

Region of Waterloo  
Stage 1 Light Rail Transit Project

Performance Output Specifications  
Article 13  
Verification, Testing, Acceptance and Commissioning (VTAC)

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**ARTICLE 13 VERIFICATION, TESTING, ACCEPTANCE AND COMMISSIONING  
(VTAC)**

**13.1 General**

- (a) This Article describes the requirements for components, equipment, and systems verifications and tests, leading to and including Integrated Systems Tests, a Demonstrated System Operations Test and a Maintainability Demonstration Test, which together, if successful, shall lead to the issuance of the Substantial Completion Certificate for the Region of Waterloo Stage 1 Light Rail Transit System. Issuance of the aforementioned Certificate is a condition precedent to the entering revenue service operations. Also, this Article addresses the development, during the performance of the Phase 1 Work, of plans to monitor the dependability of the Project during the Phase 2 Work and tests and Final Acceptance of the total System by the Region.
- (b) The presentation of specific verification, testing, acceptance and commissioning requirements within this Article must not be construed to limit or modify in any way Project Co's responsibility to provide a holistic, comprehensive, and fully functional approach to verification, testing, acceptance and commissioning responsibilities. Project Co may add to these requirements, revised lexicon, combine and rearrange these requirements, or otherwise make modifications as needed to enable Project Co to meet its overall responsibility to provide a holistic, comprehensive, and fully functional approach to verification, testing, acceptance and commissioning needed to successfully deliver the Stage 1 LRT Project. However, as a minimum, the Verification, Testing, Acceptance and Commissioning Plan shall address every aspect of the requirements cited in this Article and the rationale for all deviations or variances from any requirement cited this Article must be fully described in the Verification, Testing, Acceptance and Commissioning Plan and presented in Project Co's submission.

**13.2 Requirements**

- (a) General
  - (i) Project Co shall subject the complete LRT System to a comprehensive test program to verify the design and performance characteristics and to determine compliance with safety and dependability characteristics. The comprehensive test program shall include the following elements: design conformance, flow charts, production conformance, installation, qualitative and quantitative verification, and routine acceptance tests on all items and integrated systems. Requirements concerning test plans, procedures and reports are subject to review and approval by the Region.
- (b) Verification, Test, Acceptance and Commissioning Plan
  - (i) Project Co shall prepare an outline Verification, Test, Acceptance and Commissioning Plan ("VTAC Plan") for the review of the Region as part of the Phase 1 submission.
  - (ii) The VTAC Plan shall be fully developed as a VTAC program as the work progresses for use in Project Co's performance of the work as well as for incorporation as necessary into construction documents. The VTAC Plan shall outline the methods and procedures to be utilized to verify System compliance with the technical requirements of the Project Agreement prior to attaining Revenue Ready status. The VTAC Plan shall be structured to ensure a systematic, thorough evaluation of all individual system components, as well as their integrated performance. This evaluation shall be accomplished through data submittals, inspection, testing and demonstrations, as described herein.

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- (iii) The VTAC Plan schedules shall reflect consideration of verification constraints which may normally be expected during certain hours of the day, such as work at street crossings during peak traffic periods. The schedules shall reflect any work shifts which are outside the normal work day of 8:00 a.m. to 5:00 p.m., Monday through Friday, resulting from these considerations, and the VTAC Plan shall explain the need for the special work shifts.
  - (iv) The VTAC Plan shall also provide procedures for implementing corrective actions after failed inspections, tests, or demonstrations and following up to ensure incorporation of corrections into System design.
  - (v) The VTAC Plan shall contain adequate information to reflect the VTAC program content and shall specifically incorporate a Product Improvement Verification Program (PIVP), a Software Verification Program (SVP), an Integrated Systems Demonstration Program (ISDP), a Maintainability Demonstration Test Plan (MDTP) and a Dependability Demonstration Test (DDT) Program.
  - (vi) Project Co shall also prepare a Systems Assurance Monitoring Plan (SAMP). This plan shall set forth Project Co's proposed methodology for measuring system assurance parameters during the Operations Term and Maintenance and Rehabilitation Term.
  - (vii) The pre-final VTAC Plan shall be submitted to the Region for approval within 120 calendar days after the issuance of the Phase 1, and the final VTAC Plan shall be submitted 30 days after receipt of the Region's comments and be updated thereafter, as may be required, but no less frequent than every six months.
- (c) VTAC Program
- (i) VTAC Program Outline
    - A. Project Co shall prepare the Verification Program in a building-block manner: identifying all design and performance requirements, assigning the requirement to the appropriate verification effort(s) (e.g., component or assembly development, subsystem/subassembly qualification or acceptance, installation, combined subsystem, system acceptance, or initial operation) and define the method(s) to be used to accomplish verification (e.g., test, analysis, similarity to an equivalent application, simulation, or in the case of dimensional or cosmetic requirements, inspection). As part of the VTAC Plan, Project Co shall develop a list of verification and acceptance tests which defines the planned verification and acceptance tests. When an identifiable block of hardware is subcontracted, it shall be noted.
  - (ii) VTAC Program Categories
    - A The VTAC Program shall address, at a minimum, the following categories of verification:
      1. Subsystem design and performance verification (in-plant and field).
      2. Component, assembly, and subsystem factory acceptance testing and post delivery acceptance testing (in-plant and field).
      3. Subsystem acceptance tests - qualitative and quantitative (field).
      4. Subsystem interface verification (in-plant and field).
      5. Integrated Systems Tests.

6. Hardware/software integration (in-plant and field).
  7. Emergency procedures/drills/simulations (field).
  8. Hardware installation/replacement testing (field).
  9. Maintenance hardware verification/training of personnel (field).
  10. Product Improvement Verification Program (PIVP).
  11. Software Verification Program (SVP).
  12. Integrated System Demonstration Program (ISDP).
  13. Maintainability Demonstration Test Program (MDTP).
  14. Reporting format for each verification/test performed.
  15. Verification Plan revision procedure and controls.
  16. Identification of the required Region-furnished material, personnel and/or equipment.
- (d) Subsystem Supplier Test Requirements
- (i) Subsystem Supplier Tests are required to ensure timely and effective site acceptance and site integration testing and commissioning of systems equipment, extensive equipment testing will be performed at the suppliers' facilities prior to shipping the equipment to the site. The testing will simulate the type of testing, which is planned to be performed in the field following the installation. This testing will be conducted under the auspices of the Subsystem design engineer and quality assurance representative. Systems design engineer is responsible for reviewing and signing off the test results, and preparing test reports. The reports shall be submitted to the Region Representative for review and approval. Shipment of the equipment will be authorized once the reports are approved.
  - (ii) Development, Prototype and Type Tests (design qualification) testing will be required where development work is performed during Subsystem design. Development, prototype and type testing is mandatory for equipment which has not been service proven. Development, prototype and type testing shall be performed on the pre-production units and systems and of sample units and materials for type approval. The testing shall take place and be successfully completed before any series production of the unit or assembly is commenced
  - (iii) Production conformance test shall be performed on each article. The test shall comprise the equipment supplier's production type Subsystem verification tests and functional static and dynamic tests performed on each Subsystem element.
  - (iv) Factory acceptance test of the Subsystem will be conducted to demonstrate the interaction of the various components of the Subsystem and verify performance of the Subsystem under normal, stressed, perturbed and failure conditions. A representative sample of components that make up the Subsystem will be connected in simulated configuration and tested for compliance for the functional requirements.
- (e) Field Commissioning Test Requirements
- (i) Field installation and commissioning tests will verify installation and functionality of the Subsystems and their components.

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- (ii) Post Installation Check-out Tests are normally conducted by the equipment installer to ensure that their installation work is done in accordance with the installation design, instructions, procedures and manuals.
  - (iii) Site Acceptance Tests will be performed after Post Installation Check-out Tests on the selected Subsystem equipment to ensure that all functional, operational and safety requirements are met. Powering up equipment normally occurs during the site acceptance tests. Site acceptance tests are normally performed by Subsystem/equipment supplier under supervision of the Subsystem design engineer.
- (f) VTAC Program Numbering Scheme
- (i) Project Co shall include in the VTAC Program a numbering scheme to identify verification efforts at the major assembly level or above for both in-plant and field activities, including installation verification. The numbering scheme shall present a logical identification of verification activities by discipline, level of test, sequence of test to allow constraint identification, category of test, (safety-critical, operation-critical, or non-critical) and location of activity. The numbering scheme shall be utilized in plans, procedures, reports and schedules produced by Project Co and Subcontractors.
- (g) Product Improvement Verification Program (PIVP)
- (i) Product improvement verification refers to the sequence of analyses, data submittals, and witnessed subsystem and system level testing required to substantiate the performance, reliability and safety of an authorized product improvement and thereby qualify it for use in the Project.
  - (ii) Project Co's Submission shall have listed specific product improvements which Project Co proposes to incorporate in the Project. Project Co, within 90 days after the issuance of the Phase 1, shall submit for the approval of the Region a Product Improvement Verification Plan covering each proposed product improvement. This Plan shall present an orderly procedure to verify the performance, reliability, and safety of the improvements. It shall include:
    - A. Critical milestones related to development of the product improvement and the final decision to incorporate the improvement into the Project.
    - B. Design review meetings to review conceptual design and implementation.
    - C. Qualification tests at the manufacturer's facility, witnessed by the Region representatives, which qualify the product improvement as an individual entity. (These tests shall include specific pass/fail criteria.)
    - D. Demonstrations witnessed by the Region representatives, which verify performance of the improved subsystem within the Project. (These tests shall include specific pass/fail criteria.)
    - E. Analyses, calculations and drawings prepared by the item manufacturer for review and comment where testing and/or demonstration is impractical or specifically waived by the Region.
  - (iii) The above items A, B, C, D, and E shall be successfully completed and approved by the Region prior to beginning fabrication of production hardware or materials, unless otherwise authorized.
- (h) Software Verification Program (SVP)

- (i) All software shall be subject to design, verification and configuration control requirements equivalent to those imposed on system hardware. Software shall comply with Project Co's approved Software Documentation Plan which must include the standards that will be applied to software development and testing.
  - (ii) Design reviews for software shall be conducted in accordance with the provisions of the Project Agreement. The algorithms, design and interface requirements, functional and programming hierarchies, organization and interconnection of modules, flowcharts, internal safeguards and checks, and debugging and modification procedures shall be presented. This data shall demonstrate the capacity of the software to withstand input data anomalies and to provide the necessary real time control under emergency and other abnormal conditions.
  - (iii) The software shall be tested and verified on a digital or hybrid simulator prior to interfacing with system hardware. All subsequent software modifications shall be developed off-line and verified on the simulator prior to incorporation into the System. The test and verification of the software shall confirm its security against unauthorized access or modification.
  - (iv) Following the Final Design Review, configuration control for software shall be established by Project Co. Thereafter, all changes and reasons for changes shall be identified and approved prior to implementation.
  - (v) Integration of the software into the System and subsequent testing shall be conducted in accordance with the VTAC Plan. This plan shall include the integration and test strategy for each software hierarchy level, individual tests and schedules, sources of prerequisite data for each test, provisions for controlled input data variations (representing noise, etc.), and the facilities and interlocking hardware to be used.
- (i) Integrated System Demonstration Program (ISDP)
- (i) Project Co shall develop and implement an Integrated System Demonstration Program that encompasses all verification efforts of Project Co, its Subcontractors and others to verify that the System meets all requirements on or before the commencement of revenue service.
  - (ii) Qualification testing successfully performed as part of the Product Improvement Verification Program shall be acceptable under the ISDP Program, in lieu of further testing. However, all product improvements shall be subject to the demonstration requirements set forth in the ISDP Program.
  - (iii) The Integrated Systems Demonstration Tests shall include all in-plant (proof of design, pre-delivery acceptance, and special), field (post-delivery acceptance, installation, integrated systems, pre-revenue startup including training, demonstrated service operation and maintainability), and other Project Co and Region verification activities which are necessary to confirm compliance with the design and performance requirements.
  - (iv) Specific test requirements shall be included in Project Co's Technical Specifications and these test requirements shall be utilized to ensure that all tests are set forth in a manner which clearly demonstrates that system/subsystem tests were conducted in compliance with all requirements before incorporation into the higher level integrated tests, now being defined. Test methodology shall be designed to assure that each succeeding test builds on previous, lower level, tests.

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- (v) The Integrated System Demonstration Program shall incorporate system operations demonstrations and test demonstrations for maintainability and dependability.
- (j) Maintainability Demonstration Test Program (MDTP)
  - (i) A Maintainability Demonstration Test shall be conducted on systems and/or subsystems jointly selected by the Region and Project Co to verify that they meet the Technical Provisions on or before the commencement of revenue service. It is anticipated that 30% of the approved Lowest Line Replacement Unit (LLRU) shall be demonstrated. The Region reserves the right of final selection of systems or subsystems or components to be tested. The Maintainability Demonstration Test shall be conducted concurrently with the Demonstrated System Operation Test. The Demonstrated System Operation Test and the Maintainability Demonstration Test are discussed in Section 13.6 of this Article.
- (k) Dependability Demonstration Test (DDT) Program
  - (i) A Dependability Demonstration Test shall be performed during revenue service operations on the Stage 1 LRT Project through the completion of one year of revenue service. Project Co shall plan this Dependability Demonstration Test, which is described in section 13.6 of this Article, by coordinating requirements with the Region.
- (l) System Assurance Monitoring Plan (SAMP)
  - (i) Project Co shall prepare and submit for the review and approval of the Region a SAMP not later than 240 calendar days prior to the commencement of revenue service. This Plan shall set forth Project Co's proposed methodology for the recording/logging of all operating incidents and for collecting and analyzing data to measure system assurance parameters during the Operations Term and Maintenance and Rehabilitation Term, and how such data will be compared with the System Dependability Requirements. The System Assurance Monitoring Plan shall include all data requirements, data sources, data gathering techniques, software, procedures and instruments, and computational methods to be used in recording actual system performance, and comparing it with specified requirements.
  - (ii) At a minimum, the following elements shall be included in the SAMP:
    - A. All required data shall be available from standard maintenance and operation records;
    - B. The Plan shall specifically address the disposition of service interruptions and/or delays attributable to passenger actions;
    - C. The Plan shall provide that System Assurance Monitoring shall start at the onset of revenue service of the Stage 1 LRT Project and shall continue for a one-year period, with data being collected at all times that these services are in operation;
    - D. The Plan shall explain Project Co's proposed methods for improving the system's performance, should such be necessary in order to meet the specified requirements; and
    - E. The Plan shall set forth the content and format of the monthly System Assurance Monitoring Report.
  - (iii) All operating incidents shall be automatically recorded by the System's Central Computer. The use of software to generate operating performance reports is required. A manually



written CCF Operator's log shall also be maintained and used to assist with determining exclusions and otherwise interpreting computer-generated data.

(m) Test Management

(i) Project Co. testing shall constitute a major portion of the continuing process of design verification. The following paragraphs describe the necessary features of Project Co test program.

(ii) Test Organization

A. Project Co shall identify its VTAC organization, including assigned responsibilities, and shall be responsible for assuring that qualified personnel are available for all test planning, scheduling, performance, analyses, review of data and reporting efforts. Project Co's description of organizational responsibilities shall include preparation of verification plans, procedures, reports; recording of test data; review of test data; reporting and resolving test failures and anomalies; and coordination of each identified test effort. Project Co's test organization shall reflect continuity with verifying engineering requirements and, at a minimum, shall respond to engineering in resolution of technical test issues such as test failures and retest requirements.

B. In addition, Project Co shall supply trained personnel in support of the Pre-Substantial Completion Demonstration and other tests required by the Region.

(iii) Commissioning Coordinator

A. Project Co shall identify a Commissioning Coordinator who shall be responsible for directing the efforts of Project Co's test organization. This individual shall not have project management or site management responsibilities. The Commissioning Coordinator shall be responsible for all aspects of the Verification Test and Acceptance effort, including coordinating access to test locations, arranging for support personnel from other Project Co functional areas and areas not under Project Co authority, coordinating test effort with other functional area construction and test activity, and providing overall monitoring of Project Co's test performance. As Project Co testing expands to the field, Project Co's Commissioning Coordinator shall ensure that test management is available on site to perform the single point contact functions with full authority to make and implement test decisions.

(iv) Test Notification

A. All testing shall be reflected on current schedules. In addition, Project Co shall notify the Region a minimum of 20 days prior to the commencement of factory tests and field tests. Project Co shall identify the tests to be performed in the VTAC Plan and indicate the notification to be applied. The Region, as part of the plan approval process, will indicate any tests which shall require notification by a different number of days.

(v) Test Access

A. The Region reserves the right of access to test activity for purposes of monitoring Project Co's performance and observing test progress.

(vi) Test Responsibility

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- A. Project Co shall be responsible for all tests performed under the Project Agreement. Project Co shall furnish all test instruments and other equipment and materials necessary for performing all tests. Proof of test equipment calibration shall be submitted to the Region upon request.
- (vii) Rejection and Retesting
  - A. Failure of equipment to meet factory or field test specifications or ratings shall be sufficient grounds for rejection of equipment. Rejected equipment shall be retested after suitable modifications are performed.
- (n) Test Equipment/Instrumentation
  - (i) Suitability/Calibration
    - A. Project Co shall be responsible for assuring that all test equipment and instrumentation are available and suitable for the intended purpose.
  - (ii) Region Equipment
    - A. Project Co shall identify any equipment which is not under Project Co's control and which is required to perform a verification activity on Region-furnished property. The Region will arrange for the availability of the requested equipment, if so needed, within a minimum of 30 calendar days notice from Project Co or such longer advance notice as the Region may deem reasonable for the particular request.
- (o) Test Criticality
  - (i) Identification of Requirements
    - A. Each verification requirement in the VTAC Plan shall be assessed for its criticality to system performance and safety and classified as Safety-Critical, Performance-Critical, or Non-Critical.
  - (ii) Safety-Critical Design and Performance Requirements
    - A. Safety requirements (e.g., components, circuits, performance) shall be verified only by test unless specific directions to the contrary are provided by the Region. Project Co shall consider the use of analyses and similarity as means of accomplishing verification where the identical equipment has been successfully used under essentially identical conditions to that required in the Stage 1 LRT Project. Testing is the desired method of verification; however, when a method other than testing is used, it shall be applied no less stringently. The final analysis and evidence of similarity to an equivalent application, including the applicable test data or report, shall be provided as part of the verification report.
    - B. Equipment of which the failure could present a safety hazard shall be demonstrated to comply with design and performance requirements by testing. Project Co shall ensure demonstration of design limits and shall include simulations, where necessary, to confirm redundant safety features. Where design limit verification is not practical, Project Co shall address each case in the Integrated System Demonstration Plan for the approval of the Region, providing detail justification for testing to other than design limits.
  - (iii) Performance Critical Design and Performance Requirements

- A. Equipment, of which the failure will cause system operational delays but will result in no safety hazard, shall normally be demonstrated to comply with design and performance requirements by testing. Analysis may be used to demonstrate equipment life, provided that a minimum of 10,000 hours of demonstrated operation under essentially identical operating environments has been accomplished on another project and the test report and operational records are available to substantiate the analysis or similarity contention.
- (iv) Non-Critical Design and Performance Requirements
  - A. Equipment of which the failure will neither cause system operational delays nor provide a safety hazard shall be demonstrated to comply with design and performance requirements in a method acceptable to the Region.
- (p) VTAC Reports
  - (i) Project Co shall provide formal reports of results of all verification activities to confirm compliance with design and performance requirements as defined herein.
  - (ii) Interim Reports
    - A. Project Co shall prepare Interim Reports for tests which form a part of a distinct equipment group but which can be assessed incrementally or before completion of total equipment group tests. The Interim Report shall identify all failures and corrective actions encountered in the course of the verification activity.
  - (iii) Summary Reports
    - A. When Project Co has completed the tests in a particular classification or group level for a distinct equipment group (to be identified by Project Co in Integrated System Verification Plan) and the test results satisfy the prerequisites for beginning tests at the next classification or group level, Project Co shall submit a summary report containing such test results to the Region for approval.
  - (iv) Equipment Failure and Incident Report
    - A. The Equipment Failure and Incident Report is intended to provide an audit trail of failure areas experienced during testing. Project Co shall provide Discrepancy Reports, in tabular form, documenting all equipment failures to the lowest level replaceable part. The Equipment Failure and Incident Report shall be a composite of sequentially numbered Discrepancy Reports numbered to allow identification of equipment sub-elements and shall include all pertinent data regarding the failures. The report shall be updated quarterly until start of field tests and then be maintained current through completion of field tests, including the Dependability Demonstration Test.
  - (v) System Assurance Monitoring Report
    - A. During the Operations Term and Maintenance and Rehabilitation Term for the Stage 1 LRT Project, Project Co shall undertake the program of operational data collection and analysis as required in the approved System Assurance Monitoring Plan. These operational data are to prove the actual performance of the System in revenue service and to verify required dependability and other system assurance requirements. Project Co shall submit monthly System Assurance Monitoring Reports to the Region for review and evaluation. The System Assurance

Monitoring Report shall include all of the performance measures identified in Schedule 11; Schedule 15-3 –; Schedule 15-4, and; Appendix A of Schedule 15-3.

- (q) Notification, Briefings, and Submittals
  - (i) The Region shall be notified concerning time and location at least twenty (20) days prior to each VTAC Plan scheduled qualification test and/or demonstration, and shall have the right to witness each test or demonstration.
  - (ii) A pre-test briefing involving Project Co's testing staff and the Region representatives shall be held prior to each test. At this meeting, Project Co shall distribute approved test procedures and shall discuss the test with the Region representatives.
  - (iii) Following each test a post-test briefing, including both Project Co's testing staff and the Region representatives, shall be held to discuss the results of the test and obtain agreement upon whether it was successful or if there is a need for additional tests.
  - (iv) Test reports shall be submitted to the Region following each test and/or demonstration. These reports shall include the test procedures, prevailing weather data (if applicable), unusual conditions or events, complete test data, and pass/fail disposition. The reports shall include any failures which occurred during the test/demonstration, whether or not related to the equipment under test. Proof of calibration of all test equipment used and documented traceability to primary calibration standards shall be submitted with the test report, if requested by the Region. Subcontractor test reports shall be approved by Project Co prior to submittal to the Region. All test data sheets shall be signed by the Region representatives witnessing the tests.
  - (v) If debugging becomes necessary during any test, the test sequence affected shall be repeated at Project Co's expense.

**13.3 Work for VTAC**

- (a) Facilities Work includes but is not limited to:
  - (i) Civil Works – Structures, Beams, Columns, Foundations, TPSS Sites, Yard Leads and Yard Site
  - (ii) LRT Stops and LRT Stop Rooms or cabinets for Equipment
  - (iii) Maintenance Buildings and Equipment
- (b) Systems (Systemwide) Work includes but is not limited to:
  - (i) Vehicles (excluding Work previously verified by the Region)
  - (ii) Trackwork, including special trackwork
  - (iii) Power Distribution System
    - A. Substations
    - B. OCS
  - (iv) Train Control
    - A. On Board Vehicle Equipment
    - B. Wayside Train Control and Crossing Warning Systems
  - (v) ITS and Communication Systems, including SCADA and on-board vehicle equipment

- (vi) CCF Facility

#### 13.4 Verification Tests

- (a) General Requirements

Project Co shall test and qualify the functional performance of selected components, assemblies or subsystems prior to final construction, installation and/or assembly, as set forth herein and throughout the Project Agreement. Product or sub-element qualification tests shall be performed in accordance with industry-standard tests and specifications and/or quality assurance test specifications.

- (i) Types of Qualification Tests

Qualification testing may be of one or more of the following types:

- A. Project Co. testing and submittal of test results that are acceptable to the Region as evidence that Project Agreement requirements will be met.
  - B. Supplier testing and submittal by Project Co of reports of certified test results acceptable to the Region as evidence that Project Agreement requirements will be met.
  - C. Previous testing of the item and submittal by Project Co of reports of certified test results acceptable to the Region as evidence that Project Agreement requirements will be met.
  - D. Testing witnessed by the Region's representatives and results acceptable to the Region as evidence that Project Agreement requirements will be met.
  - E. Evidence of Service-Proven Equipment, with documented results and certification acceptable to the Region as evidence that Project Agreement requirements will be met.
- (ii) While many qualification tests may necessarily be conducted on either a test track or under laboratory conditions, certain tests, such as exterior noise and ride comfort, shall necessarily be conducted at the Work Site on the System trackways. In addition, the Region requires qualification testing for all new designs and product modifications for which acceptable data submittals are not provided. In general, subsystem or component qualification tests will be waived by the Region if acceptable data are available for the same design or identical equipment proven in a similar application or by a prior qualification test. It is not the intent of this requirement to require additional testing where sufficient other qualifying data are available. The conditions for granting a waiver of qualification testing of a component or subsystem are as follows:
    - A. The design is identical to a design which has been qualified by previous qualification testing; and,
    - B. If qualified by previous testing, copies of testing documents shall demonstrate results to the same or greater level of detail as described herein below.
  - (iii) Compliance for some aspects of the System may be verified through product qualification testing. When qualification tests are intended by Project Co to serve as a means of verifying compliance with the Project Agreement, Project Co shall specifically identify the test as a "Test for Project Agreement Compliance," and include the applicable "Compliance Verification Matrix I.D. Number" as part of the test notification.

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- (iv) For each test/verification contained in the VTAC Program, Project Co shall include the following general information, where applicable
  - A. Name of test/reference number
  - B. Procedure, objective and scope
  - C. Special environmental requirements, if any
  - D. Sample size
  - E. Equipment, facilities, and personnel required
  - F. Step-by-step procedures for tests
  - G. Glossary of technical terms used in procedures
  - H. Estimated time required
  - I. Description of set-up
  - J. Data to be recorded (data sheet)
  - K. Pass/Fail criteria
  - L. Documentation required.
- (v) Written Qualification Test Procedures and written Qualification Test Reports shall be submitted by Project Co to the Region. In addition, Project Co shall notify the Region at least thirty (30) days in advance of the date that it is anticipated the test will be conducted; the Region shall be notified at least fourteen (14) days in advance of the actual date the test is conducted. The Region shall have the right to witness any and all qualification tests.
- (vi) Within thirty (30) days after the completion of each qualification test, the qualification test data and results of the test shall be transmitted to the Region for review. The Region will notify Project Co in writing that the test results are acceptable, acceptable as noted, or not acceptable and the reason therefore. Any equipment found not to be in compliance with the Project Agreement during a qualification test may be rejected by the Region.
- (b) Tests of Materials and Subassemblies Used in the Construction of Fixed Facilities
  - (i) The testing of materials used in the construction of fixed facilities shall be conducted by Project Co, supplier, or special Subcontractor to verify that the installed materials meet or exceed the design requirements and the Project Agreement requirements.
  - (ii) Project Co shall perform field tests, non-destructive testing, and destructive testing as part of the Quality Assurance Program to assure that Project Co's design, subsequent construction, and quality of skilled workers meet the Region's satisfaction.
- (c) Factory Test of Operating System Equipment
  - (i) All assemblies and all subsystems of the Operating System shall be tested in the assembly plant prior to shipment to the site to check and establish proper individual operation. As a minimum the subsystems and subsystem equipment identified in shall undergo factory testing prior to shipping to the site. Prior notification to the Region of factory tests is not required unless:
    - A. As a result of design review or other information, the Region requests to be notified; or

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- B. Project Co intends to use a factory test for purposes of Contract compliance verification.
- (ii) The Region shall, however, have the right to witness any factory tests, conducted for whatever purposes, if such test is material to Project Co's performance as part of the Project Agreement. (It is the intent of this Article to present the general scope of factory testing to be conducted by Project Co, but not to prescribe exact methods for conducting such tests. Project Co may use established test procedures for conducting the factory tests where such procedures are appropriate to meet the same objectives as defined below.)
- (iii) When factory tests are intended by Project Co to serve as a means of verifying Project Agreement compliance, Project Co shall so notify the Region, specifically identify the test as a "Test for Project Agreement Compliance," and include the applicable "Compliance Verification Matrix I.D. Number" as part of the test notification.
- (iv) Vehicles
  - A. Each vehicle shall be checked and tested by Project Co to ensure it is fully functional before the installation of any Project Co on-board equipment. Each vehicle shall also be checked and tested by Project Co to establish as-manufactured compliance with the applicable specifications for all equipment installed by Project Co. Testing shall establish proper operation of all safety interlocks and emergency systems, proper operation of propulsion and braking, proper operation of circuit breakers and interrupts, proper response to commands from CCF, proper functioning of all communications and grounding, emergency braking distances and reaction time, and speed control. In addition, visual inspection shall verify proper workmanship, materials and finish, and graphics. Final integration tests of on-board vehicle equipment installed by Project Co shall be conducted on Stage 1 LRT facilities and wayside equipment. Each vehicle shall be fully tested with regard to its individual and entrained performance and its ability to function properly in all manual operational modes.
- (v) Train Control Equipment
  - A. Project Co shall functionally test the integrated operation of all LRT Stop and wayside Train Control equipment prior to its shipment from the factory. To the maximum extent practicable, these tests shall be performed to establish proper interfaces among items of Train Control equipment and interfaces with other subsystems and equipment through the use of appropriate simulators. As a minimum, the tests shall demonstrate the capabilities of the equipment to perform in accordance with the applicable requirements of the Project Agreement.
- (vi) Power Distribution System Equipment
  - A. Project Co shall perform all tests listed in ANSI C37.20, paragraph 5.2, as "Design Tests" on one representative switchgear assembly of each type and rating furnished under the Project Agreement.
  - B. Project Co shall also perform all tests listed as "Production Tests" in ANSI C37.20, paragraph 5.3, on every switchgear assembly, and the assemblies shall be shipped as tested.
  - C. All rectifier units and auxiliaries and rectifier-transformer equipment, if applicable, shall undergo a "Schedule of Tests" in accordance with ANSI C34.2, paragraph

5.3.1. All tests listed shall be performed. Dry-type distribution and/or power transformers shall be tested in accordance with ANSI C57.12.01, paragraph 3 and Table 7. One transformer of each type shall be tested in the "design" and "other" test classifications. All transformers shall be tested in the "routine" test classification.

- (vii) CCF Equipment
  - A. Project Co shall establish the proper integrated operation of CCF prior to shipment of the associated equipment. Tests shall include the computers, associated input/output devices, peripherals, master and remote data communication devices (including transmission elements, CCF Console, the System Standard Display, and the Power Station Display), and the communications equipment. For the purposes of these tests, interfaces with other subsystems (i.e., Train Control, power distribution, vehicle, and/or communications) may be simulated. During these tests, the subsystems software shall be fully exercised.
- (viii) Maintenance Equipment
  - A. Project Co shall functionally test the integrated operation of all Train Control and departure test equipment associated with the Maintenance and Storage Facility. Other maintenance equipment and special tools that are essential to operations, maintenance, and safety shall also be tested.
- (ix) Fare Collection Equipment Interfaces
  - A. Project Co shall test the interfaces between the fare collection equipment, the SCADA system and the intrusion detection devices within the fare collection equipment to confirm proper operation and reporting.
- (d) Fixed Facilities Tests and Inspection
  - (i) It is Project Co's responsibility to ensure that materials and workmanship are in accordance with the design documents and that the Region can perform a complete review of Project Co's work.
  - (ii) Project Co shall develop a Guidelines for Construction Inspection Manual detailing the inspection requirements and reporting methods. Once accepted by the Region, the Guidelines Manual shall be issued to Project Co's Inspectors and shall require, among other things, an Inspector's Daily Report to be completed for every day on which work is performed.
  - (iii) Project Co shall develop a Resident Engineer's Manual detailing the construction monitoring requirements of the Resident Engineer (or equivalent position). Once accepted by the Region, this Manual shall require the maintenance of a daily log of all construction site activities and a Weekly Progress Report to include the following:
    - A. Report number, period covered, and title
    - B. Scheduled status
    - C. Percentage complete
    - D. Weather
    - E. Manpower and equipment



- F. Construction status with digital photographs
  - G. Visitors
  - H. Problems
  - I. Summary of inspector reports
  - J. Log or test results.
- (e) On-Site Integration Tests
- (i) It is the intent of this Article to present the general scope of on-site integration activities that must be conducted by Project Co, but not to prescribe exact methods for conducting such tests. Project Co may use established test procedures for conducting the on-site integration activities where such procedures are appropriate to meet the same objectives described below.
  - (ii) Project Co shall ship all equipment, materials, and supplies to itself at the site, make all necessary receiving inspections, and furnish the Region with a copy of the receiving and inspection reports. All subsystem installation, checkout, and integration activities shall be accomplished in accordance with the requirements of the Project Agreement. The subsystem installation checkout and integration activities shall verify that each subsystem, and assemblies thereof, are installed and interconnected in accordance with approved design drawings and engineering installation instructions, and that they function in accordance with the intended design.
  - (iii) Prior notification to the Region of on-site integration activities is not required unless, as a result of design review or other information, the Region requests to be notified.
  - (iv) The Region shall, however, have the right to witness any on-site integration activity. All on-site integration shall be completed prior to initiation of Acceptance Testing of the Operating System.
  - (v) Trackwork and Switches
    - A. Project Co shall inspect the trackwork, particularly the gauge and superelevation and the switches, to determine conformance with the approved design and construction drawings. End-of-line buffer installations shall also be inspected and checked to be in accordance with respective Project Co installation drawings and instructions.
    - B. Once dimensions throughout the System are checked with a template sized as per Schedule 15-2 Article 11 to reflect the dynamic movement of an actual vehicle, the power distribution system shall be energized, and one vehicle shall be operated on all trackways in both directions to check trackway clearances and OCS interfaces with vehicle pantographs.
  - (vi) Vehicles
    - A. The following minimum list of activities shall be conducted on each vehicle individually and entrained. Data shall be analyzed and calibrations made or other corrective measures taken, as required:
      - 1. Speed Control - check speed regulation, balancing speed and overspeed protection.

2. Emergency Braking - check application time, stopping profile, and stopping distance.
  3. Parking Brake Application - check to see that the parking brake will hold the vehicle on the worst case grade.
  4. Direction Control and Unauthorized Motions - check proper operation.
  5. Repeat Speed Control and Emergency Braking checks on one vehicle and ultimate-length train under normal service load conditions.
  6. LRT Stop - check that the train stops at all LRT Stops, including the King and Victoria Station, meet Project Agreement requirements using a load range from an empty to a normal service load for single vehicles and two-vehicle trains.
  7. Interior Ride Quality and Surface Vibration - check compliance with the ride quality requirements for all loading conditions for trains on each trackway. Project Co shall be prepared to provide specialized equipment, if requested, to analyze and resolve ride quality problems and determine if the problems are due to the LRT vehicle design or trackway design or construction, or vehicle/track interface dynamics. This test shall be performed for trains that are unloaded and train that are loaded to the normal service loading.
  8. Interior and Exterior Noise - check compliance with the requirements for external noise emissions and for passenger compartment internal noise. This test shall be performed for trains that are unloaded and train that are loaded to the normal service loading.
  9. Operating Checks of the vehicles shall include the following:
    - I. Coupler and draft gear
    - II. Manual Control Console
    - III. Doors and Door Control (side and end)
    - IV. HVAC
    - V. Lights
    - VI. Low Voltage Power Supply
    - VII. Battery and Battery Charger.
- (vii) Train Control System
- A. Static operating checks of the train control system shall start at the functional assembly level and progress in an orderly fashion through the individual subsystems until, finally static (no vehicle) checks are performed on the entire, totally integrated system. At the assembly and individual subsystem levels, these checks shall duplicate in-plant tests performed in the factory. Beyond the subsystem level, actual interfaces shall be established, including interfaces with functioning vehicles and trains, and proper interaction between subsystems shall be confirmed. During static operating checks of CCF, all supervisory control points (alarms, indicators, and controls) shall be individually verified from point of origin

to final destination. All devices and/or functions capable of operation or initiation from CCF, including those controllable devices and/or functions associated with train control and power distribution, shall be so operated or initiated. Likewise, all conditions which result in CCF indications and/or alarm annunciations for these systems shall also be checked.

- B. Project Co shall establish proper train control signal reception over the entire length of each trackway equipped with train control elements, using vehicles especially outfitted with chart recorders or other recording devices suited for this purpose.
- C. Wayside/vehicle Train control interfaces for dwell time control, bunch control, vehicle audio message control, and vehicle data communication shall be checked, and their proper operation shall be determined at all locations on the operating system.
- D. All automatic control functions and all manual control functions shall be exercised, and their proper operation shall be checked.

(viii) Communications System Equipment

- A. Project Co shall perform the complete installation and checkout and implement full service operations of the various communications subsystems as soon as possible so that they may be employed in other integration activities. Communications equipment manufacturers' installation and checkout instructions shall be followed. By the time the various systems are placed in service, all applicable governmental requirements and standards shall have been met.
- B. Operating checks of the communications system shall include testing, from the CCF Console and other control areas, the coordinated operations of the public address systems, telephone systems, traffic signal controls, train controls, radio communication systems, CCTV systems, and communications recording systems. During these checks, all associated supervisory controls and communications options shall be functioning according to the Project Agreement. As required, communications systems shall be regression tested as the train control and SCADA systems become operational.

(ix) Power Distribution System Equipment

- A. Project Co shall as a minimum:
  - 1. Inspect each equipment installation against installation drawings and instructions.
  - 2. Make continuity checks of all interconnecting wiring and check phase of three-phase power connections.
  - 3. Check all wire and cable terminations for tightness.
  - 4. Measure and record conductor-to-ground resistance of all power cables and TES/OCS sections in the System on a circuit-by-circuit basis for each, section of OCS which can be individually isolated. Compare the results of these checks among themselves, isolate OCS and cables that do not meet the expected megaohms criteria, and remedy the problems.
  - 5. Check the calibration of circuit breaker trip units.

- B. Static operating checks of the power distribution system shall consist of checking resistance to ground, energizing the system, opening and closing all breakers, checking all interlocks, and recording no-load voltage and current readings for all valid power feed configurations.
  - C. Uninterruptible power supplies shall be checked to assure proper operations in primary supply mode and battery supply mode. The capability to switch automatically, without disruption, from primary source to battery source upon loss of primary source shall be determined. Tests shall also assure the ability to transfer manually, without disruption from battery source to primary source upon restoration of the primary supply.
  - D. Project Co shall record line voltages, line currents, power, motor current, and speed on vehicles with all auxiliaries on under the following operating conditions:
    - 1. Normal Service loading for the ultimate-length train over each trackway (round trip), with LRT Stop and service by all System power sources.
    - 2. Normal Service loading for the ultimate-length train over each trackway (round trip), with LRT Stops and service by one primary feeder with the second primary feeder out of service.
  - E. These checks shall be repeated with all trackway related power turned on.
  - F. The data taken shall be correlated by LRT Stop and analyzed to determine power factor and to verify power distribution system voltage regulation requirements. Analysis shall show that the power distribution system will impose no restrictions on ultimate train length, train operations or the operation of vehicle auxiliaries due to poor voltage regulation.
  - G. In addition to the above, checks shall be conducted to show coordination and proper operation of fault detection devices.
- (x) LRT Stop Equipment
- A. Project Co shall inspect and check the installation and operation of all LRT Stop equipment, including fare vending equipment and ticket validators provided by others, against approved installation drawings and instructions. All equipment shall be energized and the control and operation shall be operated from associated local control panels and from CCF. Control of all LRT Stop equipment shall be checked for all modes of train operation.
- (xi) Operations Maintenance and Storage Facility (OMSF) Equipment
- A. Inspection and installation checkout of all OMSF equipment shall be performed by Project Co using procedures, techniques, and acceptance criteria which are fully compatible with the installation and checkout of corresponding main line equipment; i.e., trackway and trackway-mounted equipment, Train Control equipment, control consoles UPS equipment, communications equipment, and power distribution equipment. All maintenance building equipment, furnishings, and special tools and equipment shall be checked as ready for functional use. The inventory of all such items, spare parts, and consumables shall be affirmed.

### 13.5 Acceptance

#### (a) General Requirements

- (i) This Article describes the methods and procedures by which the Fixed Facilities and the installed and delivered Operating System will be verified to the Region by Project Co as complying with the requirements of the Project Agreement, and thereafter accepted by the Region. This Article describes the Region's guidelines for an acceptable systems acceptance process. Project Co shall develop and execute its plan, making use of acceptance processes shown to be effective on past projects. Project Co's process shall achieve the objectives defined in this Article.
- (ii) Project Co shall thoroughly verify each aspect of the System and equipment prior to commencement of the acceptance test activities discussed below; such prior verification shall be accomplished during the design review, product qualification testing, factory testing, on-site integration tests and fixed facilities inspection and test.
- (iii) Project Co shall advise the Region when the Fixed Facilities and Operating System are ready for acceptance activities, which shall not occur until Project Co has completed all of the on-site integration tests and corrected any deficiencies and failures. Project Co shall provide all resources necessary for, and carry out all of, the compliance verification and acceptance activities defined herein. The Region will witness and review the results of these activities. Compliance verification and system acceptance will be accomplished on the basis of the Region's review and acceptance of the compliance verification and system acceptance activities and documentation of Project Co.

#### (b) Verification and Acceptance Procedures

- (i) Project Co shall prepare, and submit for acceptance by the Region, a list of the Fixed Facilities and Operating System requirements for which Project Co shall show compliance for acceptance purposes. Previously conducted tests and data submittals that have been accepted by the Region may also be used to satisfy appropriate requirements.
- (ii) Three methods of compliance verification and acceptance are indicated and defined as follows:
  - A. Analysis - Project Co shall submit analysis information and data in a manner so as not to impede the verification and acceptance process. Analyses provided by Project Co during the design review process may, at the sole discretion of the Region, be used for verification and acceptance purposes. At the time of the design reviews, the Region will examine the design review material and, in its sole discretion, determine its applicability for any verification and acceptance purposes.
  - B. Inspection - In cases where inspections are to serve as the basis for compliance verification, Project Co shall prepare detailed Inspection Procedures and submit these to the Region for review not later than thirty (30) days prior to the schedule date of the inspection. The inspection Procedures shall identify each element for which that inspection is to demonstrate compliance. Project Co shall conduct each inspection in accordance with the Inspection Procedures reviewed by the Region; no inspection shall be performed prior to obtaining the Region's review and approval of such Inspection Procedures. The results shall be documented in a suitable Inspection Report clearly showing if the inspection passed or failed based on the Pass/Fail Criteria shown in the procedure. Inspection reports shall be

submitted in accordance with this Article. The Region may witness any inspection conducted for compliance verification purposes. Inspections performed by permitting agencies are a valid form of compliance verification.

- C. Test - Project Co shall prepare detailed procedures for all tests, and submit them to the Region for review and acceptance not later than forty-five (45) days prior to the scheduled date of the test. The Test Procedures shall identify each line item to be tested to demonstrate compliance. Such reference shall be by line item identification number and Article of the Project Agreement. Project Co shall attempt to combine the performance verification tests of more than one item into the same test sequence, thereby minimizing the number of separate tests. Project Co shall conduct each test in accordance with the Test Procedure reviewed and accepted by the Region, and no test shall be performed prior to obtaining the Region's acceptance of such Test Procedures. Project Co shall document the results in a suitable Test Report containing test data in an easily interpretable form and clearly showing if the test passed or failed based on the Pass/Fail Criteria shown in the Test Procedure. The Region may witness any test conducted for verification and acceptance purposes.

(c) Fixed Facilities Acceptance

- (i) At its discretion, and upon written request from Project Co, the Region may perform in-progress fixed facilities inspections on selected portions of the fixed facilities. At that time, a punch list of any items to be completed or corrected shall be prepared. This inspection shall not be construed as a prefinal fixed facilities inspection. Once the System is nearing operational readiness, in Project Co's opinion, it may request a prefinal fixed facilities inspection. If this inspection is satisfactory to the Region, a punch list of any items to be completed or corrected shall be prepared. After completing the punch list, Project Co shall request in writing a final inspection of fixed facilities. Such request shall represent that (1) the punch list items have been corrected; and (2) the facility is complete and ready for final acceptance. If this inspection yields findings satisfactory to the Region, the Region will accept the fixed facilities portion of the work.

(d) Operating System Acceptance

- (i) The Region will accept the Operating System when all aspects of the Operating System have been verified to comply with the requirements of the Project Agreement. As previously presented, verification will be accomplished by analysis, inspection and testing; as a consequence, verification (and therefore System acceptance) is a step-by-step process which takes place throughout the life of the Project Agreement. Because of this, it is necessary to establish a systematic, carefully documented process to monitor and record the progress of verification and System acceptance. Such a systematic process is the purpose of the Operating System Acceptance Plan.
- (ii) As a means of implementing the compliance verification and System acceptance requirements of this Article, Project Co shall develop an Operating System Acceptance Plan including a preliminary list of the Analyses, Inspections and Tests that will be conducted by Project Co. Within 120 days after the commencement of Phase 1, Project Co shall submit this Operating System Acceptance Plan. The Region will provide comments to the Operating System Acceptance Plan and provide them to Project Co within 60 days after receipt of Project Co's Plan.

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- (iii) Once the final Operating System Acceptance Plan is approved, it shall be Project Co's responsibility to identify and finalize the list of Analyses, Inspections and Tests that will be conducted to satisfy the Plan. Analyses shall be submitted pursuant to the Design Review procedures. For each Inspection and/or Test which Project Co determines is required to satisfy the System Acceptance Plan, Project Co shall prepare an appropriate Inspection Procedure or Test Procedure, and submit this Procedure for the Region's prior review. The final activities for acceptance of the Operating System shall be the Demonstrated Systems Operations and Maintainability Demonstration Tests.
- (e) Operating System Acceptance Plan
  - (i) Purpose and Philosophy
    - A. The purpose of this Operating System Acceptance Plan is to provide a means for Project Co to demonstrate to the Region by tests and inspections that the Operating System satisfies the requirements of the Project Agreement. The proposed plan has been developed to maximize the efficiency and minimize the time required of the Region for witnessing (and that required of Project Co for conducting) these activities. The plan sets forth the specific acceptance activities which the Region believes are the minimum necessary for Project Co to demonstrate Contract compliance in general; however, each specific requirement will be individually verified by the acceptance activities.
    - B. There will be requirements that may be implied to be verified because they are embodied within or in support of a higher level requirement. However, acceptance of such higher level requirements shall not relieve Project Co of its responsibilities to meet all requirements, including any not specifically verified. The plan also establishes the general sequence of activities.
  - (ii) Plan Description
    - A. Each activity shall be conducted in accordance with written procedures prepared by Project Co and accepted by the Region prior to the start of that specific activity. Activities will be grouped into the categories and a test sequencing will be provided by Project Co. Therefore, certain activities shall be completed successfully as a prerequisite for conducting other activities. The acceptance activities will be conducted by category, with no activity being performed unless all of the activities in the prerequisite categories have been successfully completed and a test report submitted.
    - B. Test/Inspection Acceptance Categories
      - 1. The purpose of the categories is to logically group activities and establish the general sequence in which testing is to take place. The intent of the requirement that these categories of activities be conducted in a specific order is to minimize the likelihood of invalidating a previously conducted acceptance activity by making a change to a part of the System in order to successfully conduct another activity.
      - 2. The categories developed by Project Co shall be identified by a code letter in the lower right-hand corner. The sequence in which activities within each of the categories are conducted may be determined by Project Co. Activities

which are closely related may be conducted together, but documentation must be kept separated.

C. Test/Inspection Acceptance Activities

1. The proposed plan identifies the specific acceptance activities which shall be conducted by Project Co. The Region has developed a standard format, which shall be used by Project Co to prepare detailed Acceptance Inspection Test Procedures for each activity.
2. Exhibit 13.5-1 outlines an acceptable Test/Inspection Acceptance Report format.

Exhibit 13.5-1  
Test/Inspection Acceptance Activities Report

1.0	TITLE: Title of acceptance activity, including its identification code.
2.0	REFERENCE CONTRACT SECTION: The section number and title of the Project Agreement provision which is addressed by the acceptance activity.
3.0	PREREQUISITE ACCEPTANCE ACTIVITIES: The acceptance activity categories which must be successfully completed prior to conducting this activity.
4.0	OBJECTIVES: The specific intent of the acceptance activity regarding the referenced Project Agreement Article.
5.0	SAMPLE SIZE: The number of units (e.g., vehicles) required to be used in the acceptance activity or the specific area involved (e.g., maintenance building).
6.0	ENVIRONMENTAL REQUIREMENTS: Any specific environment's conditions required in order for the acceptance activity to demonstrate conformance with the referenced technical requirement.
7.0	EQUIPMENT/FACILITY REQUIREMENTS: Any test equipment or special facility needs of the acceptance activity.
8.0	PERSONNEL/SKILL REQUIREMENTS: The number of Project Co personnel required to perform the acceptance activity, as well as the skill levels of the individuals.
9.0	ESTIMATED TIME REQUIREMENT: The period of time required to conduct each acceptance activity. If the activity is conducted on each of several units (e.g., LRT Stops), the time required for each unit shall be given.
10.0	DATA TO BE RECORDED: The specific data which are necessary to show compliance with the referenced Project Agreement requirement shall be listed, as well as the means by which these are to be obtained. The specific method of documentation shall also be identified.
11.0	PASS/FAIL CRITERIA: The specific limits within which the data identified in 10.0 must fall in order for the activity to be acceptable.
12.0	PROCEDURES: The detailed, step-by-step, description of the acceptance activity. This will provide specific directions to the person(s) conducting the activity, including operating instructions for test equipment and when to record data.
13.0	COMMENTS: Narrative description of any occurrences or events that may have an impact on personnel safety, equipment integrity or the validity of the data.



Exhibit 13.5-1  
Test/Inspection Acceptance Activities Report

14.0	CONCLUSIONS: The results of the activity, including a formal test report statement by Project Co as to whether the data satisfied the Pass/Fail criteria, any open items must be identified and the signatures of the participants must be provided.
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3. Project Co will develop the details of format elements 1.0 through 12.0. Project Co may cite a test procedure document reference in lieu of the actual procedure. The detailed description of each acceptance activity must be submitted to the Region not less than six (6) months prior to its being conducted by Project Co.
4. Format elements 13.0 and 14.0 will be completed during the actual acceptance activity. Both Project Co’s personnel conducting the activity and the Region’s observer will be permitted to enter comments in item 13.0. The conclusions in item 14.0 will be those of Project Co.

(iii) Schedule

- A. The Operating System acceptance activities shall be scheduled and conducted as per Project Co's Plan. Project Co shall develop the specific Operating System Acceptance Schedule and submit it to the Region for its review and approval.
- B. Project Co may propose to conduct a category of acceptance activities prior to the completion of the System if all of the system elements related to the acceptance category are complete and fully operational.

(iv) Region Involvement

A. Procedure

1. The following procedures shall be followed to permit Region involvement in approving the procedures, and in witnessing and tracking the status of all acceptance activities.
  - I. Project Co shall develop the required Acceptance Inspection/Test Procedures for each of the activities in accordance with the required format and submit them to the Region for its review and acceptance. Project Co shall submit the Operating System Acceptance Schedule during this time.
  - II. The Region will review the Acceptance Inspection/Test Procedures for each activity submitted by Project Co. Submittals will be evaluated based on the extent to which each one addresses the letter and intent of the Project Agreement requirements. Procedures which can satisfy the requirements will be approved. Those procedures which would be acceptable if minor changes were made by Project Co will be approved, conditional on those specific changes being incorporated in the procedure. Procedures which have more significant deficiencies will be given the status “not accepted,” and procedures which are totally deficient will be “rejected.” The Region will give Project Co written notification of the acceptance status (accepted, conditionally accepted, not accepted, or rejected) for each

acceptance activity. The Region will make every effort to respond to Project Co. This is far more likely to be achieved if the submissions of acceptance activity procedures are staggered rather than delivered to the Region in one large submittal. The Region and Project Co will work to resolve any differences and concur on any of the activity procedures.

- III. The Region will review the Operating System Acceptance Schedule and give Project Co written notification of whether it approves the proposed schedule. The Region and Project Co will work to resolve any differences and concur on a final schedule.
- IV. Project Co shall revise its Acceptance Inspection/Test Procedures in accordance with the Region's review and resubmit them at least sixty (60) days prior to the beginning of acceptance activities.
- V. Each acceptance activity shall be conducted by Project Co and witnessed by the Region in accordance with the agreed-upon procedure and schedule. Briefings will be held before and after these activities, and activity reports shall be submitted to the Region.
- VI. The Region will give Project Co written notification of whether the submitted activity report is acceptable. The Region will give Project Co specific reasons for not accepting an activity report, as well as provide specific requirements for making the activity acceptable.

**B. Monitoring**

- 1. The Region will monitor the status of the documentation and progress of each activity relative to the procedure described above. The status of the Operating System Acceptance activities will be monitored and discussed at the monthly Progress Meetings.
- 2. The active status tracking of each activity will start six (6) months prior to the scheduled beginning of acceptance activities or with the first significant submittal of Acceptance Inspection/Test Procedures by Project Co, whichever occurs first. These activities will be continuously tracked through the successful completion of the acceptance activities.

**13.6 Pre-Substantial Completion Demonstration**

**(a) Demonstrated Systems Operations (DSO)**

- (i) A Demonstrated System Operations shall be conducted for the Stage 1 LRT System. The System shall be operated as though it were in full passenger service, in strict accordance with all operation and maintenance policies and procedures, except that no passengers, other than Project Co and Region authorized personnel, shall be carried.
- (ii) Project Co shall submit to the Region for its review and approval the complete System Demonstration Procedures. The specific requirements of the System Demonstration are provided below. As with the other acceptance activities, Project Co must submit the proposed procedures six (6) months prior to the beginning of the Demonstrated Systems Operations. Project Co shall revise these procedures, if required, based on changes deriving

from any System Acceptance or System Integration test results to ensure their "workability".

(iii) Demonstrated System Operation – Stage 1 LRT

- A. After completion of the Operating System Acceptance Tests, and as a prerequisite of Certification of Substantial Completion for the Stage 1 LRT System, Project Co shall conduct a full demonstration of the LRT services.
- B. This demonstration shall be called the "Demonstrated System Operation – Stage 1 LRT System" and shall involve day-to-day operation of the System in accordance with the Region-approved System Operations Plan. During the DSO, the System shall be operated continuously (without interruption), as though in passenger service (without passengers), in strict accordance with all operations and maintenance policies and procedures, until the System Service Availability specified in the Schedule 15-3 Article 3 Section 3.6 has been achieved over a consecutive 5-day operating period. Furthermore, the "Demonstrated System Operation - Stage 1 LRT System" shall include the demonstration of all routine and emergency procedures associated with operation of the Stage 1 LRT System.
- C. During Demonstrated System Operation, performance data shall be collected, analyzed and presented to satisfy the Region that the Stage 1 LRT System is ready for deployment in revenue service. It is required that the "start of revenue service" levels of dependability presented in the Technical Provisions be achieved during the DSO.
- D. During the Demonstrated System Operation, the number and skills of personnel involved in operation and maintenance of the System shall not exceed the number and skills identified in Project Co's COM Staffing Plan for the Stage 1 LRT System. This is exclusive of Project Co personnel required for demonstration administration and data collection.
- E. Within ten days of the completion of the DSO, Project Co shall prepare and submit to the Region a formal Demonstrated System Operation Report, documenting the results of all activities. This report shall also identify any changes deemed necessary in operating and/or maintenance procedures, manuals, etc., as a result of the demonstration. The Region shall accept or reject such report within ten days of receipt. The issuance of the Certificate of Substantial Completion for the Stage 1 LRT System shall not occur until approval of such report by the Region.
- F. If the Demonstrated System Operation reveals a failure to satisfy the requirements of the Project Agreement and/or the approved VTAC Plan, Project Co shall correct those items and/or aspects deemed unsatisfactory, and another Demonstrated System Operation shall be conducted. The scope and duration of all subsequent demonstrations will be as approved by the Region.

(b) Maintainability Demonstration Tests

- (i) Project Co shall provide a Maintainability Demonstration Test Plan for the conduct of a Maintainability Demonstration Test concurrently with the DSO, demonstrating the maintainability of the systems/subsystems. The Region's approval of the Plan shall be a condition to issuance of the Certificate of Substantial Completion for the Stage 1 LRT System.

- (ii) The Plan shall address separate Maintainability Demonstration Tests for the Stage 1 LRT System services with each test being conducted concurrently with the DSO. The Plan shall include the following:
    - A. A list of selected maintenance tasks to be demonstrated. These tasks shall be limited to component or assembly removal and replacement.
    - B. Safety procedures appropriate for tasks selected.
    - C. Maintenance procedures to be followed.
    - D. Skill levels required to perform each task.
    - E. Equipment or special tools required.
  - (iii) The Maintainability Demonstration Tests will be monitored by the Region for validity of procedures and conformance to Contract requirements.
  - (iv) Unless otherwise approved, all maintenance performed during maintainability demonstrations shall be by Project Co maintenance personnel. Project Co shall furnish maintenance manuals, tools and test equipment to be used as a part of the maintainability and reliability demonstration testing.
- (c) Dependability Demonstration Test (DDT)
- (i) Starting within 30 calendar days following the issuance of Phase 3 for the Stage 1 LRT System, the Dependability Demonstration Test will be conducted for a period of one year on these lines.
  - (ii) The Dependability Demonstration Test shall be planned and conducted by Project Co. All equipment incidents shall be documented on an incident report form approved by the Region. Completed incident report forms shall be submitted on a weekly basis. All testing on the program shall be considered dependability testing for the purposes of incident monitoring.
  - (iii) The Database Management Information Systems (DMIS) shall be fully functional during the entire Dependability Demonstration Test. Each applicable function of the DMIS shall be used to track the results of the Dependability Demonstration Test. The DMIS shall not be considered for final approval prior to completion of the Dependability demonstration. The DMIS shall contain the expected life cycle for each component and its design reliability parameters.
  - (iv) All of the equipment on the Stage 1 LRT System shall be included in the demonstration test. Any equipment downtime for preventive or corrective maintenance, in excess of two hours per week, shall be deleted from the test time database where such time is determined by a Region-chaired Review Committee to be the fault of Project Co. This Committee will consist of Region personnel and technical specialist contractors engaged by the Region. A final Dependability Demonstration Test Report shall be prepared and submitted by Project Co for the Region approval no later than 30 days after the completion of the test.
  - (v) Notification and Data Collection
    - A. The Region shall be notified of the commencement date for the Dependability Demonstration Test, in writing, at least 20 days prior to the start of this test.
    - B. Data Collection

1. Responsibility for capture of data, recordkeeping, analysis and data submittal shall be with Project Co. Data obtained each week shall be furnished in comprehensive detail to the Region-chaired Review Committee for review. The Committee will make a preliminary chargeability assessment for each incident, in order to maintain a continuing record of achieved dependability. The Committee will determine final chargeability assessment for each incident. Should Project Co disagree with such assessments, it may pursue relief under the provisions of the Project Agreement.
  2. The Committee may require Project Co to promptly undertake design reviews and a review of operations and maintenance procedures as a result of failure. Based on such reviews, within one month, Project Co shall present a written analysis and plan to approve failure rates. Project Co shall take corrective action to mitigate the cause.
- C. Dependability Demonstration Test Plan
1. Project Co shall prepare a plan and procedures for the Dependability Demonstration Test and submit same in a report for approval by the Region not later than 180 calendar days before the commencement of revenue service for Stage 1 LRT System. The Region shall prepare the chapter of this report dealing with the Review Committee procedures. The plan and procedures shall address the following:
    - I. Operational monitoring and incident reporting responsibilities.
    - II. Maintenance performance and responsibility, including completion of incident report forms
    - III. Review Committee procedures
    - IV. Project Co. test reports
    - V. Pass/fail criteria
    - VI. Identification of procedures, requirements, and areas needed for impounding and securing all failed hardware in bonded (fenced in, secured, and locked) areas on the Region premises.
- (vi) During the dependability demonstration, the Region and Project Co shall evaluate the compliance of equipment performance with the approved requirements. If the test experience indicates that approved requirements are not being met, the Region and Project Co may agree to terminate the test, complete corrective action and restart the demonstration from the beginning. If noncompliance is not determined until completion of the demonstration period, the entire test shall be rerun following completion of corrective action. In all cases, corrective action shall be at Project Co's expense and relevant data accumulated prior to the retest shall be purged from the database.
- (vii) The Committee may require Project Co to promptly undertake design reviews and a review of operations and maintenance procedures as a result of failure. Based on such reviews, within one month, Project Co shall present a written analysis and plan to approve failure rates. Project Co shall take corrective action to mitigate the cause.
- (viii) Equipment, subsystems and systems not meeting the test requirements shall be repaired and/or replaced by Project Co as corrective actions at no cost to the Region. Spare parts

intended for use during the Phase 3 Period shall be replaced at no cost to the Region if used for such purposes.

### 13.7 Certification

- (a) Acceptance of the Phase 2 Work by the Region shall be accomplished in two stages: Certification of Substantial Completion and Final Completion.
- (b) Substantial Completion for the Stage 1 LRT System will signify the end of the first stage of LRT construction planned by the Region, completion of the Integrated Systems Tests, Commissioning and the readiness of the Stage 1 LRT System to enter revenue service under Project Co's control.
- (c) Phase 2 Final Completion shall occur upon satisfaction of all requirements. Upon the issuance of the Certificate of Phase 2 Final Completion, Project Co shall have no obligation to perform any additional Phase 2 work under the Project Agreement.
- (d) The criteria for and procedures associated with issuance of the Certificate of Substantial Completion and the Certificate of Phase 2 Final Completion are presented in this Article.
- (e) Certificates of Substantial Completion
  - (i) Certificate of Substantial Completion – Stage 1 LRT System
    - A. The Region will provide Project Co with a Certificate of Substantial Completion for the Stage 1 LRT System when the following requirements are satisfactorily met:
      - 1. Demonstration that the Project Agreement prerequisites for revenue operation has been met during the Demonstrated System Operations Test and the Maintainability Demonstration Test, and submittal and acceptance by the Region of the reports related thereto;
      - 2. Successful completion of the Integrated System Demonstration Program (ISDP), demonstrating the System's conformance with the Project Agreement;
      - 3. The approval by the Region of the System Assurance Monitoring Plan for documentation and incorporation of dependability/maintainability changes and monitoring of system dependability growth during the Phase 3 Period;
      - 4. Demonstration by Project Co that all of Project Co's responsibilities have been substantially completed and/or successfully performed; and
      - 5. The Region approval of:
        - I. Operations and Maintenance Plans and Manuals
        - II. Training Plans and Manuals.
    - B. Along with the Certificate of Substantial Completion for Stage 1 LRT System the Region will provide Project Co with a punch list of items to be repaired or corrected.
- (f) Phase 2 Final Completion
  - (i) The Region will provide Project Co with a Certificate of Phase 2 Final Completion for the Project when the following additional requirements are met:
    - A. Verification of meeting or exceeding the dependability System Service availability requirements defined in the Project Agreement;

- B. Correction/repair of all of the punch list items and all other construction, systems, warranty items and deficiencies;
- C. Submittal and acceptance of the "as-built" documentation; and
- D. Submittal of revisions and approval of all of Project Co's Phase 3 Period Operations and Maintenance Plans and Manuals.

**13.8 System Operations and Maintenance Personnel**

- (a) During Phase 2, Project Co shall hire and provide training for all personnel who will operate and maintain the System at the commencement of the 3 Period.

**13.9 Personnel Policy Manual**

- (a) Project Co.'s Phase 2 Work shall include the preparation of the Phase 3 Staffing Plan, including an organization chart and job descriptions. Project Co shall prepare and submit a Personnel Policy Manual, for the hiring, promotion, discipline and dismissal of staff, that complies with applicable Governmental rules, including all anti-discrimination provisions. Following the Region's approval of this Personnel Policy Manual and absent any reason(s) to the contrary, applicants may be interviewed and hired.

**13.10 Qualifications**

- (a) The Personnel Policy Manual shall require pre-employment substance/drug screening of all applicants for employment in safety-related positions. Such testing, as a minimum, shall satisfy the requirements of the Region's regulated drug testing protocol
- (b) Project Co shall retain the records of all successful applications for employment, together with verification of the references. The Region reserves the right to audit these records in accordance with the Project Agreement.
- (c) The education and experience of personnel employed shall be appropriate for the duties they shall be required to fulfill, and such personnel shall be familiar with the general objectives and requirements of their job assignments at the time they are hired. Project Co shall define skill levels required for participation in each level of the training program.

**13.11 Uniforms**

- (a) Project Co. shall furnish each employee who will interface with the public appropriate uniforms, the colors and styling of which shall be approved by the Region. Later, during the Phase 3, these uniforms shall be worn by said employees at all times while on duty.

**13.12 Training of System Operations and Maintenance Personnel**

- (a) Project Co. shall provide training for all personnel who will operate and maintain the System during Phase 3. The training shall start at such a time to ensure all operations and maintenance personnel required for System Demonstration Tests are fully trained prior to the start of the System Demonstration Tests.
- (b) If so requested by the Region, Project Co shall include up to six (6) Region-designated personnel in the training classes. As part of the System Safety and Security Program, Project Co shall provide instruction for up to 10 Region and/or other agencies' fire, safety and security personnel. This training shall provide an overview of System elements and operations, describe the features and facilities available to emergency response personnel, and address applicable operation safety

- procedures. It shall also address the proper use of equipment specific to the System that shall be used in emergencies by emergency responders. In addition, training shall include the subjects listed in the Rule Book.
- (c) Project Co. shall provide all instructors, literature, and equipment necessary to train personnel. Project Co shall provide sufficient classroom and on-the-job training for operations and maintenance personnel to insure their competence in operating and maintaining the System. Classrooms shall be provided by Project Co. Training on the actual System equipment and/or the spare equipment will be permitted; however, such use shall not interfere with the pre-revenue tests and demonstrations of the System.
- (d) Project Co. shall have a testing program whereby personnel within a specific job classification are tested for proficiency within that job classification. With concurrence by the Region, certain job classifications may be exempted from such testing. Personnel shall pass the testing program appropriate to their positions prior to assuming these positions on a full-time basis. Prior to initiation of passenger service, Project Co shall provide the Region with the quantitative results of all examinations administered to the trainees during and upon completion of the training program. The results of these tests shall be sufficient for Project Co and the Region to evaluate the competence of a trainee for his/her specific assignment in the operation and/or maintenance of the System.
- (e) Training Program Plan
- (i) Project Co. shall develop a Training Program Plan responsive in all respects to the Project Agreement. The plan shall provide for:
- A. Materials: Student and instructor materials shall be developed, including course outlines and objectives, lesson plans, training aids, and student manuals. All of these materials shall become the property of the Region at the conclusion of the training program.
- B. Schedules: Training schedules shall include dates, location, and equipment requirements of each course to be presented. Project Co shall have all training completed before the start date of the pre-revenue service test program that is required to complete the pre-revenue service tests. Project Co shall recognize that some on-the-job training shall be necessary.
- C. Training Presentation: Supervisory, operations, and maintenance personnel shall receive training. Such training shall be sufficient to ensure the transfer of all System-imposed knowledge and skills necessary to fulfill the duties required by the function of said personnel.
- D. Continuing Training: Project Co shall provide the Region an electronic copy of all subject matter covered in the training program, to expedite the training for employees hired after the Phase 3 has expired. Project Co shall furnish a complete synopsis of subject matter for review, in accordance with Schedule 10 – Review Procedures.. The Region may request that selected training sessions be recorded, and Project Co shall accommodate such requests.
- (f) Training Program Courses
- (i) Types of Courses: Project Co shall develop courses of instruction in System familiarization, operation, and maintenance.



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- (ii) System Familiarization: These courses shall be designed to provide management, supervisory, and engineering personnel with a functional understanding of the System. The functions of each system element shall be covered, including the interrelationships of all system elements.
- (iii) Operations: This course shall be designed to provide: maintenance personnel, who may from time to time be called upon to manually operate a train/consist; CCF controllers; supervisory personnel; and other operating personnel with a functional understanding of the complete System from an operational viewpoint. Operation of the CCF work stations and displays, vehicle controls and displays and wayside controls and displays shall be covered in detail.
- (iv) System Maintenance: This course shall be designed to provide maintenance supervisors, engineers, and technicians with the knowledge and skills required for the performance of preventive and corrective maintenance of equipment, including that which is vehicle-carried, on the wayside, and in equipment rooms, and CCF work stations and associated equipment. Additionally, the course shall cover maintenance of all special test equipment provided, whether portable or stationary, including built-in test features.
  - A. Instruction: Classroom instruction shall be designed to cover in detail the functions of each subsystem, including the interrelationships of the subsystems. Fault isolation and troubleshooting techniques shall be covered to the extent necessary in preparation for maintenance laboratory training exercises. Maintenance laboratory instruction shall be designed to provide maintenance personnel with practical experience in the performance of preventive and corrective maintenance tasks.
  - B. Simulations: Troubleshooting and fault isolation of simulated faults shall be provided for each subsystem, including all special test equipment.
- (g) Training Materials
  - (i) The following materials shall be provided for each course specified in accordance with the:
    - A. Lesson Plans: A set of lesson plans shall be developed for each system element, corresponding to the topic outline, and shall contain the following information:
      1. Lesson Title
      2. Time
      3. Objectives
      4. Training Aids Required
      5. Instructing Sequence (Outline).
    - B. Training Aids: Project Co shall use visual media whenever practical in the classroom instruction. Visual aids shall be developed for each topic. The number of aids shall be determined by the complexity and the amount of time allotted to the topic. Operations and maintenance laboratory instruction may not require aids other than operational equipment, test equipment, and associated documentation; however, Project Co shall utilize troubleshooting and fault isolation charts developed for training purposes.
    - C. Student Material: The primary source of student instructional material shall be Operations and Maintenance manuals. In addition, Project Co shall develop, for

each course specified, student notebooks containing such additional drawings, descriptive information, and laboratory procedures as are necessary or advisable to ensure that all learning objectives are met in an orderly and timely manner. Student notebook material shall be arranged by system element and sequenced according to the topic outline.

(h) Training Program Presentation

(i) General

- A. Training shall be conducted by qualified Project Co instructors. The training sessions shall be scheduled such that the personnel receiving training shall be able to assume their assigned duties in the preventive maintenance program. Maintenance laboratory training shall be conducted utilizing installed System equipment in normal operating condition.
- B. In the event System equipment is not in operating condition at the scheduled time for training requiring such equipment, the Region shall have the right to delay training sessions or reduce the duration of training sessions.

(ii) Project Co. Facility Training

- A. Training normally provided by Project Co at Project Co's facilities shall not be construed to satisfy all the training requirements specified herein. Certain key portions of the training shall occur at and on Stage 1 LRT System facilities, except as otherwise approved by the Region.

(iii) Training Program Monitoring and Evaluation

- A. Project Co. shall monitor the initial presentation (session) of each course. Thereafter, monitoring shall be performed on a random sampling basis, by a qualified training supervisor and representatives of the Region, in order to evaluate the effectiveness of training material and instruction. The results of the monitoring shall be analyzed and corrective action taken, if and as required. Region supervisory personnel shall have the right to monitor training sessions. Instructor evaluations shall be made by analysis, instructor critiques, coverage of materials in time allotted, and results of the Region's evaluations and critiques of the training. Student critiques shall be prepared by Project Co, subject to review by the Region.

(i) Documentation

(i) Project Co shall prepare and deliver to the Region the following:

A. Training Program Plan

- 1. A Training Program Plan shall be prepared in narrative form and shall be supported by such tables, charts, schedules, and graphs as are necessary to fully convey and describe Project Co's plan for accomplishing the training set forth herein. It shall be subject to the Region's approval. The Training Program Plan shall include resumes and qualifications of key instructors and Project Co's training staff, for the approval of the Region. The Training Program Plan shall provide complete documentation to substantiate employee certification.

B. Training Program Schedule

1. A Training Program Schedule shall be submitted for the Region's approval. This schedule shall be supported by such narrative description as necessary to fully convey its impact and relationship to other Project Agreement events, including installation and testing of such System equipment as necessary for training laboratory sessions.

C. Instructor Materials

1. Two copies of Instructor Materials, except training aids, shall be provided by Project Co in accordance with the Training Program Plan Schedule, as approved by the Region.

D. Student Materials

1. Two (2) copies of student materials shall be provided by Project Co in accordance with the Training Program Plan Schedule, as approved by the Region.

E. Training Reports

1. Training Reports shall be submitted in accordance with the Training Program Schedule. The Training Reports shall include graded tests (without names) with raw scores, and a statistical evaluation of the effectiveness of the course material and testing process.
2. The Training Reports shall be furnished subsequent to the completion of each training session but not less than weekly. The report shall include a summary of the results of monitoring and evaluation as well as records of student attendance and performance.