THE CITY OF EDMONTON

DESIGN-BUILD AGREEMENT
CAPITAL LINE SOUTH LRT EXTENSION

Schedule 6
Testing and Commissioning

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SCHEDULE 6

TESTING AND COMMISSIONING

1. GENERAL

1.1 General Process

Testing and Commissioning Work is partitioned into static, dynamic, and Operational Testing.

1.1.1 Static Testing and Commissioning:

(a) Static Testing and Commissioning must be led by Design-Builder and occurs during the Design and Construction phase, and:

(i) is solely the responsibility of the Design-Builder, except for City Works which are the responsibility of the City,

(ii) does not require LRVs to be completed,

(iii) includes development of plans and sub-plans, Qualification Testing, factory acceptance tests, post installation check outs, site acceptance tests, and some level of system integration tests, so long as they do not require use of LRVs, and

(iv) does not impact operation of the Capital Line LRT.

(b) During this stage the Design-Builder provides all training to the City that is not operations training or training required for City Works.

1.1.2 Dynamic Testing and Commissioning:

(a) All SITs that require LRVs will be completed during dynamic Testing and Commissioning.

(b) Dynamic Testing and Commissioning must be led by Design-Builder. The City will coordinate with the Design-Builder the portion of Test Procedures for City Works that require dynamic Testing and Commissioning. The City will provide LRVs and necessary staff at no cost to the Design-Builder for dynamic Testing and Commissioning.

(c) The conditions precedent to commencement of dynamic Testing and Commissioning are:

(i) the Design-Builder has issued the appropriate Design Certificates, Construction Certificates and Commissioning Certificates for the systems as needed by the Independent Safety Assessor to satisfy the safety case for the Testing and Commissioning Work to transition from static to dynamic Testing and Commissioning;

(ii) all Vital systems are operational and ready to run LRVs,

(iii) the Infrastructure has been tied into the Capital Line LRT,

(iv) the City has Accepted any proposed changes to the Standard Operating Procedures; and

(v) the Design-Builder has fulfilled obligations for training pursuant to Section 8 *[Training]* of Schedule 4 *[Design and Construction Protocols]*.

1.1.3 Operational Testing:

(a) Operational Testing will be completed by the City as outlined in Section 3 *[Operational Testing]*.

(b) Operational Testing starts following Construction Completion Date.

(c) During Operational Testing the City will test the operational capability of the line through trial runs and event-based tests and or scenarios.

1.2 General Responsibilities

(a) Design-Builder must plan, schedule, coordinate and execute the Testing and Commissioning of the Infrastructure as set out in this Schedule.

(i) The Design-Builder must coordinate Testing and Commissioning with the City's Testing and Commissioning of City Works.

(ii) The Design-Builder is responsible for Integrated Testing and Commissioning with support from the City for Testing and Commissioning of City Works.

(iii) The Design-Builder must include City Works Testing and Commissioning as part of the Testing and Commissioning program deliverables, including in the:

(A) Testing and Commissioning Plan;

(B) Testing and Commissioning Schedule;

(C) Testing and Commissioning Register; and

(D) Testing and Commissioning Program Report.

The City will provide input to the program deliverables in accordance with Section 1.3 *[Testing and Commissioning of City Works].*

(b) Testing and Commissioning includes applicable requirements for LEED Certification at the Llew Lawrence OMF. Design-Builder must complete all Testing and Commissioning prerequisites and secure the required credits to achieve the LEED Silver Certification of the Llew Lawrence OMF as outlined in Section 4.4 [*LEED Silver Certification for Llew Lawrence OMF*] of Schedule 4 *[Design and Construction Protocols*] and based on the building sustainability requirements in Section 7-2.3 [*Sustainable Buildings and Infrastructure Rating Systems*] of Schedule 5 [*D&C Performance Requirements*].

(c) Design-Builder must comply with Good Industry Practice for all Testing and Commissioning Work. Design-Builder must submit all Testing and Commissioning documentation to the City in accordance with the requirements of Schedule 2 *[Submittal Review Procedure]*.

1.3 Testing and Commissioning of City Works

(a) The City is responsible for the Testing and Commissioning of City Works, including the training required for City Works.

(b) Where City Works are part of a sub-plan referenced in Section 2.5.2 *[Testing and Commissioning Sub-Plans]*, the City will provide the Design-Builder with the applicable content for the sub-plan at least 30 days in advance of the date on which the Integration Plan is scheduled to be submitted according to the Submittal Schedule and Register.

(c) The City will follow the same Testing and Commissioning requirements as the Design-Builder as outlined in this Schedule 6 for Testing and Commissioning of City Works.

(d) The City will support the overall Testing and Commissioning Work by delivering applicable Testing and Commissioning documents to the Design-Builder in accordance with Section 2.9 *[Testing and Commissioning Documents]*.

(e) The City is responsible for rectifying any defects or deficiencies in City Works.

2. TESTING AND COMMISSIONING

2.1 Applicable Standards

(a) Design-Builder must comply with the following documents, as applicable, during the Testing and Commissioning process:

(i) HFDG

(ii) City's "LRT Testing and Commissioning Guidelines" available as Disclosed Data

(iii) Commissioning Consultant Manual

(iv) Systems Assurance Guideline

(v) High Floor LRT Signal Engineering Manual

2.2 Testing and Commissioning Manager

(a) Design-Builder must retain a qualified Testing and Commissioning Manager (the "**Testing and Commissioning Manager**") at least 12 months prior to the first Testing and Commissioning Work who must:

(i) have a minimum of 10 years of demonstrable experience in the design, testing and commissioning of light rail transit systems, rail systems infrastructure, equipment and facilities of similar scope and complexity;

(ii) be registered, or be qualified to be registered, as a Professional Engineer registered to practice with APEGA;

(iii) be acceptable to the City, acting reasonably;

(iv) be familiar with and knowledgeable about the standards set out in this Schedule;

(v) be responsible for planning, implementation, management, and oversight of all Testing and Commissioning Work and for preparation of all Testing and Commissioning documentation, records, integration testing and verification activities relating to individual components, sub-systems, equipment and facilities associated with the Infrastructure; and

(vi) comply with APEGA authentication requirements.

(b) The Testing and Commissioning Manager on behalf of the Design Builder must:

(i) be responsible and oversee all tests and inspections, including all work prior to Testing and Commissioning such as review of components, equipment, and sub-systems to develop test methodologies and the Testing and Commissioning Work, required by and in accordance with, this Agreement and Good Industry Practice;

(ii) prepare and submit to the City all Commissioning Certificates and copies of the applicable documentation, records and reports required to:

(A) demonstrate to the City and all applicable Governmental Authorities that all applicable equipment, components, systems and sub-systems and the fully integrated Infrastructure comply with the Project Requirements;

(B) establish a baseline record of equipment, components, systems and sub-systems in electronic format ready for uploading to the City's Asset Management System containing asset details which may be used to aid in comparing performance and determining deterioration of assets over the applicable Design Service Life;

(C) demonstrate that the Infrastructure is ready for its intended use, and meets all of the conditions precedent for Construction Completion;

(D) verify the technical performance of individual Equipment, components, systems and sub-systems;

(E) demonstrate Integration of the individual Equipment, components, systems and sub-systems into the Infrastructure;

(F) demonstrate that all Testing and Commissioning test equipment has been properly calibrated and that such calibration is documented and traceable to the applicable standards;

(G) validate the safety and security of the Infrastructure in accordance with the Safety and Security Certification Program;

(H) confirm the Infrastructure meets the RAM targets set out in the RAM Program and this Agreement;

(I) demonstrate that the Infrastructure is electromagnetically compatible with its environment and achieves emission and susceptibility targets set out in the EMI program described in Part 6 [*Systems*] of Schedule 5 *[D&C Performance Requirements];*

(J) demonstrate that the Stray Current emissions from the Infrastructure and corrosion control activities are compliant with the levels set out in the Corrosion and Stray Current program as described in Chapter 13 *[Corrosion and Stray Current Control]* of the High Floor Design Guidelines*;*

(K) demonstrate that noise levels do not exceed the levels set out in the Noise Control Sub-Plan;

(L) demonstrate that vibration levels do not exceed the levels set out in the Vibration Control Sub-Plan;

(M) demonstrate that wheel/rail profiles and associated wear levels do not exceed the levels set out in the respective Interface Control Document;

(N) demonstrate that the OCS/pantograph contact forces and associated wear levels do not exceed the levels set out in the respective Interface Control Document;

(O) demonstrate that the LRV platform gaps are consistent with those detailed in the Interface Control Document; and

(P) demonstrate that the LRV and the Llew Lawrence OMF interfaces are consistent with those set out in the Interface Control Document.

2.3 Testing and Commissioning Sub-Committee

(a) Not less than nine months prior to the first scheduled activity of the Testing and Commissioning Work, the Design-Builder must establish and maintain, until the Construction Completion Date, a joint liaison committee with the City (the "**Testing and Commissioning Sub-Committee**") consisting of the Testing and Commissioning Manager, Design-Builder Project Director, the City's Representative, the City Persons responsible for City Works, the Independent Safety Assessor, such other members as the City may require and such other members as the Parties may agree from time to time.

(b) The Testing and Commissioning Sub-Committee must be a sub-committee of the Construction Joint Committee and is intended to provide a formal forum for the Parties to consult and cooperate in all matters relating to Testing and Commissioning, including discussion, clarification, planning and coordination of the Testing and Commissioning Work.

(c) The Testing and Commissioning Sub-Committee must meet at least once every four weeks and more frequently as necessary. If any member of the Testing and Commissioning Sub-Committee requests an additional meeting, the Parties must act reasonably in accommodating this request. Meetings of the Testing and Commissioning Sub-Committee must be convened on not less than two Business Days' notice (which notice must also identify the agenda items to be discussed at the meeting and include the then-current Testing and Commissioning Schedule), provided that, in the case of urgency, a meeting may be called at any time by any member on such notice as may be reasonable in the circumstances. The Testing and Commissioning Sub-Committee must be chaired by the Testing and Commissioning Manager unless the City requires that a representative of the City chair the Testing and Commissioning Sub-Committee.

(d) Design-Builder must keep minutes of all recommendations, action items and meetings of the Testing and Commissioning Sub-Committee and circulate such minutes to the City within five Business Days of the holding of the meeting, the making of the recommendation or the identification of the action item. Meeting minutes must clearly identify all agreed upon items.

2.4 Minimum Testing and Commissioning Requirements

2.4.1 Minimum Testing and Commissioning Requirements

(a) Successful completion of a Testing and Commissioning step, inspection or test must mean that the step, inspection or test has demonstrated compliance of the Infrastructure, or portion thereof, with the applicable Project Requirements.

(b) Design-Builder must provide all required resources and work processes to plan, schedule, coordinate and execute the overall Testing and Commissioning for the Project except where Testing and Commissioning Work is a part of the City Works.

(c) Design-Builder must ensure that:

(i) all testing equipment used for taking or recording Testing and Commissioning data is properly calibrated and that such calibration is documented and traceable to the applicable standards;

(ii) where a Nonconformity or Deficiency is discovered, it is promptly rectified and all affected Equipment, components, systems and sub-systems are re-tested in accordance with Schedule 7 *[Construction Completion, Service Readiness and Final Completion]* and Schedule 9 *[Quality Management]* until they meet the applicable Project Requirements;

(iii) where a Nonconformity is discovered during Testing and Commissioning, the applicable Nonconformity must be investigated, and the source or cause of the Nonconformity must be determined, rectified and documented in the form or a Nonconformity report prior to proceeding with further Testing and Commissioning of the affected Equipment, components, systems or sub-systems;

(iv) subject to complying with all reasonable safety procedures, including any relevant health and safety plans for the carrying out of the Testing and Commissioning Work and Design-Builder's and/or any Subcontractor's reasonable Site rules, the City's Representative, designated City Persons, and their respective representatives, have access to all Infrastructure throughout the Testing and Commissioning process;

(v) the City's Representative, designated City Persons and their respective representatives receive reasonable advance notice of, and have full access to attend, all inspections and Testing and Commissioning of all parts of the Infrastructure, including individual pieces of Equipment, components, systems and sub-systems;

(vi) copies of all inspection and test procedures, test results, technical documentation and other data and photographs recorded or observed by the Design-Builder or any Design-Builder Person are submitted to the City upon request; and

(vii) to the greatest extent practicable, all test data are provided in a digital format. Where electronic recording of test data is impracticable, such test data must be recorded manually and tabulated in a neat, consistent, and methodical manner and Design-Builder must manually enter such data into a digital platform.

(viii) testing of systems and sub-systems encompasses:

(A) device and operational testing of the individual systems and sub-systems, including their components; and

(B) end-to-end testing, confirming all integrated systems and sub-systems operate in accordance with the applicable Project Requirements.

(d) Design-Builder's Testing and Commissioning Work must include:

(i) pre-delivery tests, including:

(A) Qualification Testing on Equipment that is newly designed and developed and, where prior qualification cannot be demonstrated in a similar and representative environment. Such testing must demonstrate compliance with the standards required by the Agreement and be completed to the satisfaction of the City;

(B) Type Testing on Equipment subjected to previous Qualification Testing to demonstrate compliance with the standards required by the Agreement; and

(C) Factory acceptance tests (FAT) on Equipment, Infrastructure and Systems as specified in Section 2.3.1 of the City's "LRT Testing and Commissioning Guidelines" available as Disclosed Data and as per Good Industry Practice.

(ii) Post installation checkout (PICO) tests, audits and inspections after a component, sub-system or system has been installed as specified in Section 2.3.2 of the City's "LRT Testing and Commissioning Guidelines" available as Disclosed Data and as per Good Industry Practice; and

(iii) Site acceptance tests (SAT) following the successful completion of PICO tests, audits, and inspections as specified in Section 2.4.1 of the City's "LRT Testing and Commissioning Guidelines" available as Disclosed Data and as per Good Industry Practice.

(A) Where power, including Traction Power, is applied during SAT, site safety procedures must be implemented to reflect this new Hazard on the Testing and Commissioning site.

(e) Design-Builder's Testing and Commissioning Work must include system integration testing (SIT) of all Systems as specified in Section 2.4.2 of the City's "LRT Testing and Commissioning Guidelines" available as Disclosed Data for the following:

(i) Traction Power Sub Station;

(ii) Overhead Contact System;

(iii) Train Control System;

(iv) Communications, including the following:

(A) PA/VMS;

(B) Powered Fiber;

(C) TPSS SCADA

(D) CTC

(v) Electromagnetic interference and electromagnetic compatibility;

(vi) Track;

(vii) LRVs to the Infrastructure;

(viii) Operations and Maintenance Facility (OMF) and Mainline Track Integration, including Platform interface; and

(ix) corrosion control systems.

(f) Design-Builder's Testing and Commissioning Work must include testing and inspection of all Building Structure and Transportation Structures, including the following:

(i) maintenance equipment systems;

(ii) site development;

(iii) building envelope;

(iv) elevators and escalators;

(v) fire detection, protection, and alarm systems;

(vi) plumbing systems;

(vii) HVAC systems;

(viii) electrical systems;

(ix) security and safety systems;

(x) interfaces with Stations;

(xi) drainage systems; and

(xii) emergency power generators.

(g) Design-Builder's Testing and Commissioning Work must include testing and inspection of the civil engineering elements of the Structures for purposes of establishing readiness for intended use, including the following:

(i) Structures;

(ii) Trackway;

(iii) Roadways and Roadway related infrastructure;

(iv) landscaping and SUI elements;

(v) OCS support structures and foundations, and related infrastructure components; and

(vi) wayfinding, signage, and visual displays.

2.4.2 System Integration

Design-Builder must integrate all applicable systems in accordance with the Integration Plan described in Section 2.5.3 *[Integration Plan]* following the completion of the City Works noted as Item #3 in Table 1-1.3.1 [City Works] of Schedule 5 *[D&C Performance Requirements]*.

2.5 Testing and Commissioning Plans & Sub-Plans

2.5.1 Testing and Commissioning Plan

Not less than 30 months prior to the Construction Completion Date, Design-Builder must prepare and submit to the City a detailed plan setting out the Testing and Commissioning Work, requirements and applicable acceptance criteria, training and other activities Design-Builder intends to carry out to fully test and commission the Infrastructure and to satisfy the requirements of Section 2.4 *[Minimum Testing and Commissioning Requirements]* (the "**Testing and Commissioning Plan"**). The Testing and Commissioning Plan must:

(a) be prepared by, or under the direction of, the Testing and Commissioning Manager and in coordination with the City to include the Testing and Commissioning Work to be performed by the City for City Works;

(b) include a draft Testing and Commissioning Register to be used for monitoring the Testing and Commissioning Work;

(c) include a detailed description of the works required for Testing and Commissioning of the Llew Lawrence OMF:

(d) include the following Testing and Commissioning sub-plans, each further described in Section 2.5.2 *[Testing and Commissioning Sub-Plans]*:

(i) Traction Power Testing and Commissioning Sub-Plan;

(ii) Signalling Testing and Commissioning Sub-Plan;

(iii) Communication Testing and Commissioning Sub-Plan;

(iv) Static System Integration Testing and Commissioning Sub-Plan; and

(v) Civil Testing and Commissioning Sub-Plan;

(e) include a short description of all Equipment, components, systems, sub-systems and processes to be inspected, tested or demonstrated as part of the Testing and Commissioning Work;

(f) include a list of all Equipment, components, systems, sub-systems and processes to be subjected to Qualification Testing, Type Testing, FAT, PICO, SAT and SIT;

(g) include a detailed list of the Testing and Commissioning deliverables to be submitted, and cross-reference to the appropriate Testing and Commissioning sub-plan when applicable;

(h) include a description and diagram illustrating the structure and sequence of the Testing and Commissioning Work;

(i) describe the process for demonstrating compliance with the RAM Program, the Safety and Security Certification Program and the other Project Requirements;

(j) include the organization and responsibilities of each member of the Testing and Commissioning team, including the involvement of the Appropriate Person(s) and the Independent Safety Assessor;

(k) identify and manage Testing and Commissioning responsibilities that are shared with the City or other third-party interfaces;

(i) where an interface is defined in a specific sub-plan listed in Section 2.5.2 *[Testing and Commissioning Sub-Plans]*, include a cross-reference in the Testing and Commissioning Plan and the associated sub-plan(s).

(l) provide a description of the procedures and Testing and Commissioning rules to be implemented to manage Hazards during Testing and Commissioning arising from Train movements, energized Traction Power, and active Track switches, adjacent and crossing vehicular traffic, pedestrians and other members of the public. These procedures must include safe operating restrictions for the City whom will be participating in each Testing and Commissioning event;

(m) include a description of Design-Builder's inspection and test recording system in accordance with 2.9.3(b) for managing Testing and Commissioning documentation and records of tests, inspections, quality assurance and training to demonstrate how the requirements of Section 2.4 *[Minimum Testing and Commissioning Requirements]* will be satisfied;

(n) include an initial high-level schedule for performance of the Testing and Commissioning Work, which schedule must be consistent with the Key Dates and the then-current Construction Schedule. The high-level schedule must identify:

(i) the timing and location of all Testing and Commissioning Work, including all testing, inspection and training activities;

(ii) a narrative describing all locations and Grade Crossings impacted by each Testing and Commissioning Work activity, including details of the protective measures for vehicular traffic, pedestrians, and cyclists to be employed during the performance of the applicable Testing and Commissioning Work; and

(iii) for each of the condition precedents for Construction Completion, the date upon which Design-Builder anticipates completing the relevant Testing and Commissioning Work; and

(o) include a list of the Test Procedures for conducting the Testing and Commissioning Work.

2.5.2 Testing and Commissioning Sub-Plans

2.5.2.1 Traction Power Testing and Commissioning Sub-Plan

The Traction Power Testing and Commissioning Sub-Plan must:

(a) describe the Testing and Commissioning Work to be performed to commission the following systems:

(i) Traction Power Substations;

(ii) Overhead Contact System;

(b) include details of the organization, roles and responsibilities for the above Testing and Commissioning Work, cross-referencing the Testing and Commissioning Plan;

(c) include a list of the Testing and Commissioning deliverables required for commissioning the systems listed in this Section 2.5.2.1 *[Traction Power Testing and Commissioning Sub-Plan]*;

(d) identify the specific requirements for the City, the LRV Supplier or other third-party interfaces;

(e) include a list of all Equipment, components, systems, sub-systems and processes to be subjected to Qualification Testing, Type Testing, FAT, PICO, SAT and SIT to be commissioned under the Traction Power Testing and Commissioning Sub-Plan;

(f) include a list of the Test Procedures for conducting the relevant Testing and Commissioning Work;

(g) include a draft of each Test Procedure listed in the Traction Power Testing and Commissioning Sub-Plan as an appendix; and

(h) list the end-user and the party that will accept the system.

2.5.2.2 Signalling Testing and Commissioning Sub-Plan

The Signalling Testing and Commissioning Sub-Plan must:

(a) describe the Testing and Commissioning Work to be performed to commission the Train Control System;

(b) include details of the organization, roles and responsibilities for the above Testing and Commissioning Work, cross-referencing the Testing and Commissioning Plan;

(c) include a list of the Testing and Commissioning deliverables required for commissioning the systems listed in this Section 2.5.2.2 *[Signalling Testing and Commissioning Sub-Plan]*;

(d) identify the specific requirements for the City, the LRV Supplier or other third-party interfaces;

(e) include a list of all Equipment, components, systems, sub-systems and processes to be subjected to Qualification Testing, Type Testing, FAT, PICO and SAT to be commissioned under the Signalling Testing and Commissioning Sub-Plan;

(f) include a list of the Test Procedures for conducting the relevant Testing and Commissioning Work;

(g) include a draft of each Test Procedure listed in the Signalling Testing and Commissioning Sub-Plan as an appendix; and

(h) list the end-user and the party that will accept the system.

2.5.2.3 Communication Testing and Commissioning Sub-Plan

The Communication Testing and Commissioning Sub-Plan must:

(a) be developed in coordination with the City to capture Testing and Commissioning Work required as part of City Works for which the City is responsible;

(b) describe the Testing and Commissioning Work to be performed for the following:

(i) NTP GPS Time Source

(ii) CCTV

(iii) PA/VMS

(iv) Telephone

(v) Radio

(vi) ETS Network

(vii) Powered Fiber

(viii) City IT Network

(ix) C-Cure Security Card Access System

(x) Industrial Communication System (ICS) (BMS)

(xi) TPSS SCADA

(xii) Fare Collection

(xiii) Train Control System

(xiv) Public WI-FI

(xv) CTC

(c) include details of the organization, roles and responsibilities for the above Testing and Commissioning Work, cross-referencing the Testing and Commissioning Plan;

(d) include a list of the Testing and Commissioning deliverables required for commissioning the systems listed in this Section 2.5.2.3 *[Communication Testing and Commissioning Sub-Plan]*;

(e) identify the specific requirements for the City, the LRV Supplier or other third-party interfaces;

(f) include a list of all Equipment, components, systems, sub-systems and processes to be subjected to Qualification Testing, Type Testing, FAT, PICO and SAT to be commissioned under the Communication Testing and Commissioning Sub-Plan;

(g) include a list of the Test Procedures for conducting the relevant Testing and Commissioning Work;

(h) include a draft of each Test Procedure listed in the Communication Testing and Commissioning Sub-Plan as an appendix; and

(i) list the end-user and the party that will accept the system.

2.5.2.4 Static System Integration Testing and Commissioning Sub-Plan

The Static System Integration Testing and Commissioning Sub-Plan must:

(a) be developed in coordination with the City to capture integration activities required as part of City Works for which the City is responsible;

(b) describe the work to be performed for Testing and Commissioning the interfaces included on the Integration Register;

(c) include details of the Integrated Testing and Commissioning process;

(d) include details of the organization, roles and responsibilities for the above Testing and Commissioning Work, cross-referencing the Testing and Commissioning Plan;

(e) include a list of the Testing and Commissioning deliverables required for commissioning the systems listed in this Section 2.5.2.4 *[Static System Integration Testing and Commissioning Sub-Plan]*;

(f) identify the specific requirements for the City or other third-party interfaces;

(g) include a list of the Test Procedures for conducting the relevant Testing and Commissioning Work;

(h) include a draft of each Test Procedure listed in the Static System Integration Testing and Commissioning Sub-Plan as an appendix; and

(i) list the end-user and the party that will accept the system.

2.5.2.5 Civil Testing and Commissioning Sub-Plan

The Civil Testing and Commissioning Sub-Plan must:

(a) Describe the Testing and Commissioning Work to be performed to commission, at a minimum, the following:

(i) Building Structures and Building Structure systems;

(ii) Transportation Structures;

(iii) OCS support structures and foundations, and related infrastructure components;

(iv) Roadways;

(v) wayfinding, signage and visual displays; and

(vi) track;

(b) include details of the organization, roles and responsibilities for the above Testing and Commissioning Work, cross-referencing the Testing and Commissioning Plan;

(c) include a list of the Testing and Commissioning deliverables required for commissioning the systems listed in this Section 2.5.2.5 *[Civil Testing and Commissioning Sub-Plan]*;

(d) identify the specific requirements for the City, the LRV Supplier or other third-party interfaces;

(e) include a list of all Equipment, components, systems, sub-systems and processes to be subjected to Qualification Testing, Type Testing, FAT, PICO, SAT, SIT and other relevant tests to be commissioned under the Civil Testing and Commissioning Sub-Plan;

(f) include a list of the Test Procedures for conducting the relevant Testing and Commissioning Work;

(g) include a draft of each Test Procedure listed in the Civil Testing and Commissioning Sub-Plan as an appendix; and

(h) list the end-user and the party that will accept the system.

2.5.3 Integration Plan

(a) Not less than 120 days prior to Integrated Testing and Commissioning Readiness Date, Design-Builder must prepare and submit an integration plan for the Integrated Testing and Commissioning of CLSE (the **"Integration Plan"**).

(b) The Integration Plan must include City Works Testing and Commissioning Work for which the City will be responsible. For City Works Testing and Commissioning Work, the City will provide the Design-Builder with inputs for the Integration Plan at least 30 days in advance of the date on which the Integration Plan is scheduled to be submitted according to the Submittal Schedule and Register.

(c) The Integration Plan must:

(i) adhere to the integration requirements captured in Part 6 *[Systems]* of Schedule 5 *[D&C Performance Requirements]*.

(ii) identify each specific system that must be integrated with the Capital Line LRT infrastructure, and must include the following systems:

(A) Traction Power Substation (TPSS);

(B) Overhead Contact System;

(C) Train Control System;

(D) Communications, including the following:

(1) NTP GPS Time Source

(2) CCTV

(3) PA/VMS

(4) Telephone

(5) Radio

(6) ETS Network

(7) Train to Wayside

(8) Powered Fiber

(9) City IT Network

(10) C Cure Security Card Access System

(11) Industrial Communication System (ICS) (BMS)

(12) TPSS SCADA

(13) Fare Collection

(14) Signal System

(15) Public Wi-Fi

(16) CTC

(iii) identify and develop the process for informing the City of any and all safe operating restrictions or operating restrictions resulting from integration activities;

(iv) describe the timeline and coordination requirements for any additional training required for the City; and

(v) describe how Design-Builder will coordinate integration activities with the City.

2.5.4 Updates to the Testing and Commissioning Plans

Prior to implementation of any amendments or updates to the Testing and Commissioning Plan, Design-Builder must submit the proposed amendments or updates to the City in accordance with Schedule 2 *[Submittal Review Procedure]*.

2.5.5 Compliance with the Testing and Commissioning Plans

Design-Builder must implement and ensure that all Design-Builder Persons engaged in the Testing and Commissioning Work comply with the Accepted Testing and Commissioning Plan and any subsequent amendments or updates to the Testing and Commissioning Plan which have been appropriately endorsed by the City.

2.6 Testing and Commissioning Schedules

(a) At least

(i) 40 Business Days prior to commencement of Testing and Commissioning Work related to communication systems; or

(ii) 20 Business Days prior to the commencement of Testing and Commissioning Work not related to communication systems,

Design-Builder must prepare and submit a detailed schedule for the applicable Testing and Commissioning Work, (each, a "**Testing and Commissioning Schedule**").

(b) Each Testing and Commissioning Schedule must:

(i) update the high-level schedule included in the Testing and Commissioning Plan to provide details of the applicable Testing and Commissioning Work to be performed and the timing of all applicable Testing and Commissioning Work, including all testing, inspection and training activities. Any proposed changes to the Testing and Commissioning schedule must be included in the three month look-ahead summary of the monthly Quality Management Reports submitted by the Design-Builder;

(ii) be consistent with the Key Dates and the then-current Construction Schedule. The Testing and Commissioning schedule shall be linked to the Construction Schedule and include all construction prerequisites for all Testing and Commissioning Work; and

(iii) be safe, reasonable, practicable and in accordance with Good Industry Practice.

(c) Design-Builder must be responsible for the coordination and scheduling of all Testing and Commissioning Work and must perform all Testing and Commissioning Work in accordance with the applicable appropriately endorsed Testing and Commissioning Schedule.

2.7 Testing and Commissioning Constraints

(a) All Testing and Commissioning Works and activities that:

(i) are not intended to test and demonstrate operation during the peak hours as shown under the heading 'LRT Network General Hours of Operation' in the High Floor Operations and Maintenance Parameters; and

(ii) have the potential to disrupt adjacent or crossing vehicular traffic,

must be performed during off peak periods.

(b) All Testing and Commissioning Work and activities must comply with the Operating Rule Book and Standard Operating Procedures.

(c) Design-Builder must reasonably coordinate all Testing and Commissioning Work activities with the City's Testing and Commissioning Work described in Section 2.8 *[City Works Testing and Commissioning]*.

2.8 Notice of City Works Testing and Commissioning

The City will provide at least twenty days written notice to Design-Builder in advance of performing any Testing and Commissioning Work activities related to the City Works identified in Section 1-1.3 *[City Works]* of Schedule 5 *[D&C Performance Requirements]*.

2.9 Testing and Commissioning Documents

2.9.1 Testing and Commissioning Register

Not less than 60 days before the first scheduled activity of the Testing and Commissioning Work, Design-Builder must prepare and submit a register identifying and listing all activities to be performed as part of the Testing and Commissioning Work, (the "**Testing and Commissioning Register**"). The Testing and Commissioning Register must:

(a) be software based and have capability to manage the Testing and Commissioning data without issues due to complexity or volume of data

(b) include data fields to:

(i) record the Test Procedure document number and version to be used to perform each activity;

(ii) record the Testing and Commissioning Test Report document number to be used to record each activity;

(iii) record the actual date(s) of each activity;

(iv) record the pass/fail status of each activity;

(v) specify the sample rate or test frequency for each activity;

(vi) identify the Design-Builder Person responsible for performing each activity;

(vii) identify the Design-Builder Person responsible for witnessing each activity; and

(viii) identify the reference or document number of the standard, inspection checklist or procedure that must be used to conduct each activity.

2.9.2 Test Procedures

(a) Not less than 30 days before the scheduled date of the Testing and Commissioning Work activity, as applicable, Design-Builder must prepare and submit final inspection procedures, validation and test procedures for the relevant Testing and Commissioning Work activity, as applicable, (in each case, the "**Test Procedures**"). Each set of Test Procedures must:

(i) be assigned a unique document number that corresponds with the reference or document number identified for the corresponding activity in the Testing and Commissioning Register;

(ii) describe the purpose of the document and how the test or inspection activity must be performed;

(iii) uniquely identify the Equipment, component, system or sub-system undergoing the inspection or test;

(iv) include a description and diagram of the test configuration set-up, including test equipment connections and test points;

(v) include enumerated, step by step, instructions for performing the inspections or tests, along with pass/fail criteria and provision to record the results;

(vi) identify staffing requirements, including requirements from the City or other third parties;

(vii) identify required instrumentation, Equipment, facilities and supporting systems;

(viii) identify the test location;

(ix) provide Requirements Management traceability of the Project Requirements applicable to the inspection or test; and

(x) include detailed procedures and Testing and Commissioning rules to manage Hazards during Testing and Commissioning Work as further described in Section 2.5 *[Testing and Commissioning Plan and Sub-Plans]*.

(xi) include any requirement for involvement of LRVs and City staff. The provision of LRVs and City staff is subject to approval of the City and the following limitations:

(A) LRVs and City staff are not available on holidays or days which special events fall on.

(B) The resource requirements must be spread out over an appropriate time frame such that it does not result in the City experiencing any resourcing issues while operating the Capital Line LRT.

(C) No more than 20 LRVs if tests are scheduled during regular evening operations.

(D) A maximum of 50 LRVs if tests are scheduled during engineering hours as defined by the City.

(E) No more than 20 LRVs if tests require a weekend shutdown south of Southgate Station.

(b) Without limiting 2.9 *[Testing and Commissioning Documents]*:

(i) Test Procedures for Equipment described in Part 6 *[Systems]* of Schedule 5 *[D&C Performance Requirements]* must be in accordance with Good Industry Practice and include:

(A) Qualification Testing

(B) Factory acceptance test

(C) Site acceptance test

(D) System integration test

(ii) Test Procedures for Equipment described in Part 5 *[Facilities]* and Part 7 *[Operations and Maintenance Facility]* of Schedule 5 *[D&C Performance Requirements]* must be in accordance with Good Industry Practice and include:

(A) Qualification Testing

(B) Factory acceptance test

(C) Site acceptance test

(D) System integration test

2.9.3 Test Reports

(a) Design-Builder must prepare and submit a test report for each activity listed in the Testing and Commissioning Register (each, a "**Testing and Commissioning Test Report**"), no more than 28 days after the associated activity has been performed. Each Testing and Commissioning Test Report must:

(i) document the results for the applicable activity listed in the Testing and Commissioning Register;

(ii) be assigned a unique document number that matches the reference or document number identified for the corresponding activity in the Testing and Commissioning Register and be listed in the Handover Index for that scope or activity;

(iii) contain a reference to the corresponding Test Procedure;

(iv) record the date of the inspection or test;

(v) document version control;

(vi) record the equipment used in the inspection or test and applicable calibration results;

(vii) contain legible results, as recorded during the test or inspection;

(viii) include sample calculations demonstrating how the results were obtained from measured data;

(ix) include, where appropriate, photographs and other documentation;

(x) include a summary and conclusion of the test or inspection;

(xi) identify any Deficiencies and Nonconformities;

(xii) identify actions taken to rectify Deficiencies and Nonconformities

(xiii) be signed by the test engineer and/or Testing and Commissioning Manager

(b) Not less than 20 Business Days prior to the first scheduled Testing and Commissioning Work activity, Design-Builder must develop and implement an inspection and test recording system that permits ready retrieval of all inspection and test results. The City must be provided with secure access to the recording system. The recording system must be in compliance with the requirements of Section 6 *[Quality Control – Inspections and Testing]* of Schedule 9 *[Quality Management]*. All inspection and test results must be provided to the City upon request.

2.10 Commissioning Certificates

2.10.1 Testing and Commissioning Certification

(a) Design-Builder must issue a separate Commissioning Certificate for each applicable Work Package, Testing and Commissioning Sub-Plan described in the Testing and Commissioning Register, and a final Commissioning Certificate for the whole of the Infrastructure. The Commissioning Certificates must be in the form of the "Commissioning Certificate" included in Appendix 4B *[Certificate Forms]* of Schedule 4 *[Design and Construction Protocols]*.

(b) All Commissioning Certificates, together with the applicable Testing and Commissioning Test Report(s) and applicable supporting documentation, must be submitted to the City in accordance with Schedule 2 *[Submittal Review Procedure]*, with original signatures, stamps and registration numbers in such form as to allow the City to perform its review in respect of such Commissioning Certificates without delay.

(c) The Testing and Commissioning Manager must sign and stamp all Commissioning Certificates. The Designer must sign-off on the Commissioning Certificate.

2.11 Testing and Commissioning Program Reports

2.11.1 Testing and Commissioning Program Report

At least 30 business days before the Construction Completion Date, the Testing and Commissioning Manager on behalf of the Design-Builder must compile, prepare and submit a comprehensive Testing and Commissioning program report to the City (the "**Testing and Commissioning Program Report**"). The Testing and Commissioning Program Report must include:

(a) a description of all Testing and Commissioning Work, together with detailed records of all results, data and observations obtained during the Testing and Commissioning works;

(b) copies of all relevant Test Procedures and the corresponding test or inspection results;

(c) a copy of all applicable Testing and Commissioning Test Reports with evidence of Designer review to confirm conformance of the Infrastructure to the Project Requirements;

(d) photographs and other supplemental documentation;

(e) all signed-off test equipment quality control inspection sheets with final calibrations, set points, measurements, and inspection results; and

(f) a baseline report covering each tested piece of Equipment, component, system and sub-system, including all quantitative data required to establish a baseline for comparing performance, determining deterioration over the applicable Design Service Life and assessing the sufficiency and performance of the Maintenance Concept;

and the Testing and Commissioning Program Report must be authenticated by the Appropriate Person(s), where required to be so authenticated, and signed by the Testing and Commissioning Manager.

3. OPERATIONAL TESTING

3.1 Design-Builder Involvement in Operational Testing

(a) The City will be conducting Operational Testing for a test period of up to 90 days following Construction Completion.

(b) The City may restart the 90 day Operational Testing period should a Major Deficiency be discovered which limits the City's ability to complete Operational Testing.

(c) The City may allow the rectification of certain Deficiencies to be delayed beyond Service Readiness at its discretion.

(d) Design-Builder must make available any required Design-Builder Persons to support Operational Testing in Edmonton on 72 hours notice, or as otherwise agreed by the City, to respond to questions, address issues, provide training, attend at site visits, correct Deficiencies or fill other needs related to Design-Builder's fulfillment of the Project Requirements.

3.2 Test Activities

The City will conduct Operational Testing to confirm compliance with the requirements of Appendix 5-1B *[High Floor Operations and Maintenance Parameters]* of Schedule 5 [*D&C Performance Requirements*], including the following tests:

(a) Confirmation of service: five car trains operating on 5-minute headways sustained over a total 24-hour operation period.

(b) Confirmation that 15-minute headways can be maintained when single tracking using five car trains, including the following scenarios:

(i) Track blocking scenarios - including the existing Century Park signal territory,

(A) single track blocks,

(B) double track blocks, and

(C) triple track blocks

(ii) Signal block scenarios.

(iii) Switch blocking scenarios.

(c) VMS function validation:

(i) Accurate on-time arrival displays for both first train and second train.

(ii) System information display

(iii) Time, date, and temperature display

(iv) Targeted messaging including (service updates, station closures, etc)

(d) PA function validation:

(i) All PA announcements must be clear and at the volume prescribed in the High Floor Design Guidelines, including the station zone requirements.

(ii) Train arrival announcements

(iii) Text to voice messaging

(iv) Pre-set announcements both ad hoc and timed

(v) Direct voice communications

3.3 Operations Training

(a) All training activity that requires City personnel to be at track level or on rail borne equipment must be undertaken between the Construction Completion Date and Service Readiness Date. City trainers will be responsible for providing training to City personnel. The Design-Builder will be responsible for providing training to City trainers.

(b) The City will design training courses for all City personnel that are A-Book or B-Book certified. This will include Train Operators, LRT supervisory personnel whose job requires that they be at track level, and track level workers including both City personal or City certified contractors.

(c) The Design-Builder must review training courses prepared by the City and advise of any revisions required

3.4 Standard Operating Procedures and Operating Rule Book

The Design-Builder must review Operating Rule Book and recommend revisions as required to explain functionality of the Infrastructure and how to mitigate, troubleshoot and avoid problems associated with any new elements of the Infrastructure. Additionally, the Design-Builder must, where deemed necessary by the City, provide training that addresses the recommended revisions.