

Project TTC Toronto

Passenger Information System

Software Verification and Validation Plan (SVVP)

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Q304E	TS Section 24.18		
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Revision History

Revision	Date (yyyy-mm-dd)	Initials	Description of Changes
00	2010-04-26	TiFu	First issue
01	2010-07-20	TiFu	<p>Section 1.1 Purpose amended</p> <p>Section 1.4: Added explanation regarding the responsibility to update the SVVP</p> <p>Section 4.1.1: Added that it is the Software Quality Manager's responsibility to prepare and maintain the SVVP</p> <p>Section 4.7 Metrics added</p> <p>Missing table headings added</p> <p>Amended Section 1.2 Scope</p> <p>Section 1.4: Added a clarification that the SW Quality Manager is responsible for updating the SVVP</p> <p>Section 7.1 Anomaly Reporting amended</p> <p>Section 7.3 Deviation Policy amended</p>
02	2010-11-05	TiFu	<ul style="list-style-type: none"> Added an explanation regarding the use of [I1558] to Section 1.2 Scope Correction: Replaced "SQA process" with "software verification and validation process" in Section 2.3 Standards Correction: Replaced "SDLC" with "software development lifecycle" in Section 2.3 Standards Correction: Removed "[I1058]" from Table 3: List of Standards Table 4: List of ANNAX Project Documents: Sorted this table alphabetically; included reference to System Test Procedure Table 15: System Test Plan Verification: Replace "Software Acceptance Test Specification" with "System Test Procedure" Table 5: List of Acronyms and Definitions: Included acronyms STPr, STR, SysTPr, QA Minor formatting changes

Revision	Date (yyyy-mm-dd)	Initials	Description of Changes
03 (Draft)	2011-02-11	TiFu	<p>As a result of the SW audit held by Bombardier on 2010-12-03 in Gümligen:</p> <ul style="list-style-type: none"> In Section 4.1 Organization added an explanation regarding independence of quality roles from the project Section 4.6.2.3: Added the obligation to review test reports prior to submittal to the customer <p>Section 6.1: Correction: Task reports are in MS Excel format, not MS Word</p> <p>Section 1.2: Removed the statement that content related to BTE/PTE is preliminary</p> <p>Included Bombardier review comments (P. Lakhi, 2011-02-02):</p> <ul style="list-style-type: none"> Cover sheet: Replaced "S24.18" with "Section 24.18" Restructured and amended Section 4.6 Tools, Techniques and Methods Amended Section 7.1 Anomaly Reporting and Resolution and Section 7.2 Task Iteration Policy Changed Section 7.3 Deviation Policy Corrected Section 7.5 Standards, Practices, and Conventions
03	2011-03-03	TiFu	Included BTNA review comments (dated 2011-02-23)
04	2011-03-11	TiFu	BTNA review comments (dated 2011-03-10) included
05	2011-06-06	TiFu	<p>Action item from Bombardier Software Audit (2011-05-30/-31) included:</p> <ul style="list-style-type: none"> Document reference [ACLSRC] updated (link to new working instruction) in Section 2.2 Reworded Section 4.6.3.1 to clarify that this relates to informal testing Updated Section 7.2 Task Iteration Policy to provide more detail
06	2013-01-16	TiFu	BTNA review comments (dated 2011-12-18) included
07	2013-02-11	TiFu	BTNA review comments (email from Thomas Molkoski dated 2012-02-06) included

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1 Purpose and Scope

1.1 Purpose

This document describes verification and validation processes to be used in parallel / in conjunction with development of the software for the Passenger Information System (PIS) software for the TTC Toronto project.

It applies to all members of the involved development teams of ANNAX and also to external sub-contractors.

The intended audience of this plan includes QA Car Builder for review, TTC for approval and ANNAX engineering, project management, QA members and subcontractors who are involved in this project.

The purpose of software verification and validation (V&V) is expressed here by a citation of the introduction section of IEEE1012-2004, IEEE Standard for Software Verification and Validation [I1012]:

“The purpose of software V&V is to help the development organization build quality into the software during the software life cycle. V&V processes provide an objective assessment of software products and processes throughout the software life cycle. This assessment demonstrates whether the software requirements and system requirements (i.e., those allocated to software) are correct, complete, accurate, consistent, and testable. The software V&V processes determine whether the development products of a given activity conform to the requirements of that activity and whether the software satisfies its intended use and user needs. The determination includes assessment, analysis, evaluation, review, inspection, and testing of software products and processes. Software V&V is performed in parallel with software development, not at the conclusion of the development effort.”

1.2 Scope

This document is tailored to fit the software development effort and is related to the project planning and lifecycle description documents for the TTC Toronto project.

Software covered by this plan includes

- Development of software for the TTC Toronto LFLRV Passenger Information System (PIS)
- Development of software for the Portable Test Equipment (PTE) of the PIS (Comm./PIS PTE)
- Development of software for the Bench Test Equipment (BTE) of the PIS (Comm./PIS BTE)

The following context diagram depicts the overall system and identifies system and elements covered by this plan. It shows the interface between the PIS provided and the external environment with which it interacts.

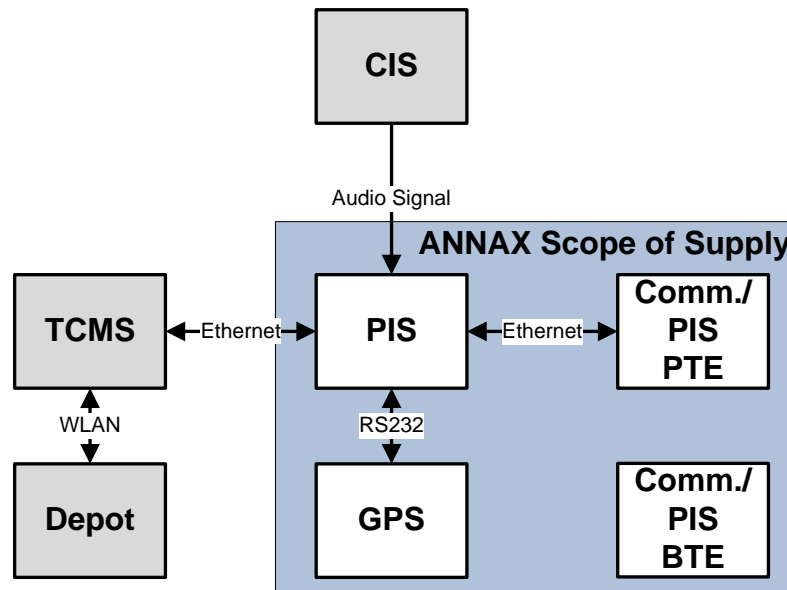


Figure 1: Context Diagram

The SVVP complies with IEEE Std 1012 – IEEE Standard for Software Verification and Validation [I1012], as modified by IEEE Std. 1558 –IEEE Standard for Software Documentation for Rail Equipment [I1558], Table A.4.

1.3 Software Configuration Items Covered

This SVVP covers all Passenger Information System (PIS) Software Configuration Items (SCIs).

The following table identifies and describes each of the SCIs to be developed. For further information related to SCIs, refer to the Software Configuration Items Summary Table [SCIST]

Table 1: Functional Elements

Device	SCI #	SCI Name	SCI Description	SW Integrity Level (SIL)
PIS Controller	AXPSC01	PSC OS	PSC Operating System	1
	AXPSC02	PSC APP	PSC Application	1
	AXPSC03	PSC DB	PSC Database	1
	AXPSC04	PSC DSPFW	PSC Digital Signal Processor Firmware	1
PCU-Box	AXPCU01	PCU-Box OS	PCU Box Operating System	1
	AXPCU02	PCU-Box APP	PCU Box Application	1
CCU	AXCCU01	CCU OS	CCU Operating System	1
	AXCCU02	CCU APP	CCU Application	1
Displays	AXDIP01	DISP OS	Display Operating System	1

Device	SCI #	SCI Name	SCI Description	SW Integrity Level (SIL)
	AXDIP02	DISP APP	Display Application	1
Comm./PIS PTE	AXPTE01	PTE OS	PTE Operating System	1
	AXPTE02	PTE APP	PTE Application	1
FMS	AXFMS01	FMS OS	FMS Operating System	1
	AXFMS02	FMS APP	FMS Application	1

Note: Comm./PIS BTE software is the same as for the PIS Car Controller.

Statements in this plan regarding Comm./PIS PTE and Comm./PIS BTE are preliminary and incomplete due to the open purchase order.

1.4 Maintenance

After internal review and approval, this SVVP will be submitted to Bombardier/TTC for official approval. After Bombardier's/TTC's approval, the SVVP will be placed under configuration management. Subsequent changes to the SVVP will follow the stipulations of the ANNAX Software Configuration Management Plan for the TTC Toronto project [ASCMP]. It is the Software Quality Manager's responsibility to update the SVVP will be updated as needed.

2 Referenced Documents

2.1 Internal templates

All templates can be found under: G:\AXis\90_Internal\Vorlagen

2.2 Internal Guidelines

The following guidelines shall be applied. These documents can be found in the document library (<http://ccpis.rd.ascom.ch/dokverwaltung/index.php?form=start>; search for the Doc ID) or via the Internet (<http://139.79.124.13/tikiwiki/tiki-index.php>)

Table 2: List of Guidelines

Doc ID	Document Description
[ACGUIL]	29900300, ANNAX Coding Guidelines
[ACLSRC]	Working instruction AA 037 Software delivery to the customer (German title: Arbeit-sanweisung Software-Lieferung an Kunden)
[AMTIR]	10012500, ANNAX Manual: "How to use the Problem Reporting System Mantis to generate a Test Incident Report"

Note: The most recent version of the documents is applicable.

2.3 Standards

The following standards were used as guides to develop this software verification and validation process. The standards were reviewed and tailored to fit the specific requirements of small database projects using the referenced software development lifecycle:

Table 3: List of Standards

Doc ID	Document Description
[I1558]	IEEE Std 1558-2004 – IEEE Standard for Software Documentation for Rail Equipment and Systems
[I1012]	IEEE Std 1012-2004 – IEEE Standard for Software Verification and Validation
[I730]	IEEE Std 730-2002 – IEEE Standard for Software Quality Assurance Plans
[I830}	IEEE Std 830-1998 – IEEE Recommended Practice for Software Requirements Specifications
[CMMI-DEV]	CMMI for Development, Version 1.2, CMU/SEI-2006-TR-008

2.4 ANNAX Project Documents

The following ANNAX project documents are referenced within this document:

Table 4: List of ANNAX Project Documents

Doc ID	Document Description
[ADRP]	201004XX, MS Project file: Developer Resource Plan (ANNAX internal document; German title: Ressourcenplan)
[ASCMP]	299016XX, ANNAX Software Configuration Management Plan for the TTC Toronto project
[ASPMP]	299014XX, ANNAX Software Project Management Plan for the TTC Toronto project
[ASPSW]	201003XX, MS Project file: Schedule Planning Software (ANNAX internal document; German title: Terminplanung Software)
[ASQAP]	299009XX, ANNAX Software Quality Assurance Plan for the TTC Toronto project
[SysTPr]	120202XX, System Test Procedure

Note: The most recent version of the documents is applicable.

3 Definitions

3.1 Acronyms

The following acronyms and definitions are used within this SVVP.

Table 5: List of Acronyms and Definitions

Acronym	Definition
BT	Bombardier Transportation
BTE	Bench Test Equipment
CDR	Conceptual Design Review
CDRL	Contract Deliverable Requirement List
DBDD	Database Design Description
FAI	First Article Inspection
FDR	Final Design Review
ICD	Interface Control Document
LFLRV	Low Floor Light Rail Vehicle
LRV	Light Rail Vehicle
Mantis	Problem Reporting Database used by ANNAX development department
MS	Microsoft
PDR	Preliminary Design Review
PIS	Passenger Information System
PRP	Project Realisation Plan
PTE	Portable Test Equipment
QA	Quality Assurance
R&D	Research & Development
RTM	Requirements Traceability Matrix
SCIST	Software Configuration Items Summary Table
SCMP	Software Configuration Management Plan
SDD	Software Design Description
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

Acronym	Definition
STPr	Software Test Procedure
STR	Software Test Report
SVVP	Software Verification and Validation Plan
SVVR	Software Verification and Validation Report
SW	Software
SWATS	Software Acceptance Test Specification
SysTPr	System Test Procedure
TIR	Test Incident Report
TS	Technical Specification [TS]
TTC	Toronto Transit Commission
V&V	Verification and Validation

3.2 Definitions

The following acronyms and definitions are used within this SVVP.

Table 6: 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	(A) A set of test inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular program path or to verify compliance with a specific requirement. (B) Documentation specifying inputs, predicted results, and a set of execution conditions for a test item. [I1012]
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) 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. (B) A document that describes the technical and management approach to be followed for testing a system or component. Typical contents identify the items to be tested, tasks to be performed, responsibilities, schedules, and required resources for the testing activity. [I1012]

Term	Definition
test procedure	(A) Detailed instructions for the setup, execution, and evaluation of results for a given test case. (B) A document containing a set of associated instructions as in (A). (C) Documentation that specifies a sequence of actions for the execution of a test. [I1012]
validation	(A) The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements. (B) The process of providing evidence that the software and its associated products satisfy system requirements allocated to software at the end of each life cycle activity, solve the right problem (e.g., correctly model physical laws, implement business rules, use the proper system assumptions), and satisfy intended use and user needs. [I1012]
verification	(A) The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase. (B) The process of providing objective evidence that the software and its associated products conform to requirements (e.g., for correctness, completeness, consistency, accuracy) for all life cycle activities during each life cycle process (acquisition, supply, development, operation, and maintenance); satisfy standards, practices, and conventions during life cycle processes; and successfully complete each life cycle activity and satisfy all the criteria for initiating succeeding life cycle activities (e.g., building the software correctly). [I1012]

4 Overview

4.1 Organization

The organizational chart shows the organizational structure for the SW development only.

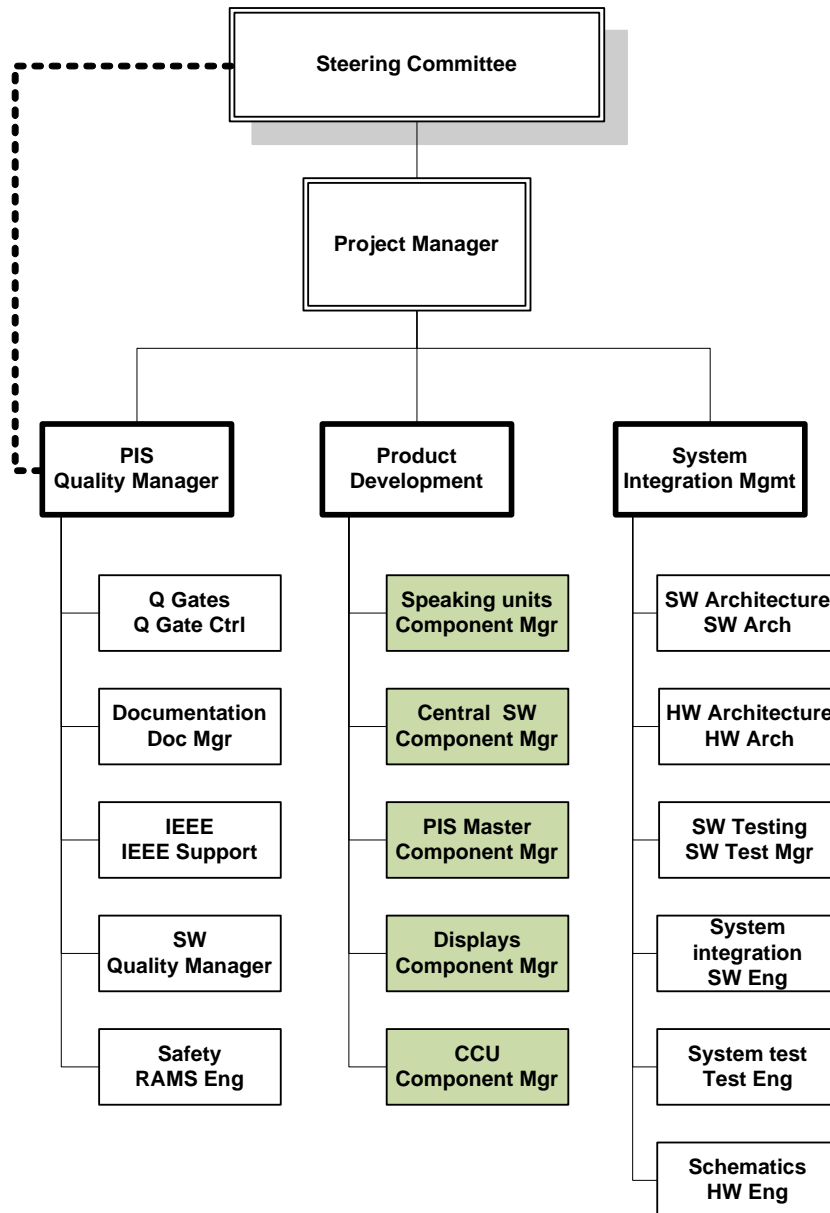


Figure 2: Organizational Chart Software

The PIS Quality Manager and the roles shown in Figure 2 below the PIS Quality Manager are independent from the Project Manager; the PIS Quality Manager reports directly to the Steering Committee.

The SW Quality Manager reports to the PIS Quality Manager. He is also permitted to directly communicate quality issues to management and team members.

The PIS Quality Manager reports to the Steering Committee. This reporting line is independent from any other project roles.

4.2 Master Schedule

The MS Project file „Developer Resource Plan“[ADRP] shows the due dates of all project activities, including V&V activities.

4.3 Software Integrity Level Scheme

As suggested by TTC TS [TS] Section 24.2.4.3, ANNAX uses a five level Software Integrity Level (SIL) scheme correlating the calculated Hazard Risk Index to SIL levels. This scheme is described in the table below:

Table 7: Software Integrity Level Scheme

Risk Assessment	Software Integrity Level (as per [I1012])
High Risk	4
Medium Risk	3
Moderate Risk	2
Low Risk	1
No Risk	0

All SCIs for the TTC Toronto project are assessed to be **Software Integrity Level 1** according to the SIL scheme above. Since this scheme is in-line with the model used in [I1012], there is a simple 1:1 mapping of the scheme in this SVVP to the scheme and the pertaining V&V activities proposed in [I1012].

4.4 Resources Summary

V&V tasks will be performed mainly by engineering project members. The SW Quality Manager will monitor that all V&V tasks take place as planned.

There are no tools or facilities other than described in the Software Project Management Plan [ASPMP] necessary for performing the V&V tasks described in this plan.

4.5 Responsibilities

As stated in Section 4.4, V&V tasks will be performed mainly by engineering project members.

Table 8: Roles and Responsibilities

Role	Responsibility
R&D Director	Perform formal or informal reviews after completion of work packages and / or at the change of stages during the software life cycle

Role	Responsibility
Engineering	Participate in peer reviews
Managing Director	Perform process reviews during monthly project reviews
SW Quality Manager	Prepare and maintain the SVVP Monitor/participate in peer reviews Track corrective actions from reviews and audits to closure Oversee the V&V tasks

4.6 Tools, Techniques, and Methods

This section focuses on software testing. Other V&V activities, especially reviews, are described in detail in the ANNAX Software Quality Assurance Plan for the TTC Toronto project [ASQAP].

Software testing validates the developed software to demonstrate that it functions in accordance with its design. The software test workflow manages the process of testing and feedback during the Integration & Test stage.

It has been identified that the use of the ANNAX Documentation Checklist as a means to document review finding and V&V task reports needs to be better introduced to the project team. While the previous tool, called ANNAX Software Documentation Checklist, has been introduced by the Software Quality Manager during a number of informal meetings, a further official training should be held in Q1/2010 to introduce the changes in the new version of the tool template.

No further training for any of the tools, techniques, and methods is required, especially since the testing techniques and methods do not differ from previous projects and the testing personnel is already familiar with those techniques and methods.

4.6.1 Tools

Tools used for V&V activities are:

- Testing tools described in the ANNAX Software Test Plan [ASTP]
- ANNAX Documentation Checklist, used for review minutes and for task reports

4.6.1.1 Personnel

The personnel associated with software testing include:

1. The Software Engineers
 2. Testing personnel drawn from the Customer Service (CS) team
- 1 Software Test Manager will be available for the duration of the project.

4.6.2 Techniques

See Section 4.6.3 below.

4.6.3 Methods

The processes associated with software testing include:

- Informal Iteration, and
- In-Stage Assessment

4.6.3.1 Informal Iteration Process

The release candidate is tested by the development staff. This informal testing is typically executed against the Software Design Description. Formal test cases and automated testing scripts may be in place to assist this effort, depending on the resources available to the project. This developer self-testing process is called a “desk check”, also referred to as “unit tests”. Once the software passes the desk check, the development team sets the build status to “ready” and informs the Project Manager. The Project Manager then initiates the in-stage assessment process.

4.6.3.2 In-Stage Assessment Process

Testers execute test cases against the release candidate. For each test case that passes, the testers indicate the successful test in the Test Report. For each test case that fails, the testers indicate the faulty test in the Test Report and generate a Test Incident Report (TIR) in the Mantis Problem Report system

4.6.3.3 Test Report

The tester uses the Test Report to describe the details of the tests executed for the test steps associated with each test case. Different projects will have different resources available for testing. The description of how the testing was performed should include details of actions taken, values entered, and results observed.

Test reports require review prior to submittal to Bombardier in order to ensure all requirements have been tested as planned and all test results are to a level that is desirable by both the client and ANNAX.

4.6.3.4 Test Incident Report

When one or more of the steps associated with a test case fail, the tester generates a TIR. One TIR may describe multiple test step failures, but all test steps must be associated with a single test case (one TIR per test case). The content of a TIR is developed first by the tester and then by the developer assigned to correct the failure. The tester describes the failure in sufficient detail to enable reproduction of the failure by the developer. The developer assigned to correct the failure uses this information to reproduce and identify the root cause of the failure. When the software has been corrected and desk checked by the developer, the TIR is updated to reflect the changes associated with the fix.

All TIRs have to be entered into the Mantis Problem Report system of the development team.

4.6.3.5 Test Methodology

Testing is based on two key concepts: Test Cases and Test Procedures.

4.6.3.5.1 Test Cases

Each test case describes a specific set of goals designed to validate the correct operation of a specific subset of the software. Test cases come in a variety of forms, each specific to the task at hand. In general, each test case is written specifically for end-users and developers that are familiar with the application.

4.6.3.5.2 Test Procedures

This test methodology utilizes two classes of test procedures:

- Acceptance testing
- Regression testing

4.6.3.5.3 Acceptance Testing

The acceptance test procedure uses a “lightweight” set of test cases intended to validate that the software is functioning correctly at the top level. Acceptance tests are used for two reasons: Acceptance into testing, and acceptance into production.

When the software is deemed ready for test by the development team, the acceptance test procedure is run to ensure that the test instances are basically functional. If the software fails to pass this limited set of tests, the software is returned to the development team for correction. If the software passes the acceptance tests, it is then subjected to comprehensive test procedures as described below.

Once the software has passed the comprehensive test procedure, a production instance of the application is installed. The acceptance test procedure is run once again to ensure that the software was properly migrated, without forcing a repetition of the comprehensive test procedure. Successful completion of the acceptance test procedure on the production instance of the application, coupled with the documentation showing that the software has previously passed the comprehensive test procedure, serves as the basis for acceptance of the software by the customer.

4.6.3.5.4 Regression Testing

During production, occasional bugs may be discovered. Regression tests are designed to ensure that all reported bugs have been fixed in all subsequent releases of the software. This becomes especially important when developers other than the original team are performing bug fixes. Certain test cases are specifically designed to make sure a bug has been fixed. The regression test procedure also uses test cases involving functions and features that may have been impacted by the bug fixing process.

4.6.3.5.5 Critical Success Factor: Application Familiarity

Familiarity with the application under test is the single critical success factor of testing, as it allows the specification of test cases that are focused on testing a specific area of the application, rather than broad spectrum test cases that walk a tester through, step-by-step, from the top of the application to the desired test areas.

For example, when a test case specifies the examination of a specific data entry screen, it does not provide a step-by-step checklist to arrive at that screen. Instead, the tester is expected to be familiar enough with the application that accessing the screen is not a mystery. This allows each test case to be tightly focused on a specific feature set.

V&V processes will be carried out throughout the project lifecycle. The following subsections describe the planned V&V activities. It is the responsibility of the Software Quality Manager to oversee and monitor V&V activities, performing tasks and producing reports as specified in this SVVP. The Software Quality Manager may, at any time, raise project issues with the Project Manager.

4.7 Metrics

Metrics collected in the course of the project are described in section 5.3.6 of the ANNAX Software Project Management Plan [ASPMP].

5 V&V Processes

5.1 Process: Management

5.1.1 ACTIVITY: MANAGEMENT OF V&V

5.1.1.1 SVVP Generation

Table 9: SVVP Generation

Task	Generate Software Verification and Validation Plan
Methods and Procedures:	Material upon which the SVVP is to be based will be collected and compiled.
Inputs:	IEEE Std 1012-1998 Standard for Software Verification and Validation [I1012]; Previous revisions of this SVVP; ANNAX Software Project Management Plan [ASPMP]; Software Quality Assurance Plan [ASQAP]; Bombardier SVVP template
Outputs:	This SVVP and updates.
Schedule:	Refer to Section 4.2
Resources:	Refer to Section 4.4
Risks and Assumptions:	None.
Roles and Responsibilities:	The SVVP will be prepared and updated as needed by the Software Quality Manager. Refer to Section 4.5.

5.1.1.2 Proposed/Baseline Change Assessment

Table 10: Proposed/Baseline Change Assessment

Task	Proposed/Baseline Change Assessment
Methods and Procedures	Proposed/requested changes will be handled as described in the ANNAX Software Configuration Management Plan [ASCMP]. The Configuration Control Board (CCB) will evaluate possible effects of proposed changes on previously completed V&V tasks and will decide on the repetition of such tasks.
Inputs	SCMP; proposed changes (documented in Mantis); this SVVP
Outputs	Task Report(s) - Baseline Change Assessment, Anomaly Report(s), updated SVVP
Schedule	This task will be performed as needed, after a change has been proposed.
Resources	Refer to Section 4.4
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.1.1.3 Management Review of the V&V Effort

Table 11: Management Review of the V&V Effort

Task	Perform Management Review of the V&V Effort
Methods and Procedures	Management reviews between the Project Manager, the Managing Director, and the Software Quality Manager will be monthly held. The Management Review will cover multiple areas of interest, among them the status of SQA and SVV activities. Management Reviews will also serve as a platform for discussion of improvement opportunities related to SQA, V&V and other processes. Minutes of the Management Reviews will be taken.
Inputs	SVVP and updates; V&V task reports, anomaly reports
Outputs	Updated SVVP (if applicable), recommendations to further activities; minutes of the Management Review
Schedule	Monthly
Resources	Refer to Section 4.4
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.1.1.4 Identify Improvement Opportunities in the Conduct of V&V

Table 12: Identify Improvement Opportunities in the Conduct of V&V

Task	Identify Improvement Opportunities in the Conduct of V&V
	Improvement opportunities in the conduct of V&V are identified during Management Reviews. Refer to Task 5.1.1.3.

5.2 Process: Acquisition

5.2.1 ACTIVITY: ACQUISITION SUPPORT V&V

5.2.1.1 System Requirements Review

Table 13: System Requirements Review

Task	System Requirements Review
Methods and Procedures	The System Requirements are mainly described in the TTC Technical Specification [TS]. These documents have been reviewed in the course of the bid phase. Results of the review are documented in the ANNAX internal Requirements Analysis for the TTC Toronto project [ARA].
Inputs	TTC Technical Specification [TTC].
Outputs	Task Report - System Requirements Review; Anomaly Report(s)
Schedule	Refer to Section 4.2

Task	System Requirements Review
Resources	Refer to Section 4.4
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.3 Process: Supply

5.3.1 ACTIVITY: PLANNING V&V

- Intentionally left blank. No mandatory V&V tasks for SIL 1 for this activity. -

5.4 Process: Development

5.4.1 ACTIVITY: CONCEPT V&V

- Intentionally left blank. No mandatory V&V tasks for SIL 1 for this activity. -

5.4.2 ACTIVITY: REQUIREMENTS V&V

5.4.2.1 Software Requirements Evaluation

Table 14: Software Requirements Evaluation

Task	Software Requirements Evaluation
Methods and Procedures	Evaluate allocated software requirements documented in the Software Requirements Specification (SRS) for conformance to IEEE Std 830 - IEEE Recommended Practice for Software Requirements Specifications [I830] and to ensure they are correct, consistent, complete, accurate, readable, verify the criteria described in IEEE Std 1012 [I1012], section 5.4.2 (2), pages 34 and 35, are satisfied
Inputs	Software Requirements Specifications, System Functional Description for ANNAX Passenger Information System [SFD], [I830], [I1012], Table 1, section 5.4.2 (2), pages 34 and 35
Outputs	Task Report(s), Anomaly Report(s)
Schedule	Refer to Section 4.2
Resources	Refer to Section 4.4
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.4.2.2 System Test Plan Verification

Table 15: System Test Plan Verification

Task	System Test Plan Verification
Methods and Procedures	<p>Verify the System Test Plan. For the TTC Toronto project, the System Test Plan is covered by the following documents:</p> <ul style="list-style-type: none"> • Software Test Plan [ASTP] • System Test Procedure [SysTPPr] <p>Validate that these documents satisfy the following criteria (see [I1012], Table 1, 5.4.2 (5)):</p> <ul style="list-style-type: none"> • Test coverage of system requirements • Appropriateness of test methods and standards used • Conformance to expected results • Feasibility of system qualification testing • Capability to be operated and maintained.
Inputs	<ul style="list-style-type: none"> • Software Test Plan [ASTP] • System Test Procedure [SysTPPr] • System Functional Description [ASFD] • Software Requirements Specifications (SRS)
Outputs	Task Report - System V&V test plan; Anomaly Report(s)
Schedule	Refer to Section 4.2.
Resources	Refer to Section 4.4.
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.4.3 ACTIVITY: DESIGN V&V

5.4.3.1 Software Design Evaluation

Table 16: Software Design Evaluation

Task	Software Design Evaluation
Methods and Procedures	Evaluate the SDDs for correctness, consistency, completeness, accuracy, readability, and testability. Verify the criteria described in [I1012], Table 1, 5.4.3 (2), are satisfied
Inputs	<ul style="list-style-type: none"> • Software Design Description documents • Software Requirements Specifications • Interface Control Documents (ICDs)
Outputs	Task Report(s) - Software Design Evaluation, Anomaly Report(s)
Schedule	Refer to Section 4.2.

Task	Software Design Evaluation
Resources	Refer to Section 4.4.
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.4.3.2 Integration Test Plan Verification

Table 17: Integration Test Plan Verification

Task	Integration Test Plan Verification
Methods and Procedures	The Integration Plan is part of the Software Test Plan (STP). Verify that the STP satisfies the criteria described in [I1012], Table 1, 5.4.3 (6), 5.4.3 (7), 5.4.4 (5), 5.4.4 (6).
Inputs	STP, SRS, STPr, SDD
Outputs	Task Report(s) - Integration Test Plan , Anomaly Report(s)
Schedule	Refer to Section 4.2.
Resources	Refer to Section 4.4.
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.4.3.3 Verify the Test Design

Table 18: Verify the Test Design

Task	Verify the Test Design
	Refer to Tasks 5.4.2.2 and 5.4.3.2 The Software Test Procedures contain the test design

5.4.4 ACTIVITY: IMPLEMENTATION V&V

5.4.4.1 Source Code and Source Code Documentation Evaluation

Table 19: Source Code and Source Code Documentation Evaluation

Task	Source Code and Source Code Documentation Evaluation
Methods and Procedures	Evaluate the source code of the SCI and the pertaining documentation, using the criteria defined in [I1012], Table 1, 5.4.4 (2).
Inputs	<ul style="list-style-type: none"> Source Code SRS and SDD documents

Task	Source Code and Source Code Documentation Evaluation
Outputs	Task Report(s) - Source Code and Source Code Documentation Evaluation, Anomaly Report(s)
Schedule	Refer to Section 4.2.
Resources	Refer to Section 4.4.
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.4.4.2 Verify the Test Cases

Table 20: Verify the Test Cases

Task	Generate and Verify the Test Cases
	Refer to Tasks 5.4.2.2 and 5.4.3.2 The Software Test Procedures (STPr) contain the test cases

5.4.4.3 Verify the Test Procedure

Table 21: Verify the Test Procedures

Task	Verify the Test Procedure
	Refer to Tasks 5.4.2.2 and 5.4.3.2 The Software Test Procedures (STPr) contain the test procedures

5.4.5 ACTIVITY: TEST V&V

5.4.5.1 Verify the Integration Test

Table 22: Verify the Integration Test

Task	Verify the Integration Test
Methods and Procedures	Use the results of the Integration Test to verify the software integration test satisfies the acceptance criteria described in the Software Test Plan.
Inputs	<ul style="list-style-type: none"> Software Test Plan Software Test Report (STR)
Outputs	Task Report(s) - Test Result, Anomaly Report(s)
Schedule	Refer to Section 4.2.
Resources	Refer to Section 4.4.
Risks and Assumptions	None.

Task	Verify the Integration Test
Roles and Responsibilities	Refer to Section 4.5.

5.4.5.2 Verify the System Test

Table 23: Verify the System Test

Task	Verify the Integration Test
Methods and Procedures	Use the results of the System Test to verify the software system satisfies the acceptance criteria described in the Software Test Plan.
Inputs	<ul style="list-style-type: none"> • Software Test Plan • System Test Report (SysTR)
Outputs	Task Report(s) - Test Result, Anomaly Report(s)
Schedule	Refer to Section 4.2.
Resources	Refer to Section 4.4.
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

5.4.6 ACTIVITY: INSTALLATION AND CHECKOUT V&V

- Intentionally left blank. No mandatory V&V tasks for SIL 1 for this activity. -

5.5 Process: Operation

5.5.1 ACTIVITY: MAINTENANCE V&V

5.5.1.1 SVVP Revision

Table 24: SVVP Revision

Task	SVVP Revision
Methods and Procedures	The Software Quality Manager will review the SVVP for necessity of change at a minimum every three months and will revise the SQAP if needed.
Inputs	SVVP
Outputs	Updated SVVP
Schedule	Refer to Section 4.2.
Resources	Refer to Section 4.4.
Risks and Assumptions	None.
Roles and Responsibilities	Refer to Section 4.5.

6 V&V Reporting Requirements

6.1 Tasks Reports

Task Reports will be created as expressed in the V&V task tables in Section 5. A MS Excel template for Task Reports will be provided for project use. The template will identify the following information:

- V&V task name
- Location (where the V&V task took place)
- Attendees (who took part in the V&V task)
- References (what was the input, what the output)
- Description (how was the V&V task done)
- Anomalies (if any)
- Signatures

6.2 V&V Activity Summary Reports

After an activity has ended, the Software Quality Manager will summarize V&V activities into a section of the Software Verification and Validation Report (SVVR). The SVVR will be incrementally filled as the project proceeds. The SVVR format will conform with Bombardier's template for the project. The SVVR will be finished and submitted to Bombardier as stipulated in Section 1.1.3 of the ANNAX Software Project Management Plan

6.3 Anomaly Report

Anomaly Reports will be created as expressed in the V&V task tables in Section 5. Anomalies will be documented using the Task Report template described in Section 6.1.

6.4 V&V Final Report

The Software Verification and Validation Report constitutes the V&V Final Report for this project. The SVVR will consist of a MS Word document plus attachments like e.g. individual Task Reports (refer to Section 6.1)

6.5 Special Studies Report

No Special Studies Reports will be provided for this project.

6.6 Other Reports

No other V&V reports will be provided for this project.

7 V&V Administrative Requirements

7.1 Anomaly Resolution and Reporting

Anomaly Reports will be created as expressed in the V&V task tables in Section 5. Anomalies will be documented using the Task Report template described in Section 6.1. The Software Quality Manager will report anomalies to the Project Manager. It is then the Project Manager's responsibility to decide on repetition of tasks in order to resolve the anomaly reported.

There will be no distinction between different anomaly severity levels. All anomalies will be entered as Change Requests into the bug tracking/change request tool Mantis. The Software Quality Manager will track anomalies to closure.

7.2 Task Iteration Policy

V&V tasks will be repeated upon decision of the Software Quality Manager together with the Project Manager and the R&D Director. As a general rule, V&V tasks that were performed during development will be repeated in case that changes need to be implemented during operation and maintenance phase. During development, prior to first delivery of software to Bombardier/TTC, all affected V&V tasks will be repeated when an input to the task has changed. Excluded are changes which are only formal document changes. For those changes, repetition of V&V tasks will be optional. Regression tests will be performed as described in Section 4.6.3.5.4.

7.3 Deviation Policy

Deviations from this plan require written permission by the Software Quality Manager. The Software Quality Manager will collect the following information and request Bombardier's/TTC's approval before granting internal permission:

- SVV task deviated from
- Rationale
- Any system effect

ANNAX can only deviate from this plan once Bombardier/TTC have approved the respective waiver.

7.4 Control Procedures

Control procedures describing how to configured, protect, and store V&V results are contained in Section 3.1.3.4 of the ANNAX Software Configuration Management Plan [ASCMP].

7.5 Standards, Practices, and Conventions

Standards, Practices, and Conventions to be applied to the project are listed in Section 2. Further standards to be applied are listed in Section 5.3 of the ANNAX Software Quality Assurance Plan [ASQAP].

8 V&V Test Documentation Requirements

Test documents to be provided throughout the project are listed in the ANNAX Software Quality Assurance Plan [ASQAP], Section 4.