SOFTWARE DEVELOPMENT PLAN

FOR THE

GLOBAL ULTRAVIOLET IMAGER

(GUVI)

FLIGHT SOFTWARE

7366-9002

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Table of Contents

1. Introduction

1.1 Scope

This document defines the software development plan for the Global Ultraviolet Imager (GUVI) flight instrument. This document addresses only the GUVI flight software. The GUVI ground segment software development plan is defined in a separate document.

1.2 Definitions

CDR	Critical Design Review
DP	Data Processing
ECU	Electronics Control Unit
EEPROM	Electrically Erasable Programmable Read Only Memory
GSE	Ground Support Equipment
GUVI	Global Ultraviolet Imager
ICD	Interface Control Document
I/O	Input/Output
I&T	Integration and Test
JHU/APL	The Johns Hopkins University/Applied Physics Laboratory
PDR	Preliminary Design Review
POC	Payload Operations Center
PROM	Programmable Read Only Memory
QA	Quality Assurance
RAM	Random Access Memory
S/C	Spacecraft
SIS	Scanning Imaging Spectrograph
SSUSI	Special Sensor Ultraviolet Spectrographic Imager
TIMED	Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics
UV	Ultraviolet

1.3 Applicable Documents

(1) GUVI Technical Requirements Specification, 7366-9001

(2) GUVI Software Quality Assurance Plan, 7366-9003

(3) GUVI Product Assurance Implementation Plan, 7366-9190

(4) Space Department Software Quality Assurance Guidelines, SDO-9989, September 1992

2. Overview

2.1 Project Overview

GUVI is an instrument on the Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) spacecraft. The GUVI flight instrument consists of a cross-track scanning imaging spectrograph that operates in the far ultraviolet region. GUVI produces horizon to horizon line scan images at five simultaneous far ultraviolet wavelengths.

The GUVI flight instrument consists of two major subsystems, the scanning imaging spectrograph (SIS) and the electronics control unit (ECU). The scanning imaging spectrograph subsystem includes the spectrograph optics housing and electronics package, and the detector tubes, high voltage power supplies, and focal plane electronics. The electronics control unit contains the processor, interface, and power switching circuitry required by the GUVI instrument.

The GUVI ground segment consists of both engineering and data processing payload operations centers (POC). The engineering POC will be used to control the instrument during pre-launch ground testing and post-launch operations. The engineering POC will evaluate instrument health and status data and originate instrument commands. The data processing POC will perform the routine data product generation and data access and distribution functions during post-launch operations.

2.2 Software Project Overview

The GUVI flight instrument contains two processors, the telemetry processor and the detector processor. The telemetry processor is the main control unit of the instrument. The detector processor is dedicated to processing the detector photon event data. The telemetry and detector processors will execute the software defined by this plan.

The GUVI telemetry processor software provides the control and telemetry functions for the GUVI instrument. The telemetry processor accepts commands from the TIMED spacecraft and controls the operation of the various GUVI detectors, power supplies, and mechanisms. The processor receives and formats data from the spectrograph detectors along with general housekeeping information, and sends the data to the spacecraft data handling subsystem for transmission to ground stations.

The GUVI detector processor software computes the position of each photon event in the spectrograph and bins the events from each measurement frame into spatial and spectral pixels. The detector processor receives photon event data from the spectrograph detector, and transfers the binned spectrograph data to the telemetry processor.

3. Management

3.1 Products

The GUVI flight software consists of the following two components.

(1) Telemetry processor flight software
(2) Detector processor flight software

The telemetry processor software shall control the operation of the instrument, and is embedded in the telemetry processor. The detector processor software shall process the detector photon event data, and is embedded in the detector processor.

3.2 Organization

The GUVI software organization chart is shown in figure 1.

3.3 Responsibilities

The GUVI system engineer will develop the flight software requirements. The telemetry processor software lead engineer is responsible for developing the telemetry processor flight software. The detector processor software lead engineer is responsible for developing the detector processor flight software. The GUVI system engineer will develop the flight software requirements specification, software interface control document, and software test plan.

3.4 Resources

The flight software shall be developed on personal computer based development systems. The personal computers and compilers to be used during software development are available from previous programs. No computer aided software engineering tools will be used. Initial software component testing shall be performed on prototype versions of the flight processor boards. The prototype boards will be fabricated after the GUVI PDR. The instrument ground support equipment will be available to support software testing.

3.5 Risks, Assumptions, and Contingencies

The detector processor software will be a modified version of code that was developed for the SSUSI instrument. The detector processor will be identical to the processor used in the SSUSI instrument, the Harris RTX2000, or it will be the upgraded version of the processor, the RTX2010. The detector processor software will be written using the Forth language.

The telemetry processor will be a 80C186 microprocessor. The telemetry processor design has been used in other instruments, and the telemetry processor code will be similar to software developed on the other projects. The telemetry processor software will be written in C++. The interfaces between the telemetry processor and the rest of the GUVI instrument are well defined from the SSUSI instrument experience.

3.6 Monitoring and Reporting

Software development progress shall be reported at the GUVI program status meetings, held weekly, and at the TIMED/GUVI technical interchange meetings, held quarterly. The GUVI software QA engineer will monitor the software development.

3.7 Development Activities

3.7.1 Requirements Definition

The GUVI flight software requirements will be documented in the flight software requirements specification. The requirements will be defined in meetings and discussions between the GUVI system engineer and the flight software lead engineers.

3.7.2 Preliminary Design

The flight software top level design will be reviewed at the preliminary design review. The flight software will be developed in one build. This build will satisfy all flight software requirements.

3.7.3 Detailed Design / Prototype Development

The flight software detailed design will be developed following the software PDR. The flight software code implementation will begin during this phase, and the code will be tested on the prototype processor boards. The flight software lead engineers are responsible for code implementation and component level testing during this phase. The testing during this phase is informal and will be documented in the unit development folders. The detailed design will be reviewed at the critical design review.

3.7.4 Final Implementation and Test

Following the critical design review, the flight software code implementation will be completed, and the code tested on the prototype processor boards. A code walkthrough will be held after the completion of implementation and test. Configuration control of the flight software code will start after the code walkthrough. The software components will be identified by version numbers. After the code walkthrough, the flight PROM's will be burned and installed into the flight processor boards. The EEPROM code will be embedded in the flight telemetry and detector processor boards, and delivered for the start of instrument integration and test.

3.7.5 Instrument Integration and Test

At the beginning of the instrument integration and test phase, the GUVI electronics control unit (ECU) flight boards and chassis will be integrated. After the ECU integration is completed, the first of two formal flight software tests will be conducted. The flight software test will be performed with the code installed in the flight ECU unit. The ECU will be connected to the GSE simulators of the detector and spectrograph subsystems.

The second formal flight software test will be performed after the entire GUVI flight instrument has been integrated. This flight software test will be conducted on the flight ECU, spectrograph, and detector subsystems. The software test may be incorporated with the instrument detailed electrical test.

The GUVI engineering POC is required during all phases of instrument integration and test. The engineering POC hardware and stand-alone GSE are required to control the ECU during instrument testing. The engineering POC software will be tested during the initial instrument integration period to confirm that it can command the instrument and receive instrument data.

3.7.6 Maintenance

The flight software lead engineers will provide support for modifications of the flight software during the operational life of the instrument. All flight software changes after formal configuration control begins will be approved by the GUVI software change control board. The software development computers, prototype processor boards, and GSE will be available to support flight software upgrades and regression testing. The software lead engineers shall retain up to the ten previous versions of the flight software.

4. Administration

4.1 Statement of Work

The GUVI flight software team shall develop the software for the telemetry and detector processors that meets the requirements in the GUVI flight software requirements specification. The flight software shall be embedded in the flight processor boards at the start of instrument integration and test. The flight software team shall support any flight software changes that may be needed during the mission life.

4.2 Work Breakdown Structure

The telemetry processor flight software will be developed at the Aerospace Corporation. The detector processor flight software will be developed at the Johns Hopkins University/Applied Physics Laboratory.

4.3 Program Schedule

The flight software development schedule and key program milestone dates are listed here.

January 1997	System Preliminary Design Review

May 1997	Software Preliminary Design Review
May 1997 - Jan 1998	Detailed Design/Prototype Development
November 1997	S/C Emulator Required
January 1998	Critical Design Review
Feb - April 1998	Final Implementation and Test
May 1998	Code Walkthrough
May 1998	Begin Configuration Control
June 1998	Burn PROM's
July 1998	Begin Instrument I&T
August 1998	Software Acceptance Test
January 1999	Instrument Delivery for S/C I&T
May 2000	Launch
May 2002	End of Mission

4.4 Deliverable Items

The GUVI flight software is embedded in the two flight processors and is not deliverable to the sponsor. The telemetry processor software will consist of code stored in both PROM and EEPROM on the telemetry processor board. The detector processor software will consist of code stored in PROM on the detector processor board and code stored in EEPROM on the telemetry processor board.

5. Software Quality Assurance

5.1 Software Attributes

The GUVI flight software has the following attributes. The flight software is mission impact, as TIMED instruments are considered not mission critical. The software is embedded in the instrument, and is not deliverable. The flight software will be a modified version of code that was developed for similar instruments, and should be of low technical risk. The software program will involve a small development team, consisting of one software engineer for each flight software component.

5.2 Required Documentation

The following documentation is required for the GUVI flight software.

Flight Software Requirements Specification
Flight Software Interface Control Document
Flight Software Test Plan
Telemetry Processor Detailed Design Document
Detector Processor Detailed Design Document
Telemetry Processor Unit Development Folder
Detector Processor Unit Development Folder

5.3 Reviews and Audits

The GUVI flight software will be subject to the following reviews.

Preliminary Design Review
Critical Design Review
Code Walkthrough
Instrument Pre-Ship Review

5.4 Standards, Practices, and Conventions

Top down modular design will be used for the development of the flight software. The software shall be designed to provide maximum flexibility for modification and expansion. Source code files shall contain headers that include the file name, purpose, version number, change history, and list of procedures in the file. No computer aided software engineering (CASE) tools will be used. Software component design notes and test results will be documented in the unit development folders by the software lead engineers.

5.5 Problem Reporting and Correction

After configuration control, software problems shall be reported to the GUVI software QA engineer. During instrument integration and test, software problems shall be documented using the JHU/APL software problem report form (reference no. SOR-0122A). Problems shall be resolved by the GUVI software change control board. After delivery for spacecraft I&T, software problems and changes shall be approved by a representative of the TIMED program and the GUVI software change control board.

5.6 Safety and Security

There are no critical safety or security concerns with the GUVI flight software.

6. Configuration Management

6.1 Configuration Identification

Version numbers shall be maintained for the telemetry processor and detector processor software. Separate version numbers shall be used for the PROM based and EEPROM based code. Version numbers shall be listed in the source code headers. The current version numbers of all flight software components shall be listed in the GUVI engineering log book.

6.2 Configuration Control

Formal configuration control of the flight code shall begin after the code walkthrough. Code version number accounting will start at this time. Software change requests will be approved by the GUVI software change control board.

The GUVI software change control board shall consist of the instrument scientist, software QA engineer, system engineer, telemetry processor software lead engineer, detector processor software lead engineer, engineering POC software lead engineer, and data processing POC software lead engineer.

6.3 Configuration Status Accounting

Flight software version numbers shall be identified in instrument test reports. The flight software version configuration shall be reported at the instrument pre-ship review.

6.4 Configuration Audits

The GUVI software QA engineer will conduct periodic configuration audits and inspections during the flight software development.

7. Verification and Validation

7.1 Design Verification

The flight software requirements and top level design will be reviewed at the software preliminary design review. The flight software detailed design will be reviewed at the critical design review.

7.2 Implementation Verification

The flight software code will be tested on prototype processor hardware during code implementation. A code walkthrough will be held before the code is burned into the flight PROM's.

7.3 Integration Testing

The flight software code will be tested on the flight processor boards before delivery for instrument integration and test. Software tests will be conducted by the flight software lead engineers before instrument I&T begins.

7.4 Acceptance Testing

Two formal software tests will be performed during instrument integration and test. The first software test will be performed after the flight ECU integration is completed. The second software test will be performed after the ECU has been integrated with the flight spectrograph and detector subsystems. The software acceptance tests will be conducted by the GUVI system engineer.