Analyses	Systems Deliverable 044	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Safety Report	Systems Deliverable 045	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Preliminary SCADA Software Documentation	Systems Deliverable 046	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary SES Report	Systems Deliverable 062	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Software Design Specification	Systems Deliverable 047	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Special Trackwork Report	Systems Deliverable 161	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Station Specific Smoke Re-Circulation Studies	Systems Deliverable 162	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary TIDS System Documentation	Systems Deliverable 048	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary TVCS Hardware and Software Architecture and Design Specification	Systems Deliverable 049	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary TVS Integrated Testing Plan	Systems Deliverable 163	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Requirements Specifications	Systems Deliverable 050	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Requirements Verification Categorization Report	Systems Deliverable 089	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Risk Assessment	Systems Deliverable 051	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Safety Requirements Specifications	Systems Deliverable 052	Appendix G	In accordance with the Systems Safety Program Plan	I	Consent Procedure
Safety Requirements Verification Categorization Report	Systems Deliverable 168	Appendix G	In accordance with the Systems Safety Program Plan	I	Consent Procedure
Software Development Plan	Systems Deliverable 054	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Software Quality Assurance Plan	Systems Deliverable 055	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
Station Specific CFD Analysis Reports	Systems Deliverable 164	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
System Performance and Failure Management Analysis Report	Systems Deliverable 056	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Cut-Over Plan	Systems Deliverable 057	Appendix G, Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
Systems Preliminary Design Review Package	Systems Deliverable 058	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Preliminary Design Review Report	Systems Deliverable 059	Appendix G	Within 15 Business Days of the formal design review meeting	N/A	Review Procedure
Systems Risk Management Plan	Systems Deliverable 060	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Preliminary TVS Installation Drawings	Systems Deliverable 171	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Preliminary Mode Tables	Systems Deliverable 172	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary TVS Motor Starting Study	Systems Deliverable 173	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary TVS Software Management Plan	Systems Deliverable 174	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary Proposed Canada Line TVS Control System Changes	Systems Deliverable 175	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Preliminary CFD and SES Model Files	Systems Deliverable 176	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure

*Notes:

“I” – to Technical Safety BC for information

“FR” – upon formal request by Technical Safety BC

“N/A” – Not applicable

1.19.4 Systems Final Design Review (SFDR) Deliverables

Table 1.19-4 Systems Final Design Review (SFDR) Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
CCTV Equipment Plans, Layouts and Views Report	Systems Deliverable 106	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
Contractual Technical Specifications	Systems Deliverable 107	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure
Corrective Maintenance Plan	Systems Deliverable 063	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Cut-Over Hazard Assessment	Systems Deliverable 064	Appendix G	In accordance with the Systems Safety Program Plan	I	Review Procedure
Cyber Security Risk Assessment	Systems Deliverable 065	Appendix G, Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Design Safety Case	Systems Deliverable 066	Appendix G	In accordance with the Systems Safety Program Plan	I	Consent Procedure
EMC Control Report	Systems Deliverable 067	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Final Communications Software Documentation	Systems Deliverable 068	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Computer Room Layout	Systems Deliverable 069	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Control Room and Engineer Maintenance Duty Manager Layouts	Systems Deliverable 070	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Human Factors Report	Systems Deliverable 071	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Power System Load Flow Analysis	Systems Deliverable 072	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Power System Short Circuit, Protection, Grounding, Harmonic and Power Factor Analyses	Systems Deliverable 073	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final SCADA Software Documentation	Systems Deliverable 074	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final SES Report	Systems Deliverable 104	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Software Design Specification	Systems Deliverable 075	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 75 -

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Final Special Trackwork Report	Systems Deliverable 108	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Station Specific CFD Reports	Systems Deliverable 165	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Station Specific Smoke Re-Circulation Studies	Systems Deliverable 166	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final TIDS System Documentation	Systems Deliverable 076	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Final TVCS Hardware and Software Architecture and Design Specification	Systems Deliverable 077	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final TVS Integrated Testing Plan	Systems Deliverable 159	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Grounding Study Report	Systems Deliverable 078	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Hazard Log	Systems Deliverable 079	Appendix G, Part 2, Article 13	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Interface Management Plan	Systems Deliverable 080	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Intermodulation Analysis	Systems Deliverable 081	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
License Amendments	Systems Deliverable 082	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
LIM Rail Structural Performance and Compliance Report	Systems Deliverable 083	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Operational and Support Hazard Analysis	Systems Deliverable 084	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Preventative Maintenance Plan	Systems Deliverable	Appendix G	In accordance with the	N/A	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
	085		Systems Management Plan		
RAM Analysis Report	Systems Deliverable 086	Appendix G	In accordance with the RAM Program Plan	N/A	Consent Procedure
Reliability Analysis	Systems Deliverable 087	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Requirements Specifications	Systems Deliverable 088	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Requirements Verification Categorization Report	Systems Deliverable 138	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Requirements Verification Report	Systems Deliverable 053	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Risk Assessment	Systems Deliverable 090	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Safety Distance Calculations Report	Systems Deliverable 091	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Safety Requirements Specifications	Systems Deliverable 092	Appendix G	In accordance with the Systems Safety Program Plan	I	Review Procedure
Safety Requirements Verification Categorization Report	Systems Deliverable 022	Appendix G	In accordance with the Systems Safety Program Plan	I	Review Procedure
Safety Requirements Verification Report	Systems Deliverable 093	Appendix G, Part 2, Article 13	In accordance with the Systems Safety Program Plan	I	Review Procedure
SkyTrain and ECOMM Radio Coverage Report	Systems Deliverable 094	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
Subsystem Failure Modes, Effects & Criticality Analyses	Systems Deliverable 095	Appendix G	In accordance with the Systems Safety Program Plan	FR	Review Procedure
System Expandability Plan	Systems Deliverable 096	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
System Fault Tree Analysis	Systems Deliverable	Appendix G	In accordance with the	FR	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
	097		Systems Safety Program Plan		
System Performance and Failure Management Analysis Report	Systems Deliverable 098	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Cut-Over Plan	Systems Deliverable 100	Appendix G, Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
Systems Final Design Review Package	Systems Deliverable 101	Appendix G	In accordance with the Systems Management Plan	N/A	Review Procedure
Systems Final Design Review Report	Systems Deliverable 102	Appendix G	Within 15 Business Days of the formal design review meeting	N/A	Review Procedure
Systems Risk Management Plan	Systems Deliverable 103	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Validation, Inspection, and Test Plan	Systems Deliverable 105	Appendix G	In accordance with the Systems Management Plan	N/A	Consent Procedure
Final Integrated CH Station CFD Analysis Report	Systems Deliverable 177	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Mode Tables	Systems Deliverable 178	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final TVS Installation Drawings	Systems Deliverable 179	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final TVS Motor Starting Study	Systems Deliverable 180	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final TVS Software Management Plan	Systems Deliverable 181	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final Proposed Canada Line TVS Control System Changes	Systems Deliverable 182	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Final CFD and SES Model Files	Systems Deliverable 183	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure

BROADWAY SUBWAY PROJECT
PROJECT AGREEMENT
SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Commercial in Confidence
EXECUTION COPY

- 78 -

Notes:

“I” – to Technical Safety BC for information

“FR” – upon formal request by Technical Safety BC

“N/A” – Not applicable

1.19.5 Construction Deliverables

Table 1.19-5 Construction Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Best-fit Alignment Report	Systems Deliverable 109	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
Track Fine Tuning Report	Systems Deliverable 110	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure

otes:

“N/A” – Not applicable

1.19.6 Testing and Verification Readiness Deliverables

Table 1.19-6 Testing and Verification Readiness Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
30-Day Look Ahead Test Schedule Detailing Commissioning and Safety Test Activities	Systems Deliverable 132	Appendix G Part 2, Article 13	20 Business Days prior to start of commissioning and updated weekly	I	Review Procedure
90-Day Look Ahead Schedule Detailing Commissioning and Safety Test Activities	Systems Deliverable 133	Appendix G Part 2, Article 13	60 Business Days prior to first test and updated as required by the Province’s Representative	I	Review Procedure
Canada Line CH Ventilation Test Plan	Systems Deliverable 012	Part 2, Article 21	At SCDR	I	Review Procedure
Commissioning Monthly Report	Systems Deliverable	Appendix G	Commencing the first month	N/A	Review Procedure

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
	129		after the SFDR		
Commissioning Safety Plan	Systems Deliverable 111	Appendix G	30 Business Days Prior to the first Systems Field Test Readiness Review	N/A	Consent Procedure
Documentation Package to Allow for Testing of Train Operation Between the BSP and the Existing SkyTrain System	Systems Deliverable 112	Appendix G	20 Business Days prior to the testing of Train movement between the BSP and the Existing SkyTrain System	I	Review Procedure
Documentation Package to Allow the Movement of Trains on the BSP	Systems Deliverable 113	Appendix G	20 Business Days prior to the movement of Trains on the BSP	I	Review Procedure
Factory Acceptance Test Program and Acceptance Criteria for Ventilation Fan and Damper Equipment Report	Systems Deliverable 115	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
LIM Generated Noise Demonstration Plan	Systems Deliverable 116	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
On-Time Performance Demonstration Test Plan	Systems Deliverable 117	Part 2, Article 13	30 Business Days prior to start date for test	N/A	Review Procedure
Safety Commissioning Test Plan	Systems Deliverable 119	Appendix G	Draft at SCDR; Final 30 Business Days Prior to the first Systems Field Test Readiness Review	I	Consent Procedure
Site Acceptance Test Program Including an Acceptance Criteria for Cold Flow Tests Report	Systems Deliverable 114	Part 2, Article 21	In accordance with the Systems Management Plan	N/A	Review Procedure
Subsystem Test Plans	Systems Deliverable 121	Appendix G	Draft at SPDR; Final 30 Business Days Prior to the first Systems Field Test Readiness	N/A	Consent Procedure

**BROADWAY SUBWAY PROJECT
PROJECT AGREEMENT**

**Commercial in Confidence
EXECUTION COPY**

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 81 -

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
			Review		
Systems Commissioning Plan	Systems Deliverable 122	Appendix G	Draft at SCDR; Final 30 Business Days Prior to the first Systems Field Test Readiness Review	N/A	Consent Procedure
Systems Field Test Readiness Review Packages	Systems Deliverable 123	Appendix G	30 Business Days Prior to the related Systems Field Test Readiness Review	N/A	Consent Procedure
Systems Test Plans	Systems Deliverable 124	Appendix G	Draft at SCDR; Final at SFDR	N/A	Consent Procedure
Test and Commissioning Rules and Procedures	Systems Deliverable 125	Appendix G	30 Business Days Prior to the first Systems Field Test Readiness Review	N/A	Consent Procedure
Test Procedures	Systems Deliverable 126	Appendix G	30 Business Days prior to the related System Test Readiness Review	N/A	Review Procedure
TIDS Performance Demonstration Test Plan	Systems Deliverable 127	Part 2, Article 13	30 Business Days prior to start date for test	N/A	Review Procedure
Travel Time Demonstration Test Plan	Systems Deliverable 128	Part 2, Article 13	20 Business Days prior to start date for test	N/A	Review Procedure
TVS Integrated Testing Plan	Systems Deliverable 130	Part 2, Article 21	At SCDR	N/A	Review Procedure
Validation, Inspection, and Test Plan	Systems Deliverable 131	Appendix G	Draft at SCDR; Final at SFDR	N/A	Consent Procedure
Independent Safety Assessment Monthly Report	Systems Deliverable 185	Appendix G	In accordance with the Systems Safety Program Plan	I	Consent Procedure

Notes:

“I” – to Technical Safety BC for information

“N/A” – Not applicable

1.19.7 Testing and Verification Results Deliverables

Table 1.19-7 Testing and Verification Results Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Diamond Crossover Impact Report	Systems Deliverable 169	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Consent Procedure
EMC Control Report	Systems Deliverable 149	Appendix G	20 Business Days after completion of applicable test	N/A	Consent Procedure
Failure Reporting Analysis and Corrective Action System Report	Systems Deliverable 150	Appendix G	Monthly	N/A	Review Procedure
Final Deficiency List	Systems Deliverable 134	Appendix G	Monthly	I	Consent Procedure
Final Safety Case	Systems Deliverable 135	Appendix G	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
Hazard Log	Systems Deliverable 136	Appendix G, Part 2, Article 13	In accordance with the Systems Safety Program Plan	FR	Consent Procedure
LIM Generated Noise Demonstration Report	Systems Deliverable 167	Part 2, Article 13	In accordance with the Systems Management Plan	N/A	Review Procedure
On-Time Performance Demonstration Results	Systems Deliverable 137	Part 2, Article 13	20 Business Days after completion of test	N/A	Review Procedure
Requirements Verification Report	Systems Deliverable 099	Appendix G	25 days prior to Substantial Completion	N/A	Consent Procedure
Safety Certificate Documentation Package to Allow Service Commencement Involving the Carrying of Passengers on the BSP	Systems Deliverable 139	Part 3, Article 4	20 Business Days prior to Substantial Completion	I	Consent Procedure
Safety Requirements Verification	Systems Deliverable	Appendix G,	25 days prior to Substantial	I	Consent

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
Report	140	Part 2, Article 13	Completion		Procedure
System Performance Demonstration Report	Systems Deliverable 141	Appendix G, Part 2, Article 13	After test completion	I	Consent Procedure
Test Reports	Systems Deliverable 142	Appendix G, Part 2, Article 13	20 Business Days after completion of applicable test	N/A	Review Procedure
TIDS Performance Demonstration Results	Systems Deliverable 143	Part 2, Article 13	20 Business Days after completion of test	N/A	Consent Procedure
Travel Time Demonstration Results	Systems Deliverable 144	Part 2, Article 13	20 Business Days after completion of test	N/A	Consent Procedure
Trial Running Safety Memorandum	Systems Deliverable 145	Appendix G	15 Business Days prior to the start of Trial Running	I	Consent Procedure
Trial Running Test Plan and Procedure	Systems Deliverable 146	Appendix G	20 Business Days prior to the start of Trial Running	I	Consent Procedure
Trial Running Test Report	Systems Deliverable 147	Appendix G	10 Business Days after completion of Trial Running	I	Consent Procedure
Warranty Period RAM Demonstration Report	Systems Deliverable 148	Part 2, Article 13	Every 3 months	I	Consent Procedure
Independent Safety Assessment Final Report	Systems Deliverable 186	Appendix G	In accordance with the Systems Safety Program Plan	I	Consent Procedure

Notes:

“I” – to Technical Safety BC for information

“FR” – upon formal request by Technical Safety BC

“N/A” – Not applicable

1.19.8 Operation and Maintenance Deliverables

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

Table 1.19-8 Operation and Maintenance Deliverables

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
BSP Systems Cyber Security Baseline Report	Systems Deliverable 157	Appendix G	At least 15 days before Substantial Completion	N/A	This is to be delivered directly and only to a designated individual, as determined by SkyTrain .
Communications and SCADA Software Changes Report	Systems Deliverable 158	Part 2, Article 13	Prior to Substantial Completion (with allowance for the Province to complete its review under the Consent Procedure)	N/A	Consent Procedure
Maintenance Manuals and Operations Manuals for Systems	Systems Deliverable 151	Part 3, Article 3	Draft at SFDR; Final prior to Substantial Completion (with allowance for the Province to complete its review under the Review Procedure)	N/A	Review Procedure
Manual Delivery Plan	Systems Deliverable 152	Part 3, Article 3	In accordance with the Systems Management Plan	N/A	Consent Procedure
Records Documentation	Systems Deliverable 153	Part 3, Article 3, Part 2, Article 13	Prior to Substantial Completion (with allowance for the Province to complete its review under the Review Procedure)	N/A	Review Procedure
Project Co Redlining Input to the System Operations Manuals – Final	Systems Deliverable 154	Part 3, Article 3	Prior to Substantial Completion (with allowance for the Province to complete its review under the Review	N/A	Review Procedure

**BROADWAY SUBWAY PROJECT
PROJECT AGREEMENT**

**Commercial in Confidence
EXECUTION COPY**

SCHEDULE 4: APPENDIX G: SYSTEM GENERAL REQUIREMENTS

- 85 -

Deliverable Title	Deliverable No.	Deliverable Location	Submission Schedule	Technical Safety BC*	Review or Consent Procedure
			Procedure)		
Project Co Redlining Input to the System Operations Manuals – Preliminary	Systems Deliverable 155	Part 3, Article 3	6 months after SFDR or 30 Business Days Prior to the Systems Field Test Readiness Review, whichever is earlier	N/A	Review Procedure
Spare Parts Lists	Systems Deliverable 156	Appendix G, Part 3, Article 3	In accordance with the Spare Parts Plan	N/A	Review Procedure

Notes:

“N/A” – Not applicable