

Independent Verification and Validation (IV&V) of NASA Program Software

July 2004

IV&V Project Plan

Project-X1 IV&V

**Prepared for:
Project-X1 Project
NASA Center X
New City, XY 55555**

**Prepared by:
NASA IV&V Facility
100 University Drive
Fairmont, WV 26554**

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1 FOREWORD

1.1 Project Overview

This section gives an overview of the Project-X1 Mission and of the software and firmware to be developed. The following descriptions were extracted from the Project-X1 Project Software Management Plan, XYZ A-2567, Version 1.0, July 2, 2003.

1.1.1 Mission Type

The Project-X1 Project was selected on July 15, 2002 by the National Aeronautics and Space Administration (NASA) XY Program Office. The primary industrial partner, who will develop the spacecraft and participate in mission operations, is XYZ Company of New Town, New State. Foreign partnerships are limited to the New Country Space Agency (NCSA), and the Second Partner Space Agency (SPSA). NCSA will contribute the Instrument1 and an operations center for the Instrument1 during flight. SPSA will contribute the Instrument2 and an operations center for the Instrument2 during flight.

1.1.2 Mission Objective

The Project-X1 Mission's primary objective is to significantly increase our understanding of the following: xxx, xxx, and xxx. This will be accomplished by sending a spacecraft to perform science investigations of the xxx using xxx, xxx and xxx.

1.1.3 Project System Overview

The Project-X1 Project comprises the following three major systems: FLS System, P1 System and Science Analysis System. Table 1-1 identifies the major components of each system.

Table 1-1 Project-X1 System Components

System	Scope
FLS System	<ul style="list-style-type: none">• The S/C1 hardware and software• The xxx System• Other applicable/selected hardware (e.g. xxx, xxx)
P1 System	<ul style="list-style-type: none">• Instrument1• Magnetometer• Other hardware and applicable software
Science Analysis System	<ul style="list-style-type: none">• Instrument2• Data collection plan and approach• Other selected systems

1.1.4 Project Software Overview

The Project-X1 Project consist of the Spacecraft1 (S/C1) Flight Software (FSW), Instrument1 FSW, Instrument2 FSW, S/C1 Simulation Software, S/C1 Ground Support Software including Software for S/C1 Test and Operations Software, and Science Analysis Software.

[Detailed S/C1 flight operations and FSW interfaces descriptions REMOVED]

[REMOVED]

Figure 1-1 Project-X1 System Software Architecture

1.2 Purpose

The purpose of this effort is to provide an Independent Verification and Validation (IV&V) of the Project-X1 S/C1 Flight Software (FSW) in an attempt to identify issues early in the development process and thereby reduce software risk prior to launch. The scope of IV&V for the Project-X1 Project is full life cycle activities performed on the Spacecraft (S/C1) FSW and supporting systems as shown in Figure 1-1 above.

This project plan identifies the tasks that will be performed to accomplish IV&V of the Project-X1 Project's critical software. The plan includes information on how the IV&V schedule is dependant on the program schedule. There is also a resource plan, list of dependencies and a product delivery schedule. The reporting channels and organization hierarchy are provided as well. Training needs and responsibilities for configuration management are also identified.

1.3 Assumptions

This plan is based on the Project-X1 Top-Level Program schedule and the Project-X1 FSW schedule that were provided to the IV&V team in May 2004. The relevant dates for the various FSW and Reviews are based on the information received from the NASA Center X IV&V Project Liaison in May 2004. The delivery schedule for IV&V products is based on the assumption that development artifacts listed in Section 7 will be available by the dates shown. It is also presumed that an agreement will be reached between the Project-X1 Project and the Developer to make the needed artifacts available to the IV&V Facility. If the project does not provide the necessary artifacts to IV&V team in a timely manner, then this will adversely impact the IV&V team's task schedule and performance of the analysis tasks.

1.4 Referenced Documents

1.4.1 Project-X1 Reference Documents

1. Project-X1 S/C1 and FSW Specification, Rev. C, November 9, 2003.
2. Project-X1 COM1 Flight Software Requirements Specification, draft, December 20, 2003
3. Project-X1 SubSystem2 Flight Software Requirements Specification, draft, May 15, 2003
4. Project-X1 Software Development Plan, xx1, Revision A, February 11, 2003
5. Project-X1 Project Implementation Plan, xxx1, Revision D, January 2003.
6. Project-X1 Project Software Management Plan, Version 2, August 10, 2003.
7. Project-X1 Top Level Schedule, January 04, 2004.
8. Project-X1 Flight Software Schedule, June 11, 2004.
9. [REMOVED]

1.4.2 IV&V Reference Documents

1. Project-X1 Startup Assessment Report (SAR), March 2004.

1.5 Definitions

1.5.1 Acronyms

CO	Contracting Officer
COTR	Contracting Officer Technical Representative
COTS	Commercial-Off-The-Shelf
DID	Data Item Description
FSW	Flight Software
GFE	Government Furnished Equipment
H/W	Hardware
IAL	IV&V Analysis Level
IAT	Independent Assessment Team
IV&V	Independent Verification & Validation
MRR	Mission Readiness Review
NASA	National Aeronautics and Space Administration
PDR	Preliminary Design Review
PI	Principal Investigator

PITS	Project Issue Tracking System
SAR	Startup Assessment Report
S/C	Spacecraft
SLP	System Level Procedure
TBD	To Be Determined
TBS	To Be Supplied
TO	Task Order
[REMOVED]	

2 PRODUCT SAFETY

There is no requirement to address product safety in this project plan.

3 TASK DEFINITION

The basic objective is to assist the Project-X1 Project in achieving successful execution of the Project-X1 mission objectives. This in turn implies that the software performs as intended, does not perform unintended functions, and is developed within cost and schedule constraints.

Consequently, the NASA IV&V Facility shall perform life cycle IV&V on the Project-X1 Spacecraft1 (S/C1) to ensure compliance with these requirements. The IV&V tasks as described in the subsections below shall be prioritized in accordance with the results of the Project-X1 Critical Functions List (CFL), which is documented in the Project-X1 Startup Assessment Report (SAR).

IV&V tasks include three general types: (1) IV&V analysis, (2) Phase independent support, and (3) IV&V management and planning. The IV&V analysis tasks are aligned to the corresponding software development phases: requirements, design, code and test. The specific scope of these tasks is based on the recommended IV&V analysis levels (IALs). The IV&V management and planning tasks support task definition, execution, interfaces to the Project, and reporting. Phase independent tasks (e.g., Issue and Risk Tracking, Metrics Analysis, etc.) are generally not directly associated with the FSW development phases but are performed and repeated as needed to support Project technical needs. The sections below provide a list of recommended tasks per year that will serve to meet the IV&V team's basic objective.

3.1 FY 2004 Tasks

The IV&V Team will perform the following IV&V tasks to support the Project-X1 Project during FY 2004. The tasks will be tailored for each software function according to the IALs identified in CFL in the Project-X1 Startup Assessment Report.

3.1.1 IV&V Analysis Tasks

3.1.1.1 FSW Process Analysis:

Evaluate the Developer Software Development Plan to determine if it adequately reflects the requirements, constraints, etc. found in the Project Software Development Plan. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.1.2 Requirements and Traceability Analysis:

Verify requirements flow-down from L2 to L3 to the L4 SRSs. Perform requirements analysis on the L3 - focusing on software - and on the xxx and xxx CSCIs. Perform analysis of the ICDs (between instruments and spacecraft1). Tailoring of these tasks may occur depending on the Project-X1 Project's characteristics.

3.1.1.3 Test Program Analysis:

Perform test analysis for the xxx and xxx systems based on the individual test plans/procedures as shown in the IV&V schedule. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.1.4 Design analysis:

Perform design analysis for functions receiving Limited and Focused analysis levels. Verify traceability of the software requirements to the design implementation. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.1.5 Code Analysis:

Perform code Analysis for functions receiving Limited and Focused analysis levels. Verify traceability of requirements and design to the code modules. Perform Static Code analysis using static code analysis tools (e.g., Tool X) on all FSW functions. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.1.6 Software Test Analysis:

Perform test analysis on functions receiving, Basic, Limited, and Focused analysis levels. Trace requirements to tests. This task represents an augmentation of the original Test Program Analysis, which only focused on evaluation of the initial test plans. The purpose of this task is to evaluate additional test artifacts (e.g., test case descriptions, procedures, scripts, results) produced for each xx build. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.1.7 Project Review Support:

Participate in the Project-X1 Project subsystem reviews and the Project CDR. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.1.8 Report Generation and Delivery:

Support development, review, and delivery of all technical deliverables. Tailoring of this task may occur depending on the Project-X1 Project's characteristics. Refer to Section 8 for the list of deliverables.

3.1.1.9 XXX Analysis:

Perform requirements analysis, static code analysis, and test analysis on the XXX FSW. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.2 IV&V Management and Planning

3.1.2.1 Task Management:

Interface with the Project-X1 Project. Direct the IV&V technical work, and prepare, coordinate, and review IV&V deliverables.

3.1.2.2 IV&V Planning for FY 04:

Develop and update as necessary the IV&V Project Plan for FY 04.

3.1.3 IV&V Phase Independent Support

3.1.3.1 Baseline Change Assessment:

Analyze changes to software baselines (specifications, design, code) as directed by Project change notices. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.3.2 Issue and Risk Tracking:

Evaluate Project response to IV&V issues and risks, and update the status of the issues and risks using the IV&V team's Project Issue Tracking System (PITS). Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.3.3 IV&V Tool Support:

Adapt existing tools or create new analysis tools for use on the Project-X1 IV&V Project.

3.1.3.4 Criticality Analysis Update for FY 04:

Update the CFL based on analysis of Project requirement documents and on material presented at the CDR. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.1.3.5 Metrics Analysis:

Initiate work to track software problem reports, to analyze trends, and to identify code change trends/stability. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.2 FY 2005 Tasks

The IV&V team anticipates performing the following IV&V tasks to support the Project-X1 Project in FY 2005. The tasks described in the sections below will be tailored for each software function according to the IALs identified by the CFL presented in the Project-X1 Startup Assessment Report.

3.2.1 IV&V Analysis Tasks

3.2.1.1 Design analysis:

Perform design analysis on functions receiving Limited and Focused analysis levels. Verify traceability of the software requirements to the design implementation. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.2.1.2 Code Analysis:

Perform detailed code analysis for functions receiving Limited and Focused analysis levels. Verify traceability of requirements and design to the code modules. Perform Static Code analysis using static code analysis tools (e.g., Tool X) on all FSW functions receiving Basic, Limited, and Focused analysis levels. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.2.1.3 Software Test Analysis:

Perform test analysis on functions receiving Basic, Limited, and Focused analysis levels. Trace requirements to tests. This task is a follow on to the Software Test Analysis task, which initiated in FY 04. The purpose of this task is to evaluate additional test artifacts (e.g., test case descriptions, procedures, scripts, results, etc.) produced for the remaining XX builds. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.2.1.4 System Test Analysis:

Perform test analysis on system/subsystem V&V tests (e.g., mission scenario tests, regression tests, etc.) as the tests relate to the critical software functions, verify traceability of the L3 software related requirements to tests, and support the NASA Center X independent test team. That status of the results of IV&V analysis will be presented at the MRR.

3.2.1.5 Report Generation and Delivery:

Support development, review, and delivery of all technical deliverables. Tailoring of this task may occur depending on the Project-X1 Project's characteristics. Refer to Section 8 for the list of deliverables.

3.2.1.6 XXX Analysis:

Complete the static code analysis and test analysis for the XXX FSW.

3.2.2 IV&V Management and Planning

3.2.2.1 Task Management:

Interface with the Project-X1 Project. Direct the IV&V technical work, and prepare, coordinate, and review IV&V deliverables.

3.2.2.2 IV&V Planning for FY 05:

Develop and update as necessary the IV&V Project Plan for FY 05.

3.2.3 IV&V Phase Independent Support

3.2.3.1 Baseline Change Assessment:

Analyze changes to software baselines (specifications, design, code) as directed by Project change notices. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.2.3.2 Issue and Risk Tracking:

Evaluate Project response to IV&V issues and risks, and update the status of the issues and risks using the PITS. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.2.3.3 IV&V Tool Support:

Adapt existing tools or create new analysis tools for use on the Project-X1 IV&V Project.

3.2.3.4 Metrics Analysis:

Continue the task initiated in FY 04 to track software problem reports, to analyze trends, and to identify code change trends/stability. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.3 FY 2006 Tasks

The IV&V team anticipates performing the following IV&V tasks to support the Project-X1 Project in FY 2006. The tasks described in the sections below will be tailored for each software function according to the IALs identified by the CFL presented in the Project-X1 Startup Assessment Report.

3.3.1 IV&V Analysis Tasks

3.3.1.1 Code Analysis:

Perform detailed code analysis for the XXX FSW Build 8 functions receiving Limited and Focused analysis levels. Verify traceability of requirements and design to the code modules. Perform Static Code analysis using static code analysis tools (e.g., Tool X) for all of the XXX FSW Build 8 functions receiving Basic, Limited, and Focused analysis levels. Tailoring of this task may occur depending on the Project-X1 Project's characteristics. The IV&V Team will present the status of the analysis results at the Mission Readiness Review (MRR).

3.3.1.2 System Test Analysis:

Perform test analysis on system/subsystem V&V tests (e.g., mission scenario tests, regression tests, etc.) as the tests relate to the critical software functions, verify traceability of the L3 software related requirements to tests, and support the NASA Center X independent test team. The IV&V Team will present the status of the analysis results at the Mission Readiness Review (MRR).

3.3.1.3 Project Review Support:

Participate in the Project-X1 Project MRR and present the IV&V Team's findings, status of issues, open risks, and recommendations. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.3.1.4 Report Generation and Delivery:

Support development, review, and delivery of all technical deliverables. Tailoring of this task may occur depending on the Project-X1 Project's characteristics. Refer to Section 8 for the list of deliverables.

3.3.2 IV&V Management and Planning

3.3.2.1 Task Management:

Interface with the Project-X1 Project. Direct the IV&V technical works, prepare, coordinate, and review IV&V deliverables.

3.3.2.2 IV&V Planning for FY 06:

Develop and update as necessary the IV&V Project Plan for FY 06.

3.3.3 IV&V Phase Independent Support

3.3.3.1 Baseline Change Assessment:

Analyze changes to software baselines (specifications, design, code) as directed by Project change notices. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.3.3.2 Issue and Risk Tracking:

Evaluate Project response to IV&V issues and risks, and update the status of the issues and risks using the IV&V Team's PITS. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

3.3.3.3 IV&V Tool Support:

Adapt existing tools or create new analysis tools for use on the Project-X1 IV&V Project.

3.3.3.4 Metrics Analysis:

Continue the task initiated in FY 04 and continued in FY 05 to track software problem reports, to analyze trends, and to identify code change trends/stability. Tailoring of this task may occur depending on the Project-X1 Project's characteristics.

4 RESOURCES

4.1 Required Staffing

Table 5-1 shows the technical staffing that is needed to support this IV&V effort.

Table 4-1 Resources - Required Technical Staff

Number	IV&V Skill	Average Equivalent Level Load
1	Project Mgr.	xx EP
2	Systems/Software Analyst	xx EP
3	Sr. Systems/Software Analyst	xx EP
4	Expert Systems/Software Analyst	xx EP
5	XXX Analyst	xx EP
6	Project Support Staff	xx EP
7	Others	xx EP
TOTALS		XX.XX EP

4.2 Required Materials

At the time of delivery for this Project Plan, no unique material resources have been identified as required to complete the IV&V analysis tasks defined in Section 3.

4.3 Planned Contractors

Table 5-2 shows the list of contractors supporting performance of the Project-X1 IV&V tasks.

Table 4-2 Resources - Planned Contractor Support

Contractor Name	Support Category
[REMOVED]	

4.4 Required Tools

Table 4-3 lists the Tools that are required to support the IV&V tasks defined in Section 3 and shown on the Project-X1 IV&V Task schedule. Access to the tools is required prior to the start of the IV&V tasks identified in Table 7-1.

Table 4-3 Resources - IV&V Tools Needed

Tool	Location	Task(s)
[REMOVED]	Fairmont	ID #

5 IV&V SCHEDULE

The IV&V task schedule is provided as a separate Microsoft Project 2002 file to this Project Plan. The file name is "Project-X1-xx-2004". The Project-X1 IV&V task schedule provides the details from the Project-X1 Project Top-Level schedule and the Project-X1 FSW schedule that will impact the IV&V Team's tasking. The schedule identifies all known dependencies associated with the start and/or completion of all tasks. All dates assume on-time delivery of all artifacts needed to complete the analysis and contiguous execution of tasks. Report Dates are tentative based on the anticipated end of the associated analysis task(s), which are tied to the Project-X1 Project schedules.

6 RESOURCE PLAN

The IV&V Team will conduct planning activities in September 2004 to determine the effort required to perform the planned tasks for FY05. An update to this Project Plan will be submitted prior to the current FY end date.

Table 6-1 Resources – EP Allocations per Task

	Month 1									TOTAL (FY 04)
Requirements Analysis EP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Code Analysis EP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others EP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTALS										0.00

7 EXTERNAL INPUTS AND DEPENDENCIES

All IV&V activities and products are dependent on the availability of Project-X1 software development artifacts or products. Table 7-1 provides a list of the Project-X1 Project artifacts required to perform the IV&V tasks specified in Section 3.

Table 7-1 External Input Dependencies

External Input	Associated Schedule Task	Output ID
FSW Source Code for xxx	ID #	ID #
FSW CSCI test plans, test procedures	ID #	ID #
S/C1 ICD	ID #	ID #

8 PRODUCTS

The following IV&V products assume on-time delivery of artifacts needed to complete analysis and contiguous execution of task.

Table 8-1 Deliverables

Schedule ID	Product	Dependency	Need By	Schedule
101	Project-X1 FSW Requirements Analysis Report	XXX	xx/xx/xx	15 days after analysis completed
102	S/C1 FSW Test Analysis Report	Test Plans, Test Cases	xx/x/xx	15 days after analysis completed
103	Monthly Software Status Report	N/A	N/A	XXX

9 PROJECT ORGANIZATION AND INTERFACES

9.1 Internal Organization

The tables below define the NASA IV&V Civil Servants and the PROJECT-X1 IV&V Team members, their position and contact information.

Table 9-1.1 NASA IV&V Civil Servants

Position	Name	Contact Information
NASA IV&V COTR	NASA CS	
NASA IV&V Project Manager	NASA CS	

Table 9-1.2 Project-X1 IV&V Team

Position	Name	Contact Information
Project Manager	Name	--
--	--	--
--	--	--

The NASA IV&V Project Manager will coordinate availability of artifacts, IV&V Team issues, and questions that arise with the Project-X1 NASA Center X IV&V Liaison.

9.2 External Organization

Table 9-2 provides the list of PROJECT-X1 Project personnel, position titles and their contact information.

Table 9-2 External Points of Contact

Position	Name	Contact Information
NASA Center X Project-X1 Project Manager	--	--
--	--	--

10 REPORTING

The NASA IV&V Project Manager will submit Technical Issues on a periodic basis to be determined after initiation of the IV&V analysis tasks.

The NASA IV&V Project Manager will deliver the Monthly Software Status Reports and other formal deliverables to the PROJECT-X1 Project based upon the requirements.

11 TRAINING AND QUALIFICATIONS

Table 11-1 specifies the unique qualifications and/or training required for the analysts to support the Project-X1 IV&V tasks, defined in Section 3 of this document.

Table 11-1 IV&V Analysis Team Training Requirements

		C	C++	Tool X	Others
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All of the Project-X1 IV&V Team members meet the training requirements as shown above.

12 CONFIGURATION MANAGEMENT OF EXTERNAL INPUTS

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[REMOVED]

13 NON-DISCLOSURE AGREEMENTS

Contractor work performed on artifacts produced by Developer X is covered by the NDA signed on January 5, 2003 between Company X and Developer X. All data originating from Developer X or NASA Center X shall be protected from disclosure according to the terms of the referenced NDA.