ACCEPTANCE TEST PLAN

FOR THE

GLOBAL ULTRAVIOLET IMAGER

(GUVI)

INSTRUMENT

7366-9060

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1. Scope

This document describes the acceptance test plan for the Global Ultraviolet Imager (GUVI) instrument. The acceptance test plan defines the subsystem and system level tests to be performed on the GUVI flight instrument prior to delivery for spacecraft integration.

GUVI is an instrument on the Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) spacecraft. The GUVI flight instrument consists of the following components. Each component is separately mounted to the spacecraft deck.

SIS Housing
SIS Electronics
Focal Plane Electronics #1
High Voltage Power Supply #1
Focal Plane Electronics #2
High Voltage Power Supply #2
Electronics Control Unit

2. Applicable Documents

The following documents form a part of this document to the extent specified herein.

TIMED Component Environmental Specification, 7363-9010

TIMED General Instrument Interface Specification, 7363-9050

GUVI Specific Instrument Interface Specification, 7363-9046

GUVI Product Assurance Implementation Plan, 7366-9190

GUVI Technical Requirements Specification, 7366-9001

GUVI Contamination Control Plan, 7366-9015

GUVI Subsystem Electrical Interface Control Document, 7366-9020

3. SIS Subsystem Tests

The Scanning Imaging Spectrograph (SIS) tests are performed by the vendor on the unit before delivery to APL. The SIS subsystem consists of the SIS housing and SIS

electronics. SIS subsystem tests are performed by the vendor before the detector tubes are installed on the SIS housing.

3.1 SIS Mechanisms Functional Test

3.1.1 Scan Mirror

The SIS scan mirror assembly will be tested on a rotary table measurement system. The functional test will measure the scan motor step rate, step resolution, step linearity, settling time, scan range, and the motor position indicator accuracy. The test will be performed at ambient temperature.

3.1.2 Cover

The SIS dust cover mechanism will be tested to verify the open function with both actuator devices and the position indicators. The test will be performed at ambient temperature.

3.1.3 Slit Mechanism

The SIS slit mechanism will be tested to verify the in and out positions of both slit motors and the position indicators. The test will be performed at ambient temperature.

3.1.4 Pop-up Mirror

The SIS pop-up mirror mechanism will be tested to verify the in and out position of the pop-up motor and the position indicator. The test will be performed at ambient temperature.

3.2 SIS Optical Alignment

All optical components will be assembled into the SIS housing. The assembly will be performed in a class 100 clean room. The alignment of all mirrors will be verified. All optical components will be aligned by triangulation using a HeNe source.

3.3 SIS Electronics Thermal Cycle Test

The SIS electronics package will be thermal cycle tested with all boards installed in the chassis. The SIS housing components will not be connected to the SIS electronics. Any test loads will be located outside the test chamber.

Duration:	8 cycles The last 4 cycles are to be failure free. 1 hour dwell at high and low temperature levels
Pressure:	Ambient pressure
Temperature:	–24° C to +55° C

3.4 SIS Vibration Test

The SIS vibration test will be performed at a test laboratory selected by the vendor. The SIS housing and SIS electronics components will be vibration tested while mounted to the same fixture. A low level sine survey (0.5 g) will precede the sine sweep and random vibration tests. At least one triaxial response accelerometer will be mounted on the SIS housing during vibration testing.

3.4.1 Sinusoidal Vibration

The SIS units will be sine sweep tested to the following levels.

Thrust Axis

Frequency (Hz)	Acceleration
5 - 24	0.50 in (double amplitude)
24 - 50	15.5 g
50 - 100	2.0 g

Rate = 4 octaves/minute

Lateral Axis

Frequency (Hz)	Acceleration
5 - 18	0.50 in (double amplitude)
18 - 30	8.5 g
30 - 100	2.0 g

Rate = 4 octaves/minute

3.4.2 Random Vibration

The SIS units will be random vibration tested to the following levels.

Primary Axis (perpendicular to mounting surface)

Frequency (Hz)	PSD Level
20	0.004 g^2/Hz
20 - 100	+6 dB/oct
100 - 600	0.10 g^2/Hz
600 - 2000	-9 dB/oct
2000	0.003 g^2/Hz

Overall amplitude = 9.0 grms
Duration = 60 seconds/axis

In-Plane Axes: Test levels are reduced 3 dB.

3.5 SIS Thermal Vacuum Test

The SIS subsystem will be thermal vacuum tested with the SIS housing connected to the SIS electronics. Any test simulators will be located outside the test chamber. The test will be performed at the vendor's facility. A baseline electrical test will be performed during each hot and cold temperature dwell. The baseline test will activate the scan motor, slit, and pop-up mechanisms. The scan motor dynamics will be measured during each cycle. The SIS cover will be opened by actuator command during the first cycle cold soak.

Duration:	1 survival cycle followed by 6 operational cycles 6 hour dwell at high and low temperature levels
Pressure:	less than 10^{-5} Torr
Temperature:	
Survival:	–29° C to +50° C (SIS housing) –29° C to +60° C (SIS electronics)
Operational:	–29° C to +50° C (SIS housing) –24° C to +55° C (SIS electronics)

4. Detector Subsystem Tests

The detector subsystem tests will be performed by APL. Two detector subsystems are required for the GUVI instrument. Each detector subsystem consists of three components, the detector tube assembly, focal plane electronics (FPE) package, and detector high voltage power supply (HVPS) package.

4.1 Detector Tube Measurements

The wedge-and-strip detector tubes will be characterized by the tube vendor and APL. The tube quantum efficiency vs. wavelength, and electron gain will be measured.

4.2 Detector Functional Tests

Baseline electrical tests will be performed on the detector tube assembly, focal plane electronics package, and detector high voltage power supply. The baseline tests will exercise all input signals, verify all output signals and power dissipation, and set tailor points.

4.3 Detector Thermal Cycle Tests

All detector components, the FPE, HVPS, and detector tube assembly, will be thermal cycle tested.

4.3.1 Focal Plane Electronics

The detector focal plane electronics package will be thermal cycle tested without the detector tube. The FPE input source will be a remote signal generator located outside the test chamber.

Duration:	8 cycles The last 4 cycles are to be failure free. 1 hour dwell at high and low temperature levels
Pressure:	Ambient pressure
Temperature:	–24° C to +55° C

4.3.2 Detector HVPS

The detector high voltage power supply package will be thermal cycle tested by the vendor prior to delivery to APL.

Duration:	8 cycles The last 4 cycles are to be failure free. 1 hour dwell at high and low temperature levels
Pressure:	Ambient pressure
Temperature:	–24° C to +55° C

4.3.3 Detector HVPS Burn In

A burn in test will be performed by the vendor following final assembly of the HVPS package. The burn in will be done first at ambient pressure and temperature for 84 hours, followed by 84 hours in vacuum at ambient temperature.

4.3.4 Detector Tube Assembly

The detector tube assembly will be thermal cycle tested by APL after the detector tube is potted into the tube housing. The test temperature range has been reduced to prevent damage to the tube.

Duration:	8 cycles The last 4 cycles are to be failure free. 1 hour dwell at high and low temperature levels
Pressure:	Ambient pressure
Temperature:	–25° C to +30° C

4.4 Detector Vibration Tests

The first detector tube assembly from each vendor will be vibration tested to qualify the tube design. The vibration test levels are listed in section 6.8. The tube assembly will be mounted on the SIS mass simulator during the vibration test.

One FPE assembly will be vibration tested prior to system integration to qualify the design. The vibration test levels are listed in section 6.8. Both FPE assemblies will be vibration tested at the GUVI system level.

The HVPS components will be vibration tested only at the GUVI system level.

5. ECU Subsystem Tests

The ECU subsystem tests will be performed by APL. The ECU consists of seven printed circuit boards (the telemetry processor, instrument I/O board, 1553 board, detector processor, detector A/D converter board, and two power converter boards) and a mother board backplane. The telemetry processor, instrument I/O, and 1553 boards are supplied by the Aerospace Corp.

5.1 ECU Functional Test

A baseline electrical test will be performed on the ECU subsystem after all boards have been installed in the chassis. The baseline test will exercise all input signals, and verify all output signals and power dissipation. All GUVI operating modes will be exercised. The GUVI GSE unit will be required for the test.

5.2 ECU Thermal Cycle Test

The ECU package will be thermal cycle tested with all boards installed in the chassis. The spectrograph components will not be connected to the ECU. Any subsystem simulators will be located outside the test chamber.

Duration:	8 cycles The last 4 cycles are to be failure free. 1 hour dwell at high and low temperature levels
Pressure:	Ambient pressure
Temperature:	–24° C to +55° C

5.3 ECU Vibration Test

The ECU package will be vibration tested prior to system integration to qualify the design. The vibration test levels are listed in section 6.8. This will be the only vibration test of the ECU package. The ECU will not be included with the other GUVI components during the system level vibration test because it mounts on a different spacecraft panel.

5.4 Flight Software Testing

The various levels of flight software testing are described in this section. The software runs on the two processors in the ECU.

5.4.1 Unit Testing

Program unit testing will be performed separately on the telemetry and detector software modules. Unit integration testing will build and test the entire software module by adding program units together from the top-level on down. Unit testing will be performed by the software lead engineer for that module. Unit development will be performed on the breadboard processors.

5.4.2 Integration Testing

A flight software integration test will be performed on the ECU subsystem before it is integrated with the SIS subsystem. Integration testing will confirm that the two software modules meet the requirements set forth in the GUVI Flight Software Requirements Specification. The integration test will be conducted by the GUVI system engineer.

5.4.3 Software Acceptance Test

A software acceptance test will be performed on the GUVI flight instrument during the first system level functional test. Acceptance testing will verify that the software requirements are met after the software program is installed in the integrated flight instrument. The test is conducted on the flight instrument by the GUVI system engineer.

6. GUVI System Level Tests

The GUVI system level testing consists of an integration and preliminary test phase before the test readiness review, followed by the qualification test phase, and the flight acceptance review.

6.1 System Integration

The ECU subsystem will be integrated with the SIS subsystem using the flight harness. A detailed electrical test will be performed to measure power bus electrical parameters. A functional electrical test will be performed to verify proper operation of the instrument. System integration will be performed in a class 100 clean room at APL.

The SIS housing will be purged with research grade nitrogen. The SIS dust cover will be closed, or the protective test cover in place, at all time.

6.2 System Functional Test

A functional electrical test will be performed on the integrated GUVI instrument at various points during system level tests at APL and spacecraft tests at APL. The test is performed with the SIS protective cover installed. The total test duration is estimated at 2 hours.

The GUVI EPOC and stand-alone GSE will be required for the functional test. The test will be performed in a class 100 clean room at APL. The SIS housing will be purged with research grade nitrogen. The SIS dust cover will be closed, or the protective test cover in place, at all time.

The functional test consists of the following test modes and actions.

1. Install SIS Protective Test Cover

2. GUVI Power On

3. Maintenance Mode
   Verify memory commands in maintenance mode.

4. SIS Mechanisms Test
   Verify operation of slit motors.
   Verify operation of pop-up motor.

5. Scan Motor Test
   Verify operation of scan motor for primary and secondary drives.

6. Pulse Height Test/Detector #1
   Select detector #1
   Go to test mode.
   Verify detector dark count.
   Verify pulse height distribution with test lamp on.

7. Spectrograph Mode/Detector #1
   Go to spectrograph mode.
   Verify spectrograph data with test lamp on.

8. Pulse Height Test/Detector #2
   Select detector #2
   Go to test mode.
   Verify detector dark count.
   Verify pulse height distribution with test lamp on.

9. Spectrograph Mode/Detector #2
   Go to spectrograph mode.
   Verify spectrograph data with test lamp on.

10. Imaging Mode/Primary Drive/Detector #1
    Select detector #1, primary scan motor drive.
    Go to imaging mode.
    Verify imaging data.

11. Imaging Mode/Secondary Drive/Detector #1
    Select secondary scan motor drive.
    Go to imaging mode.
    Verify imaging data.

12. Park Scan Mirror
    Park scan mirror in caged position.
    Remove SIS protective test cover and close flight cover.

13. GUVI Power Off

6.3 Short Functional Test

A short functional test will be performed on the integrated GUVI instrument between system level vibration tests at APL and during spacecraft tests at APL. The SIS flight cover remains closed during the short functional test. Because the SIS protective cover is not used, the test lamp is not available and the scan motor cannot be activated.

The short functional test consists of the following test modes and actions.

1. GUVI Power On

2. Maintenance Mode
   Verify memory commands in maintenance mode.

3. SIS Mechanisms Test
   Verify operation of slit motors.
   Verify operation of pop-up motor.

4. Pulse Height Test/Detector #1
   Select detector #1
   Go to test mode.
   Verify detector dark count.
   Verify pulse height distribution.

5. Spectrograph Mode/Detector #1
   Go to spectrograph mode.
   Verify spectrograph data.

6. Pulse Height Test/Detector #2
   Select detector #2
   Go to test mode.
   Verify detector dark count.
   Verify pulse height distribution.

7. Spectrograph Mode/Detector #2
   Go to spectrograph mode.
   Verify spectrograph data.

8. GUVI Power Off

6.4 Initial Optical Calibration

The GUVI instrument will be tested in the APL Space Department Optical Calibration Facility. The GUVI EPOC and stand-alone GSE is required during calibration. The two detector tubes will be aligned on the SIS. The SIS optical performance will be characterized during the initial calibration prior to environmental testing.

6.5 Test Readiness Review

A test readiness review will be held prior to the start of qualification testing for the GUVI instrument. Results of the integration and preliminary tests will be presented, and fabrication and assembly status will be reviewed.

6.6 EMC Test

The GUVI instrument will have the following EMC tests performed in accordance with the requirements in MIL-STD-461, according to the procedures in MIL-STD-462. The test will be performed at a facility to be selected.

1. CE01 Conducted Emissions, 30 Hz to 15 KHz
2. CE03 Conducted Emissions, 30 Hz to 15 MHz
3. CE07 Transient Emissions on Power Leads
4. CS01 Conducted Susceptibility of Power Leads, 30 Hz to 50 KHz
5. CS02 Conducted Susceptibility of Power Leads, 50 KHz to 400 MHz
6. CS06 Conducted Susceptibility of Power Leads, Transient Spikes
7. RE02 Radiated Emissions, Electric Fields
8. RE01 Radiated Susceptibility, 14 kHz to 10 GHz

6.7 Mass Properties

Each GUVI component will be weighed. The components include the SIS housing, SIS electronics, FPE packages, HVPS packages, ECU, system harness, and thermal blankets. The components will be weighed at APL prior to vibration testing. The center of gravity of each GUVI component will be determined by analysis.

6.8 Vibration Test

The GUVI system vibration test will be performed at APL. The vibration test will consist of sinusoidal and random vibration tests. The SIS Housing, SIS Electronics, FPE, and HVPS components will be mounted to a common baseplate for the vibration test. The ECU will be tested separately because it mounts on a different spacecraft panel. The ECU vibration test will be performed prior to the system vibration test.

6.8.1 Sinusoidal Vibration

The GUVI instrument will be sine sweep tested to the following levels.

Thrust Axis

Frequency (Hz)	Acceleration
5 - 24	0.50 in (double amplitude)
24 - 50	15.5 g
50 - 100	2.0 g

Rate = 4 octaves/minute

Lateral Axis

Frequency (Hz)	Acceleration
5 - 18	0.50 in (double amplitude)
18 - 30	8.5 g
30 - 100	2.0 g

Rate = 4 octaves/minute

6.8.2 Random Vibration

The GUVI instrument will be random vibration tested to the following levels.

Primary Axis (perpendicular to mounting surface)

Frequency (Hz)	PSD Level
20	0.004 g^2/Hz
20 - 100	+6 dB/oct
100 - 600	0.10 g^2/Hz
600 - 2000	-9 dB/oct
2000	0.003 g^2/Hz

Overall amplitude = 9.0 grms
Duration = 60 seconds/axis

In-Plane Axes: Test levels are reduced 3 dB.

6.9 Pyro Shock

The pyro shock test consists of opening the SIS cover by firing the pyro actuators. The two actuator devices will be fired at different times. The test will be performed at APL following the system vibration test. The test will be performed at ambient temperature and pressure. The subsystems will be inspected for damage after the test. A system functional test will follow the pyro shock test.

6.10 Thermal Balance

The system thermal balance test will be performed on the integrated GUVI instrument. The environments of each component will be controlled by thermal shrouds and independent deck control when necessary. The test setup will not exactly match the orbit environments, however the test setup will be modeled, and the analysis results will be compared

to the test results. The survival heaters will be tested with the instrument powered off. The test will be performed at APL.

Duration:	1 cold balance and 1 hot balance, at least 4 hour dwell at each plateau. (plateau dwell determined by equilibrium)
Pressure:	less than 10^{-5} Torr

6.11 Thermal Vacuum

The system thermal vacuum test will be performed on the integrated GUVI instrument. The environments of each component will be controlled by thermal shrouds and independent deck control when necessary. The test will be performed at APL. A system functional test will be performed during each temperature plateau.

Duration:	1 survival cycle followed by 6 operational cycles at least 4 hour dwell at high and low temperature levels (plateau dwell determined by equilibrium)
Pressure:	less than 10^{-5} Torr
Temperature:	
Survival:	–30° C to +50° C (SIS housing) –29° C to +60° C (all electronics)
Operational:	–25° C to +30° C (SIS housing) –24° C to +55° C (all electronics)

6.12 Final Optical Calibration

The GUVI instrument will be tested in the APL Space Department Optical Calibration Facility. The GUVI EPOC and stand-alone GSE is required during calibration. The SIS optical performance will be verified during the final calibration after the conclusion of all environmental tests.

6.13 Flight Acceptance Review

A flight acceptance review will be held at the conclusion of qualification testing for the GUVI instrument. Results of all qualification tests will be presented, and verification of all requirements will be demonstrated.

6.14 Storage

The GUVI instrument will be stored at APL when not in use. The GUVI flight components will be stored in a sealed container. The container will be air tight, and purged with research grade nitrogen. The storage temperature range shall be +10° C to +35° C.

6.15 Delivery

The GUVI instrument will be delivered to the APL space integration and test facility for spacecraft integration. The GUVI instrument will be delivered in the sealed storage container.

6.16 Instrument Burn-In

The instrument shall accumulate a minimum of 250 hours of operating time prior to launch. The last 100 hours of operating time prior to delivery for spacecraft integration shall be failure free.

6.17 End-to-End Test

Any stand-alone functional test of the GUVI instrument requires the use of the GUVI EPOC computer, GUVI GSE rack, and the spacecraft simulator computer to control the operation of the instrument. All system level functional tests of GUVI are end-to-end tests since they involve the GUVI EPOC, spacecraft emulator, and GUVI flight instrument.

7. Trend Analysis

The following parameters will be monitored during GUVI system level tests. Test reports that summarize the trend data will be presented at the Flight Acceptance Review.

	Parameter	Monitor
1.	+28V Bus Current	Bus current in imaging mode.
2.	Scan Motor Current	Motor current in imaging mode.
3.	Detector #1 High Voltage	HV setting to maintain constant pulse height distribution.
4.	Detector #2 High Voltage	HV setting to maintain constant pulse height distribution.
5.	Detector #1 Dark Count	Dark count at room temperature.
6.	Detector #2 Dark Count	Dark count at room temperature.
7.	Motor Position	Nadir step number in imaging mode
8.	SIS Spectral Stability	Spectral bin number using test lamp

8. Contamination Control

8.1 Purge Requirements

The GUVI spectrograph unit requires a continuous, research grade nitrogen purge, when feasible, during integration testing. A flow rate of 1.0 to 4.0 liters per minute is required. The hydrocarbon level must not exceed 15 parts per million.

8.2 Contamination Levels

To maintain the scan mirror BRDF at the required value, the cleanliness level of the SIS scan mirror must remain less than 500. Contamination control procedures defined in the GUVI Contamination Control Plan shall be followed to ensure that this cleanliness level on the optics will be achieved.

9. Test Documentation

The test documentation requirements are defined in the GUVI Product Assurance Implementation Plan.

9.1 Test Procedures

Test Procedures will be developed for the GUVI subsystem, system level, and optical calibration tests. The test procedures will be available for review 30 days before the particular test.

9.2 Test Reports

A brief test report summarizing test results and their implications will be available within 15 days after test completion. A final test report will be prepared within 30 days after test completion.

A log book containing test data for each subsystem will be maintained by the lead engineer for that subsystem. A log book containing system test data for the GUVI instrument will be maintained by the system engineer. The log will include the number of test hours on the instrument.