

Project TTC Toronto

Passenger Information System

Software Test Plan (STP)

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Revision History

Revision	Date (yyyy-mm-dd)	Initials	Description of Changes
00	2010-07-09	TiFu	First issue
01	2010-11-05	TiFu	<ul style="list-style-type: none">Added an explanation regarding the use of the System Test Procedure to Section 6.4 System TestingMinor spelling and formatting correctionsAdded "Wireshark " to position 17 of Table 7: Test Equipment for System TestingAdded a new position # 4 "Oscilloscope" to Table 8: Test Tools
02	2011-01-21	TiFu	Changes adapted to changes the performed in the Software Configuration Items Summary Table
03	2011-04-20	TiFu	Bombardier review comments (Document inspection checklist dated 2011-04-06) included
04	2011-05-18	TiFu	Bombardier Mannheim review comments included (two different system test procedures). Changes in blue.
05	2011-10-20	TiFu	TTC review comments (provided by Bombardier on 2011-10-06) included

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1 Test Plan Identifier

Software Test Plan - TTC Toronto - Passenger Information System, document number 299026.

2 Introduction

2.1 Objectives

To prescribe the scope, approach, resources, and schedule of the testing activities related to the Passenger Information System (PIS) for the TTC Toronto project. To identify the items being tested, the features to be tested, the testing tasks to be performed, the personnel responsible for each task, and the risks associated with this plan.

2.2 Scope

This Software Test Plan (STP) covers all testing of the SCIs for TTC Toronto Passenger Information System (PIS), with special focus on internal testing prior to delivery of the PIS to Bombardier.

Tests described in this STP include tests of the car-borne PIS SCIs as well as tests of the related depot-based PIS SCIs, e. g. SCIs for the Fleet Management System (FMS), for the Comm./PIS Portable Test Equipment (PTE), or the Bench Test Equipment (BTE).

This version of the STP is limited to the car-borne SCIs.

This STP will be submitted to Bombardier/TTC for approval. The intended audience of this STP therefore includes Bombardier/TTC staff as well as ANNAX internal staff engaged with the TTC Toronto project.

2.3 References

2.3.1 Standards

The following standards are applicable to this STP:

Table 1: List of Standards

Doc ID	Document Description
[I1558]	IEEE Std 1558-2004 - IEEE Standard for Software Documentation for Rail Equipment and Systems
[I829]	IEEE Std 829-1998 - IEEE Standard for Software Test Documentation

2.3.2 ANNAX Project Documents

The following ANNAX project documents are referenced within this document:

Table 2: List of ANNAX Project Documents

Doc ID	Document Description
[ADRP]	201004XX, MS Project file: Developer Resource Plan (ANNAX internal document; German title: Ressourcenplan)
[APRP]	Project Realisation Plan for the TTC Toronto project (ANNAX internal document)
[ASCMP]	ANNAX Software Configuration Management Plan for the TTC Toronto project, Doc. No. 299016
[ASPMP]	ANNAX Software Project Management Plan for the TTC Toronto project, Doc. No. 299014
[ASQAP]	ANNAX Software Quality Assurance Plan for the TTC Toronto project, Doc. No. 299009
[ICDIPPIS]	Bombardier IP Interface Control Document TCMS - PIS Controller, Doc. No. 590017128
[ICD_IP]	Bombardier Interface Control Document TCMS – PIS Controller, Doc. No.
[SRS_CCU]	Software Requirements Specification for CCU, Doc. No. 215259
[SRS_DISP]	Software Requirements Specification for Displays, Doc. No. 215263
[SRS_PCUB]	Software Requirements Specification for PCUB, Doc. No. 215258
[SRS_PSC]	Software Requirements Specification for PIS Controller, Doc. No. 215260
[SRS_PTE]	Software Requirements Specification for PTE, Doc. No. 215283
[STPr_CCU]	Software Test Procedure for CCU, Doc. No. 120198
[STPr_DISP]	Software Test Procedure for Displays, Doc. No. 120201
[STPr_PCUB]	Software Test Procedure for PCU, Doc. No. 120200
[STPr_PSC]	Software Test Procedure for PIS Controller, Doc. No. 120199
[STPr_PTE]	Software Test Procedure for PTE, Doc. No. 120217
[SysTPr]	System Test Procedure for PIS, Doc. No. 120202
[SysTPr_PT]	System Test Procedure for PIS Tools No. 299089

2.4 Acronyms

The following acronyms and definitions are used within this STP.

Table 3: List of Acronyms and Definitions

Acronym	Definition
BT	Bombardier Transportation
BTE	Bench Test Equipment
CCB	Configuration Control Board
CDR	Conceptual Design Review

Acronym	Definition
CCU	Cab Control Unit
CDRL	Contract Deliverable Requirement List
DBDD	Database Design Description
FAI	First Article Inspection
FDR	Final Design Review
FMS	Fleet Management System
ICD	Interface Control Document
LFLRV	Low Floor Light Rail Vehicle
LRV	Light Rail Vehicle
Mantis	Problem Reporting Database used by ANNAX
Ofris	Open Framework for Railvox Information System
PCU	Passenger Communication Unit
PDR	Preliminary Design Review
PIS	Passenger Information System
PRP	Project Realisation Plan
PSC	PIS Controller
PTE	Portable Test Equipment
REC	Railvox Embedded Controller
RFS	Root File System
R&D	Research & Development
SCIST	Software Configuration Item Summary Table
SCMP	Software Configuration Management Plan
SDD	Software Design Description
SDN	Software Delivery Note
SFD	System Functional Description
SPMP	Software Project Management Plan
SQAP	Software Quality Assurance Plan
SRS	Software Requirements Specification
SRTM	Software Requirements Traceability Matrix
STP	Software Test Plan
STPr	Software Test Procedure
SVN	Subversion
SVVP	Software Verification and Validation Plan
SVVR	Software Verification and Validation Report

Acronym	Definition
SW	Software
SWATS	Software Acceptance Test Specification
SysTPr	System Test Procedure
SysTR	System Test Report
TIR	Test Incident Report
TS	Technical Specification [TS]
TTC	Toronto Transit Commission
UDP	User Datagram Protocol
V&V	Verification and Validation

2.5 Definitions

The following terms and definitions are used within this STP.

Table 4: List of Terms and Definitions

Term	Definition
anomaly	Anything observed in the documentation or operation of software that deviates from expectations based on previously verified software products or reference documents. [I1012]
system testing	Testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. [I1012]
test case	Documentation specifying inputs, predicted results, and a set of execution conditions for a test item. [I1012], [I829]
test design	Documentation specifying the details of the test approach for a software feature or combination of software features and identifying the associated tests. [I1012]
test plan	A document describing the scope, approach, resources, and schedule of intended test activities. It identifies test items, the features to be tested, the testing tasks, who will do each task, and any risks requiring contingency planning. [I829]
test procedure	Documentation that specifies a sequence of actions for the execution of a test. [I1012], [I829]

3 Test Items

Items to be tested and the pertaining documentation are listed in Table 5.

Table 5: Test Items and Pertaining Documentation

Test Item	SRS	STPr
Car-borne Software		
PIS Controller software	[SRS_PSC]	[STPr_PSC]
PCU Box software	[SRS_PCUB]	[STPr_PCUB]
CCU software	[SRS_CCU]	[STPr_CCU]
Display software	[SRS_DISP]	[STPr_DISP]
Depot-based Software		
Comm./PIS PTE software	[SRS_PTE]	[STPr_PTE], [SysTPr_PT]
FMS software	N/A	[SysTPr_PT]
BTE software	N/A	[SysTPr_PT]

4 Features to be Tested

Features to be tested include:

1. Software functions as expressed in Section 3 of the respective SRS document
2. Interfaces of software to hardware and to other software

Thus, all features will be tested.

5 Features not Tested

There are not features of SCIs which are not tested.

6 Approach

The software system will be tested on different levels, corresponding with the development steps. The philosophy of testing applied to the TTC Toronto project is to find as many software failures as early as possible in the project.

6.1 Software Module Testing

After implementation of a software module, the software module will be tested. The software module test will not require written procedure and will be performed by default by the respective software implementer.

6.2 Software /Hardware Integration Testing

After successful software module test, the software will be transferred to the target hardware. Now, a software/hardware integration test will take place in order to ensure the software modules are

adequately communicating together and interfacing with the hardware as stipulated into the software architectural design part of the SDD. The software/hardware integration test will be performed according to the Software Test Procedures ([STPr_CCU], [STPr_PSC], [STPr_PCUB], [STPr_DISP]) and documented in Software Test Reports.

6.3 Software Acceptance Testing (Factory Acceptance Test)

After successful software/hardware integration, software acceptance testing will take place, executing the tests defined in the Software Test Procedures (STPrs).

6.4 System Testing

After successful software acceptance testing, system testing will take place, executing the tests defined in the System Test Procedure (SysTPr) documents. There will be two different system tests performed: one test for the PIS system itself and another test for the PIS tools (BTE, PTE and FMS).

The SysTPr will also include the tests to be performed during system acceptance testing (refer to Section 6.5) in form of e.g. FAI, Level 3 Test, Static Vehicle Test, Dynamic Vehicle Test, and others.

6.5 System Acceptance Testing (Site Acceptance Test)

After installation of the PIS on the LFLRV, a site acceptance test will be performed. This test will expand the system test by testing features and interfaces that were not available without vehicle.

6.6 Interface Testing

Interface tests with the TCMS will be performed to demonstrate full compliance of all interfaces to the System Functional Description [SFD_PIS] and Bombardier's IP Interface Control Document [ICDIPPIS]

6.7 Regression Testing

Regression testing will be conducted throughout the testing phases following changes to the software. Regression testing shall test the particular changes that have been made and show that the unmodified software has not been corrupted by the change and the software meets its technical requirements.

7 Item Pass/Fail Criteria

A test of a test item (i.e, software as defined in Section 3) shall be considered failed if at least one of the test cases described in the individual software test procedure documents fails. Test cases shall be considered failed if the result of at least one test step pertaining to the respective test case deviates from the expected result as described in the software test procedure.

8 Suspension Criteria and Resumption Requirements

Suspension and resumption of software module tests and hardware/software integration tests are subject to the tester's decision.

Software acceptance tests and system tests will be suspended depending of the failure class detected during test. The criteria defined in Table 6 apply.

Table 6: Failure Classes and Test Suspension for SW Acceptance Tests and System Test

Failure Class	Failure Class Criteria	Test Suspension
1 - Not operation disturbing failures	Major function of software remains granted. Adverse effect is marginal	The test step will be approved with comments and the test will be continued. After failure correction, the respective test step will be repeated. Further test steps potentially impacted by the failure will be repeated.
2 - Operation disturbing failures	Adverse effect of failure to software function. A defined requirement is not fulfilled, e.g. layout, sequence or timing failure. This class includes particularly failures resulting in wrong passenger information.	The test step will be disapproved, but the test will be continued. After failure correction, the respective test step will be repeated. Further test steps potentially impacted by the failure will be repeated.
3 - Test preventing failures	The adverse affect is not limit to the current step. Impact on already approved or subsequent test steps is likely. Function of the software is not granted anymore.	The test step will be disapproved and the test phase will be suspended until the failure has been corrected. After failure correction, all concerned and depending test steps will be repeated.

Remark: An issue in Mantis (ANNAX bug tracking system) must be entered for each failure detected during system tests.

9 Test Deliverables

Test deliverables are:

- Software Test Plan (STP) - This document
- Software Test Procedures (STPr)
- Software Test Report (STR)
- System Test Procedure (SysTPr)
- System Test Report (SysTR)

- Test Logs - as defined in the STPr documents

10 Testing Tasks

Testing tasks are:

- Plan the software test (as documented in this STP)
- Prepare for the test, e.g. by setting up the test environment
- Execute the test as described in the STPr documents
- Document the test results

11 Environmental Need

Software module tests and hardware/software integration tests will take place at the software implementer's desk.

Software acceptance tests and system tests will take place in a separate test room in Guemligen (Switzerland). A floor area of approximately 8x3 m is necessary for test equipment and test personnel.

The system test environment will be similar to the test system shown in Figure 1.



Figure 1: Example Test System

The test equipment will consist of the PIS hardware as needed for one TTC Toronto car plus additional equipment:

Table 7: Test Equipment for System Testing

Pos.	Device	Quantity [Pieces]
1	PIS Controller	2
2	CCU	4
3	PCU-Box	5
4	PCU	3
5	DPCU	2
6	External Loudspeaker	5
7	Internal Loudspeaker	15
8	Cab Control Loudspeaker	4
9	Network Switches	6
10	Front / Rear Destination Display	2
11	Side Destination Display	2
12	Internal Display Single Sided	1
13	Internal Display Double Sided	1
14	Operator microphone gooseneck	2
15	Microphone for shunting station	2
16	GPS module	1
17	Service Computer (1 standard PC as used by software implementers, with Wireshark installed)	1
18	Power supply 24 V DC	1
19	Set of cables for the Audio Voice Line and Audio Control Line	1
20	Set of cables for the Multi-traction lines	1
21	Set of cables between Switches	1
22	Set of cables between the Network and the TCMS Simulator	1

For software acceptance testing, a subset of test equipment listed in Table 7 is required.

Table 8: Test Tools

Pos.	Description	Remark
1	TCMS-Simulator Software (UDP Simulator)	
2	Digital multimeter	
3	Signal generator	
4	Oscilloscope	

12 Responsibilities

The following list is an excerpt from the Software Project Management Plan [ASPMP]:

Table 9: Test Responsibilities

Role	Responsibility
Software Architect	<ul style="list-style-type: none">• Preparation or review of STPr
Software Engineer	<ul style="list-style-type: none">• Review or preparation of STPr• Module test
Document Manager	<ul style="list-style-type: none">• Control all document submittals to the customer• Maintain overview of document submittal status
Software Test Manager	<ul style="list-style-type: none">• Plan and monitor software tests• Prepare and maintain the STP
Test Engineer	<ul style="list-style-type: none">• Hardware/software integration testing
Software System Integrator	<ul style="list-style-type: none">• Configuration management• Change management• Release management• Prepare and maintain SCMP

13 Staffing and Training Needs

Staff required for the software project is documented in the [APRP].

Staff training requirements were identified and documented in the Project Realisation Plan [APRP].

14 Schedule

Software activities (including software testing activities) and their relationships are shown in the Developer Resource Plan [ADRP].

15 Risks and Contingencies

Risks and contingencies of the project including test are described in section 5.4 of the ANNAX Software Project Management Plan [ASPMP]. Risks will be identified during the project planning phase and will be documented in the Project Realisation Plan [APRP].

16 Approvals

Approvals required for this plan are described in a table in section 4 of the ANNAX Software Quality Assurance Plan [ASQAP]. [An extract of Section 4 is provided below.](#)

Title	Preparation	Verification	Approval	To be Reviewed/Audit, Criteria described in
[...]				
Software Test Plan (STP)	Software Test Manager	SW Quality Manager	Project Manager	Section 6.2.8 [Editorial note: This relates to Section 6.2.8 of [SQAP] where Managerial Reviews with the participation of Managing Director, Software Quality Manager and Project Manager] are described.
[...]				