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REVISION A
S4S-0-680A
APRIL 1972

QUALIFICATION PLAN

FOR THE

ULTRAVIOLET SPECTROMETER EXPERIMENT S169

Prepared for
NASA Manned Spacecraft Center
under Contract NAS9-11528
DRL 47, DRD TM-095T

T 72-19223

The Johns Hopkins University
Applied Physics Laboratory
8621 Georgia Avenue
Silver Spring, Maryland 20910

CR-128572

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1.0 SCOPE

This plan defines the qualification methods used to verify that the UVS hardware meets the technical requirements of the Contract End Item (CEI) Specification, 7232-0009. Included in this plan are test location, the qualification UVS to be tested, test objectives, and all tests required to verify that the UVS meets all performance and environmental requirements of the CEI Specification. Additionally, environmental test conditions, testing time or cycles, allowable maintenance, logging requirements, manner of analysis, and utilization of test results, disposition of test specimens, failure criteria, retest requirements, facilities and support requirements, and the time phasing of the tests are presented. When methods other than tests are to be used, the specific method to be used is identified and the objectives defined.

This plan has been prepared in accordance with MSC Number DRL 47, DRD TM-095T.

2.0 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this plan to the extent specified herein. In the event of conflict between this plan and documents referenced herein, this plan shall take precedence.

2.1 MILITARY DOCUMENTS

MIL-STD-810B (USAF)	Environmental Test Methods for Aerospace and Ground Equipment

2.2 APL/JHU DOCUMENTS

S4S-0-673	Logistics Plan, UVS Experiment S169
S4S-0-679A	End Item Test Plan, UVS Experiment S169
S4S-0-681C	Acceptance Test Plan, UVS Experiment S169
S4S-0-785	Acceptance Test Procedure, UVS Experiment S169
S4S-0-750	Qualification Test Procedure, UVS Experiment S169
SOR-70-030	Reliability Program Plan, UVS Experiment S169
SOR-70-060	Contamination Control Program Plan for the UVS Experiment S169
SOR-71-002	System Safety Plan, UVS Experiment S169
SOR-70-031	Quality Program Plan, UVS Experiment S169
RQAM-8.002	APL Discrepancy Report System
7232-0009	CEI Specification for Flight and Qualification Units, UVS Experiment S169
7232-0012	CEI Specification for Bench Test Equipment for UVS Experiment S169

2.3 OTHER DOCUMENTS

NHB 8080.1	Apollo Test Requirements

NHB 5300.4(1B)	Quality Program Provisions for Space System Contractors
MC999-0002C	Electromagnetic Interference Control for the Apollo Space System

3.0 TEST EQUIPMENT, FACILITIES, AND LOGISTICS

3.1 TEST EQUIPMENT OBJECTIVES

a. Provide the controls and external stimuli required for the proper operation of the Ultraviolet Spectrometer (UVS).

b. Expose the end items to the stress levels specified herein.

c. Make quantitative performance measurements to establish that specified performance margins have been achieved.

d. Monitor and record operational functions so that anomalies can be recognized and assessed in time for remedial action.

e. Provide protection for the safety of test personnel and the unit under test.

f. Provide diagnostic assistance for fault isolation.

3.2 TEST EQUIPMENT AND FACILITIES REQUIRED

3.2.1 Equipment

The following principal items of electrical and mechanical test equipment are required to perform the specified tests:

a. Experiment Ground Support Equipment (Handling Fixtures 7232-0409 and Shipping Container 7232-0495).

b. Peripheral Test Equipment (Digital Voltmeters, Oscilloscopes, as specified in the Qualification Test Procedure, S4S-0-750).

c. Bench Test Equipment (BTE), CEI Specification No. 7232-0012.

d. Calibration Test Equipment (CTE), CEI Specification Number DRD JHU I-UVS.

3.2.2 Facilities

The following APL and JHU/Physics Department facilities are required to perform the tests specified herein:

a. Vibration Test Laboratory - ETL/APL.

b. Class 10,000 Clean Room - APL.

c. Mass Properties Laboratory - CR/APL.

d. Thermal-Vacuum Test Facility - ETL/APL.

e. Shock-Test Facility - Dayton T. Brown and General Test Labs.

f. EMI Test Laboratory - Melpar, Inc.

3.3 TEST CONDITIONS AND MEASUREMENTS

3.3.1 Test Area Conditions

3.3.1.1 During non-operational periods, the UVS will be protected within its storage container and/or a nylon bag purged with dry nitrogen.

3.3.1.2 When operational tests or environmental exposures of the UVS are required, the following test area ambient conditions shall prevail and be maintained whenever the UVS is removed from its protective cover:

Clean Conditions - ≤10,000 level

Ambient Temperature - ≤80°F (max.)

Relative Humidity - 60% (max.)

Dew Point Temperature - ≤55°F (max.)

Hydrocarbon Vapors - nonexistent

All other environmental constraints are delineated in the UVS Contamination Control Program Plan (SOR-70-060), which forms an integral part of this test plan.

3.3.2 Measurements

All measurements shall be made with instruments whose accuracy is verified periodically and which have been calibrated within the time span specified for that instrument (at least each 12 months, preferably every 6 months). The time span shall encompass the duration of the test. All instruments and test equipment used in conducting the tests specified herein shall:

a. Conform to laboratory standards whose calibration is traceable to the primary standards at the U. S. Bureau of Standards.

b. Have an accuracy of at least one-third the tolerance for the variable to be measured. In the event of conflict between this accuracy and a requirement for accuracy in any one of the test methods of this plan, this plan shall take precedence.

c. Be appropriate for measuring the test parameters.

3.3.2.1 Tolerances - The maximum allowable tolerances for qualification test conditions shall be as follows unless otherwise specified by the applicable section in the environmental test procedures:

a. Temperature - ±2.5°F (exclusive of accuracy of instruments).

b. Vibration Frequency - ±2% or 1/2 Hz below 20 Hz.

c. Sine Vibration - sinusoidal acceleration, ±10%.

d. Random Vibration - Overall g RMS, +15%, -5% as measured by a true RMS voltmeter with a sharp cut off filter at 2000 Hz in the circuit. Power spectral density is as follows:

Spectrum Frequency Band	Filter Bandwidth	Tolerance
20-100 Hz	10 Hz or less	+3 db, -1.5 db
100-350 Hz	25 Hz or less	+3 db, -1.5 db
350-2000Hz	50 Hz or less	+3 db, -1.5 db
20-100 Hz	5 Hz or less	+4.5 db, -1.5 db
100-350 Hz	10 Hz or less	+4.5 db, -1.5 db
350-2000 Hz	25 Hz or less	+4.5 db, -1.5 db

No tolerance below 20 Hz.

e. Test Duration - +10%, -0%.

f. Additional Tolerances - Additional tolerances shall be as specified in the Qualification Test Procedure, S4S-0-750.

3.3.2.2 Vacuum Gauges - The vacuum shall be indicated by a vacuum gauge whose sensing element is directly exposed to the environment of the chamber test space. The gauge shall measure the absolute pressure to which the UVS is exposed with a tolerance of ±1 decade, centered about a reading of 1×10^{-6} torr.

3.3.3 Logistics

The UVS and BTE logistic support requirements are delinetated in the Logistics Plan, S4S-0-683, which forms an integral part of this test plan.

4.0 QUALITY ASSURANCE PROVISIONS AND GENERAL REQUIREMENTS

4.1 DOCUMENTATION

4.1.1 Applicability of NHB 5300.4(1B)

The intent of NHB 5300.4(1B), "Quality Program Provisions for Space System Contractors", will be accomplished in accordance with the approved Quality Program Plan for the UVS Experiment S169, SOR-70-031, MSC Number DRL 56, DRD RA-0[illegible]3T. All performance parameters, tolerances, and tests shall be in

accordance with the provisions of the UVS Experiment S169, Contract End Item Specification, APL Number 7232-0009, and the End Item Test Plan, S4S-0-679, MSC Number DRL 46, DRD TM-094T.

4.1.2 Test Procedures

Test procedures are required for the performance of all tests and test operations. The UVS Experiment S169 Qualification Test Procedure, S4S-0-751, shall describe the step-by-step procedures to be accomplished in detail and in their logical sequence to accomplish the requirements of this test plan.

4.1.3 Data Sheets

Data sheets are provided in the test procedures and will be used to record all pertinent data obtained during the course of the testing program. Data sheets witnessed and approved by the Systems Test Engineer, the Reliability Engineer, and the MSC Representative become part of the End Item Data Package for customer buy-off. Whenever practical, the data sheets shall be a part of the test procedures, but separate data sheets will be needed for certain tests, such as optical calibration.

4.1.4 Product Assurance

Testing is subject to monitoring and validation by the SDD Reliability Office (SOR) and designated Manned Spacecraft Center (MSC) representatives.

4.1.5 Log Books

A log book will be issued for each end item and compiled in chronological order. Entered in the log books will be items such as test identification, significant planned or unplanned events, operating cycles including flight connector mating and demating and UVS running time, discrepancies, and a list of test witnesses. The log books shall be delivered with the end item.

4.1.6 Environmental Exposure Log Sheet

An environmental exposure log sheet will be maintained by the cognizant environmental test engineer providing a detailed history of each environmental exposure. Vibration test records will be in the form of magnetic tape recordings of exciter input signals and accelerometer outputs. Accelerometer calibrations shall be recorded. All significant test events (such as test equipment anomalies, test chronology, deviations from procedures, successful implementation of tests, etc.) contained in the exposure log sheets are transmitted to the System Engineer for inclusion into the Test Report.

4.1.7 Setup Photographs

When possible, a photographic record of significant test setups will be included in the Test Report. These photographs will also be maintained and filed in the APL Film Library.

4.1.8 Discrepancy Reports

Discrepancy reports will be issued in accordance with the APL Discrepancy Report System, RQAM-8.002.

4.1.9 Qualification Report

A Qualification Report will be prepared upon completion of the test series in accordance with DRL 49, DRD TM-097T and will be included in the End Item Data Package.

4.2 SATISFACTORY OPERATION AND FAILURE CRITERIA

Satisfactory operation is defined as that operation in which the experiment maintains the proper input-output electrical or electro-optical relationship as defined in the S169 CEI Specification, 7232-0009. No adjustments to compensate for environmental extremes are allowed. Failures shall be as defined in Paragraph 6.2.2 of this document. In addition, significant deviations from test to test are considered anomalies and must be dispositioned by the Test Review Board.

4.3 SAFETY

It is essential that the exposure of both personnel and equipment to hazardous environments be avoided or at least minimized. NASA/MSC safety requirements and previous APL safety experience in test equipment design and in equipment handling and test operations, as specified in the System Safety Plan, SOR-71-002, will be utilized to the fullest extent possible.

5.0 QUALIFICATION METHODS

5.1 QUALIFICATION MATRIX

Qualification methods to verify that the UVS hardware meets the technical requirements of the CEI Specification, 7232-0009, are defined in the Qualification Matrix, Table I.

5.2 QUALIFICATION END ITEM DATA PACKAGE

The end item data package resulting from this Qualification Plan shall include but not necessarily be limited to the following reports:

a. Technical Reports describing the results of all analyses (stress analysis, thermal analysis, ray trace, etc.)

b. Inspection Reports.

c. Qualification Report as specified in Section 4.1.9 above.

d. Discrepancy Reports and Disposition.

e. Test Deviation Log.

f. UVS Equipment Log Books as detailed in Section 4.1.5 above.

TABLE I

QUALIFICATION MATRIX

QUALIFICATION METHOD:

NA—NOT APPLICABLE
1—SIMILARITY
2—ANALYSIS
3—INSPECTION
4—DEMONSTRATION
5—TEST

CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.0	X							
3.1	X							
3.1.1	X							
3.1.1.1						X	Spectrum resolution will be measured during optical calibration in CTE at JHU/PD.	Demonstrate spectrum resolution is 8 Å to 15 Å.
3.1.1.2			X				A ray trace will be prepared which documents the field of view.	Determine that FOV is 12° x 12°.
3.1.1.3			X				Computations based on PM tube measurements will document the output and detection limits.	Determine that minimum output is 30 photoelectrons/sec at λ of maximum sensitivity.
3.1.1.4						X	T.B.D.	Demonstrate dynamic range from dark count to 50 K to 65,535 pulses/.1 sec.

TABLE I

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.1.5			X			X	Spot checks at discrete wavelengths during optical calibration.	Determine cam program meets specification requirements.
3.1.1.6				X			Inspect the UVS to determine compliance with Electrical ICD for power.	Verify that UVS meets Electrical ICD for power, "ON" and "OFF".
3.1.2	X							
3.1.2.1				X			Inspect UVS to determine that envelope and mounting provisions are per ICD.	Verify that UVS meets Mechanical ICD envelope and installation requirements.
3.1.2.2						X	Weigh during Acceptance Test sequence.	Demonstrate that UVS weighs less than 40 lb.
3.1.2.3						X	Determine c.g. during Acceptance Test sequence.	Demonstrate that UVS c.g. meets Mechanical ICD requirements.
3.1.2.4				X			Inspector shall verify that method of mounting is per Mechanical ICD.	Verify that method of mounting is as specified in Mechanical ICD.

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.2.5			X				Will be determined from study of a ray trace developed from drawings of the instrument.	Demonstrate the alignment of viewing axis is as specified in Mechanical ICD.
3.1.2.6				X			Inspector shall verify correctness of connector wiring. (Use BTE.)	Verify that all external connectors and wiring are as described in Electrical ICD.
3.1.2.7				X			By inspection, verify that UVS is comprised of 5 subassemblies.	Verify 5 subassemblies of UVS are per CEI Specification.
3.1.2.7.1				X			Inspector shall verify that subassemblies mount conveniently on main housing and provide light protection.	Verify that UVS main housing is per CEI Specification.
3.1.2.7.2				X			Verify by inspection that electrical module contains all circuits and is vented.	Verify that UVS electrical module is per CEI Specification.
3.1.2.7.3			X				A ray trace shall demonstrate that only the scattered light per CEI enters.	Determine by analysis that scattering requirements of CEI are met.

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.2.7.4				X			Verify by inspection that Ebert mirror housing complies with CEI Specification.	Verify that Ebert mirror module is per CEI Specification.
3.1.2.7.5				X			Verify by inspection that all CEI features are present on front plate assembly.	Verify that front plate assembly is per CEI Specification.
3.1.2.8			X				Use a ray trace to show the light path through the UVS.	Determine that light path is per CEI Specification.
3.1.2.9				X			Inspect for presence of protective covers of proper type.	Verify that protective covers of proper type are provided.
3.1.3	X							
3.1.3.1	X							
3.1.3.2				X		X	Measurments and optical tests shall be performed on each mirror tc verify compliance with CEI.	Verify that Ebert mirror is per CEI Specification and demonstrate compliance with optical requirements by Acceptance Test at part level.

TABLE I

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.3.3				X		X	Measurements and optical tests on each replica grating shall verify compliance with CEI.	Verify that replica grating is per CEI Specification. Acceptance Test at part level demonstrates that optical properties comply with requirements.
3.1.3.4				X		X	Measurements and optical tests on each slit mirror shall verify compliance with CEI.	Verify that slit mirrors are per CEI Specification. Acceptance Test at part level demonstrates optical properties comply with requirements.
3.1.3.5				X			Measurements shall verify that slit dimensions and locations are correct.	Verify that slits are per CEI Specification.
3.1.3.6			X				Ray trace shall verify proper action of entrance slit baffles in excluding scattered light from exit slit.	Determine that internal entrance slit baffles prevent scattered light from reaching exit slit.
3.1.4	X							

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.4.1				X		X	Operational verification procedure will test grating drive period. Inspect for grating scan and fiducial mark.	Verify grating drive is per CEI Specification and demonstrate that it meets specification requirements..
3.1.4.2				X		X	Measurements of each detector assembly at JHU/PD will show compliance with CEI Specification.	Verify detector assembly is per CEI Specification and demonstrate at component level that it meets specification requirements.
3.1.4.3						X	Operational verification procedure will include tests of scientific data handling system.	Demonstrate that data handling system meets requirements of CEI Specification.
3.1.4.3.1						X	Operational verification procedure will include tests of count period and UV pulse count.	Demonstrate that counts and synchronization meet specification.
3.1.4.3.2						X	Operational verification procedure will include tests for presence of synchronization words.	Demonstrate that synchronization words are present and meet CEI Specification.

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.4.3.3						X	Operational verification procedure will include check that proper count of 400 pps pulses exists.	Demonstrate count of 400 pps pulses is present.
3.1.4.3.4						X	Operational verification procedure used for qualification testing will check format and waveforms of scientific data.	Demonstrate that digital data words meet CEI Specification.
3.1.4.3.5						X	Operational verification procedure will show that UVS responds to simulated SDS gates, shift clock and timing signals.	Demonstrate that proper enable gates, shift clock and 400 pps timing responses are achieved.
3.1.4.1						X	Measurements shall be made of analog channel impedance and voltage ranges.	Demonstrate that sensors/conditioners meet CEI Specification requirements.
3.1.4.4.1			X			X	Operational verification procedure will verify presence of TM signal. Range and accuracy to be verified by analysis of calibration reports.	Determine/demonstrate housing temperature signal meets CEI Specification requirements.

TABLE I

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.4.4.2			X			X	Operational verification procedure will verify presence of TM signal. Range and accuracy to be verified by analysis of calibration reports.	Determine/demonstrate motor temperature signal meets CEI Specification requirements.
3.1.4.4.3			X			X	Operational verification procedure will verify presence of TM signal. Range and accuracy to be verified by analysis of calibration reports.	Determine/demonstrate input voltage signal meets CEI Specification requirements.
3.1.4.4.4			X			X	Operational verification procedure will verify presence of TM signal. Range and accuracy of be verified by analysis of calibration reports.	Determine/demonstrate input current signal meets CEI Specification requirements.
3.1.4.4.5			X			X	Operational verification procedure will verify presence of TM signal. Range and accuracy to be verified by analysis of calibration reports.	Determine/demonstrate PM tube hi-voltage signal meets CEI Specification requirements.

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.4.4.6			X			X	Operational verification procedure will verify presence of TM signal. Range and accuracy to be verified by analysis of calibration reports.	Determine/demonstrate regulate-voltage signal meets CEI Specification requirements.
3.1.4.5						X	Operational verification procedure will verify proper power to scan drive motor.	Demonstrate presence and synchronization of 100 Hz motor drive current.
3.1.4.6	X							
3.1.4.6.1						X	Operational verification procedure will show normal operation over range of input voltage.	Demonstrate normal operation on specified input voltages.
3.1.4.6.2						X	Operational verification procedure will measure power consumption of UVS.	Demonstrate input power is less than 12 W at 27.5 V DC.
3.1.4.6.3						X	Ability of UVS to withstand specified transients will be shown during Qualification Test.	Demonstrate UVS can withstand 21-32 V transients with recovery in 1 sec.

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.4.6.4						X	Proper operation of automatic circuit breaker will be shown during operational verification.	Demonstrate that automatic circuit breaker prevents input current from exceeding 1.5 A.
3.1.4.6.5						X	Installation and proper wiring of reverse polarity diodes to be tested during harness assembly.	Demonstrate that UVS is not damaged by application of reverse polarity.
3.1.4.7			X				An FMECA will be submitted to show fail-safe nature of the design.	Determine that UVS design is fail-safe.
3.1.5	X							
3.1.5.1						X	EMI tests per MC-999-0002C will be conducted as part of the Qualification Test.	Demonstrate UVS design complies with applicable portions of MC-999-0002C.
3.1.6	X							

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.6.1						X	Duration of Qualification Test including T-V will be long enough to show 600 hours life.	Demonstrate that UVS will operate within specifications for 600 hours following Acceptance.
3.1.7	X							
3.1.7.1			X			X	Thermal analysis will provide flight temperatures for all operating modes. T-V tests will verify accuracy of analytic results.	Determine/demonstrate that passive thermal control maintains satisfactory temperatures.
3.1.8	X							
3.1.8.1	X							
3.1.8.1.1			X				T-V test temperatures range over wider extremes, so provide tests results to verify CEI requirements.	Determine that UVS meets specifications after exposure to -45°F to 140°F temperatures in the shipping container.

TABLE I

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.8.1.2						X	Pressure test will be part of container acceptance.	Demonstrate that UVS shipping container maintains pressure at atmosphere for 8 hours.
3.1.8.1.3						X	Container with instrumented mass simulator of UVS will be drop tested per MIL-STD-810B.	Demonstrate that UVS shipping container attenuates shock to less than 15 g pk, 50 ms rise time, when container is dropped 18 in. on each corner.
3.1.8.1.4						X	Container with instrumented mass simulator of UVS will be exposed to MIL-STD-810B vibration profiles.	Demonstrate that UVS shipping container limits vibration levels to specified values.
3.1.8.2	X							
3.1.9	X							
3.1.9.1	X							

TABLE I

QUALIFICATION MATRIX

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CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.9.1.1						X	Operational verification procedure will provide periodic checks of UVS operation.	Demonstrate that UVS will operate within specification limits during all flight phases.
3.1.9.1.2						X	Pump-down rate for T-V test will exceed specified ascent rate.	Demonstrate that UVS can successfully stand specified ascent rate.
3.1.9.1.3						X	Vibration exposures followed by operational verification procedure will show UVS ability to meet vibration environment.	Demonstrate that UVS can successfully withstand specified vibration environment.
3.1.9.1.4						X	Shock exposures followed by operational verification procedure will show UVS ability to meet shock environment.	Demonstrate that UVS can successfully withstand specified pyrotechnic shock environment.
3.1.9.1.5			X				Analysis will be provided to show vibration environment subjects UVS to more severe stresses than steady-state acceleration.	Demonstrate that UVS can successfully withstand specified steady-state acceleration.

TABLE I

QUALIFICATION MATRIX								
QUALIFICATION METHOD: NA—NOT APPLICABLE 1—SIMILARITY 2—ANALYSIS 3—INSPECTION 4—DEMONSTRATION 5—TEST								
CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.9.1.6			X				An analysis, using established techniques, will determine effects on each component of the proton flux density specified in CEI Specification.	Determine ability of components exposed to external environment to withstand proton flux density specified in CEI Specification.
3.1.9.2	X							
3.1.9.2.1						X	T-V test with periodic operation of UVS will demonstrate high-vacuum capabilities.	Demonstrate ability of UVS to operate within specifications while exposed to high vacuum.
3.1.9.2.2						X	Operation will be monitored while undergoing specified EMI tests.	Demonstrate capability of UVS to perform specified functions while in an EMI environment.
3.1.9.2.3			X				An analysis, using established techniques, will determine effects on UVS of the proton flux density specified in CEI Specification.	Determine that UVS will operate satisfactorily in specified proton flux.

TABLE 1

QUALIFICATION MATRIX

QUALIFICATION METHOD:

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1—SIMILARITY
2—ANALYSIS
3—INSPECTION
4—DEMONSTRATION
5—TEST

CEI SPECIFICATION REFERENCE	QUALIFICATION METHOD						DESCRIPTION	OBJECTIVE
	NA	1	2	3	4	5		
3.1.9.2.4						X	Corona checks will be made during pump-down for T-V exposure.	Demonstrate that UVS will satisfactorily perform specified electronic functions over the specified pressure range.
3.2	X							
3.2.1				X			Dimensional check against drawings will verify configuration.	Verify that UVS configuration corresponds to 7232-0000 and all drawings and engineering data thereunder including approved changes.
3.2.2	X							
3.2.3				X		X	Inspection of UVS against ICD's will verify physical compliance; tests will verify functional compliance.	Verify that UVS does not violate any provisions of the ICDs.

6.0 TESTS

6.1 QUALIFICATION TEST OBJECTIVES

a. To establish and verify acceptability of the Qualification UVS for formal acceptance review by MSC under Contract NAS9-11528.

b. To verify that operation of experiment elements and components meets the performance and environmental requirements of the Contract End Item Specification, 7232-0009, when assembled and operated as a system.

c. To evaluate and understand possible malfunctions and to take remedial action.

6.2 TEST DIRECTION - GROUND RULES AND CONSTRAINTS

6.2.1 Test Direction

All system-level tests will be conducted under the direct supervision and control of the UVS System Engineer. The System Engineer will have responsibility and authority for the following.

6.2.1.1 Application of test procedures and use of associated data sheets. Deviations from the procedures will not be initiated without agreement of the System Engineer and concurrence of the Test Review Board (UVS Reliability Engineer and the designated MSC representative). Responsibility for proper application of environmental conditions

shall reside with the Structures Engineer (vibration and mass properties determinations), Thermal Engineer (temperature/pressure), or the Mechanical Engineer (mechanical tests). During each of these exposures, the engineer designated shall be the single point of contact providing directions to Environmental Test Laboratory personnel.

6.2.1.2 To determine the readiness of an end item to begin a test. Readiness shall comprise:

a. Availability of approved procedures and satisfactory completion of previous milestones with signed records (data sheets, log books, process control card, etc.).

b. Availability of an approved test procedure.

c. Notification of the UVS Reliability Engineer and the designated MSC representative (Government representative).

6.2.1.3 To stop a test and take other necessary precautions when it is apparent that a test item or test equipment is not operating correctly or that a failure is imminent.

6.2.1.4 Complete responsibility for the end items from the start of final assembly through acceptance review. This responsibility includes handling, operational testing, and system performance. The Mechanical Engineer shall be

responsible for providing procedures for handling the units and will either monitor each experiment move for proper procedures or designate an alternate for this purpose. All other aspects of the UVS logistic support requirements are specified in the Logistics Plan, S4S-0-673.

6.2.1.5 To determine the procedure to be followed in the event that "troubleshooting" is required on the UVS Qualification Unit. All steps performed and test equipment used will be documented in detail in the log book and Test Deviation Notices will be prepared as required.

6.2.1.6 To furnish the Material Review Board with reports of all anomalies in test and to act upon recommendations of that Board.

6.2.1.7 To carry out decisions of the Material Review Board regarding the amount of testing required when an assembly or component is replaced during test.

6.2.1.8 Compile and maintain a log book for each UVS and BTE.

6.2.2 Failures

6.2.2.1 The UVS end items being tested shall meet the requirements as specified in CEI Specification 7232-0009 and shall be within the specified limits under the conditions and for the duration specified for each category

of test in Section 7.0 herein. Equipments not meeting these requirements shall be considered as failed equipment, and the failure circumstances recorded on the Failure Investigation Action Report (FIAR), MSC Form 2174.

6.2.2.2 Test items with physical deficiencies, including those from damage by any cause, as revealed by a Quality Control inspection or by any other inspection shall be considered as failed equipment and reported as outlined in Section 6.2.2.1 herein.

6.2.2.3 The Material Review Board shall determine disposition of failed equipment.

6.2.2.4 Disassembly and troubleshooting shall not be done on a test item except when directed by the UVS System Engineer as authorized by the Test Review Board. Corrective actions taken will be subject to approval by the Material Review Board.

6.2.2.5 Failure Investigation Action Reports (FIAR) will be submitted to MSC in accordance with the requirements of the Reliability Program Plan, SOR-70-030, Paragraph 3.6.

6.2.3 Government-furnished property will be handled in conformance with the provisions of the Contract End Item Specification.

6.2.4 All tests performed on deliverable hardware shall be accomplished in accordance with approved procedures, and the results recorded on data sheets. Any revisions to such procedures can be accomplished only by an approved Test Deviation Notice.

6.2.5 An equipment log book will be maintained by the System Engineering staff for each complete experiment to be tested as detailed in Section 4.1.5 herein.

6.2.6 Test techniques shall remain the same at all levels of test to permit correlation of data.

6.2.7 Alterations in parts or adjustments or modification of hardware shall not be permitted in order to pass a test unless the test procedure specifies same. Any such actions will be considered as equipment failures.

6.2.8 No tests other than acceptance tests shall be permitted on flight hardware.

6.2.9 Application of overstress to flight hardware shall make it automatically unacceptable for delivery as flight hardware unless ruled otherwise by the Material Review Board.

6.2.10 Deviations from an approved test sequence can be accomplished only with an approved Test Deviation Notice.

6.2.11 Experiment Retest

6.2.11.1 Disposition of Failures - The disposition of any failures during system-level assembly or testing prior to system-level environmental testing shall be in accordance with Section 6.2.2.3 herein.

6.2.11.2 Retest Criteria, Qualification Tests

A. If a failure is detected during a vibration exposure and the test is stopped before completing the vibration profile, the following steps will be taken with the approval of the Material Review Board:

(1) The failed component will be replaced with a flight-qualified spare, or the failed unit will be repaired and retested at the component qualification level.

(2) If the failed component can be replaced without alteration of the optical properties of the instrument, with the approval of the Material Review Board, a functional test will be run to determine whether satisfactory operation of the UVS has been reinstated. If the failed component replacement results in a compromise of the optical properties of the UVS, the UVS will be subjected to a complete electro-optical alignment followed by an operational and optical reverification in the calibration test equipment. Having

satisfactorily completed the above, the UVS will then be reinstated in the vibration test phase as follows:

(3) The reassembled experiment will be re-exposed to a flight-acceptance-level vibration followed by re-exposure to the qualification-level vibration test. If it can be conclusively demonstrated that failure was not due to previously completed qualification vibration profiles, testing can be continued from the beginning of the profile during which the component failed.

B. Should a failure induced by vibration exposure not be detected until post-vibration testing, the following steps will be taken with the approval of the Material Review Board:

(1) The failed component will be replaced with a flight-qualified spare and retested as per Paragraph 6.2.11.2.A.(2).

(2) The reassembled experiment subsystem will be exposed to a flight-acceptance-level vibration exposure.

C. If a failure occurs during subsequent environmental exposures or after completion of the environmental series, the procedure of Section 6.2.11.2(B) will be followed.

6.3 QUALIFICATION TEST PROGRAM

6.3.1 Test Sequence

After successfully passing the Acceptance Test Program, the Qualification Unit will be exposed to the following operations, in the sequence shown, constituting the Qualification Test Program to be conducted at APL and JHU/Physics Department:

a. Acceptance Test Series.

b. Vibration (ETL) - APL.

c. Operational Verification (in CR with BTE - APL.

d. Optical Verification (in CTE with BTE - PD.

e. Shock Test - Contract Laboratory (T.B.D.).

f. Operational Verification (in CR with BTE) - APL.

g. Optical Verification (in CTE with BTE) - PD.

h. Thermal-Vacuum (ETL) - APL.

i. Optical Calibration (in CTE with BTE) - PD.

j. EMI Test - Melpar.

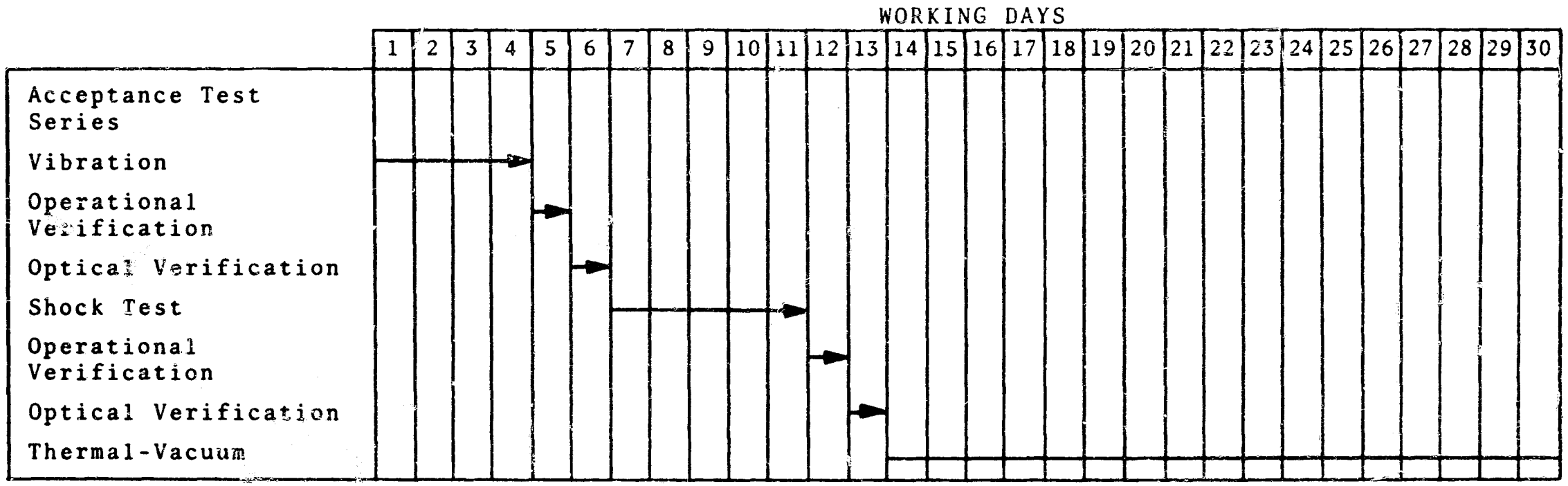
k. Operational Verification (in CR with BTE) - APL.

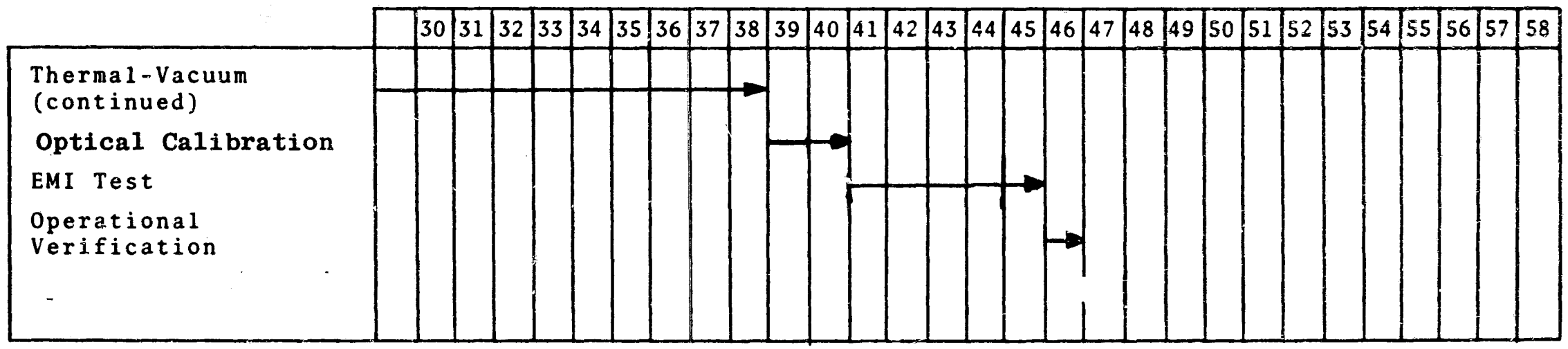
l. Qualification Test Review.

6.3.2 Test Schedule

See Table II.

TABLE II. S169 EXPERIMENT QUALIFICATION TEST SCHEDULE





6.3.3 Test Items and Disposition

The designated end item, Serial No. 2, will be subjected to the Acceptance Test Program followed by the Qualification Program. Should a discrepancy be found during final optical calibration, this end item will be disassembled to the level determined by TRB action and inspected to determine margins of safety and any potential failure modes. Final disposition of the Serial No. 02 Spectrometer will be as directed by MSC.

7.0 QUALIFICATION REQUIREMENTS

7.1 ACCEPTANCE

The Serial No. 02 UVS will be subjected to acceptance tests, inspections, and calibration in accordance with the requirements of the End Item Test Plan, S4S-0-679A, and the Acceptance Test Plan, S4S-0-681C, and conducted in accordance with the Acceptance Test Procedure, S4S-0-785.

7.2 QUALIFICATION

7.2.1 Following CARR, the Qualification Program will be conducted in accordance with this plan and with the Qualification Test Procedure, S4S-0-750.

7.2.2 The experiment hardware shall demonstrate its compliance in form, fit, and function to the requirements

of the Contract End Item Specification, 7232-0009, throughout the inspections and tests specified herein.

7.2.3 The experiment hardware shall demonstrate its compatibility in form, fit, and function with the associated ground support equipment (i.e., handling fixture, shipping container, and BTE).

7.3 TESTING

7.3.1 General Test Requirements

All qualification tests will be conducted under conditions consistent with the requirements of the Contamination Control Program Plan, SOR-70-060; the System Safety Plan, SOR-71-002; and the Logistics Plan, S4S-0-673. The tests will be conducted in accordance with NHB 808 .1 and as specified in the Qualification Test Procedure, S4S-0-750.

a. Qualification tests for vibration will be conducted as specified in MIL-STD-810B, Method 514.1, Procedure VI, Part 1, and as specified in the Qualification Test Procedure.

b. Qualification tests for thermal-vacuum will be conducted as specified in MIL-STD-810B, Method 517.1, Procedure II, and as specified in the Qualification Test Procedure.

c. Qualification tests for shock will be conducted as specified in the Qualification Test Procedure.

d. Qualification tests for electromagnetic interference and susceptibility will be in accordance with the methods and limits in applicable parts of Specification MC999-0002C and as specified in the Qualification Test Procedure.

7.3.1.1 All normal, alternate, and selected emergency operational modes shall be tested.

7.3.1.2 The experiment will have been aligned and verified, both operationally and optically, prior to the conducting of formal acceptance testing. Absolute calibration of the UVS will have been accomplished during the acceptance test sequence.

7.3.1.3 Qualification tests shall be performed under strictly controlled environments and test procedures as specified in Sections 3.3 and 6.2 of this document. Substitution, adjustment or tuning of hardware shall not be permitted during qualification testing unless it is normal to in-service operation. When a failure occurs, the failure shall be reported in accordance with Section 6.2.2 of this document. The degree of retest necessary in event of failure shall be proposed in accordance with the provisions of Section 6.2.11 and submitted to the Material Review Board for approval. A failure shall be as defined in Section 6.2.2.

7.3.1.4 Any repairs, modifications, or replacements after completions of qualification tests shall require re-testing to assure the acceptability of the change. The degree of retest necessary shall be proposed in accordance with Section 6.2.11 and submitted to the Material Review Board for approval.

7.3.2 Operational Verification

An operational verification test will be conducted after each environmental exposure and during thermal-vacuum using the BTE only. All electrical circuitry will be exercised and compared with predicted values. The performance of the scanning mechanism, digital and analog data handling system, etc., will be verified.

7.3.3 Optical Verification

Following each environmental exposure, an abbreviated optical calibration at two wavelengths will be performed under vacuum conditions at the JHU/Physics Department to verify that the sensitivity has not changed.

7.3.4 Optical Calibration

An essential part of the Qualification Program is the optical calibration, which must be performed under vacuum conditions. The spectrum resolution, sensitivity, dynamic range, scan coverage, wavelength and telemetry word synchronization will be measured under the most exacting

conditions possible at The Johns Hopkins University Physics Department Spectrometric Laboratory following the environmental exposures detailed below.

7.3.5 Vibration

The UVS, with the control accelerometer mounted as specified below for each exposure, will be exposed to the sine and random vibration schedules detailed below. Sketches showing the set-ups and detailing the exact accelerometer locations for each exposure below will be included in the Test Procedures, S4S-0-750.

7.3.5.1 Sinusoidal (Ground and Flight) - The UVS will be tested to the following sinusoidal levels in three axes (X, Y, Z) relative to the UVS at a sweep rate of two minutes per octave:

5 to 9 Hz	0.75 inches D.A.
9 to 11 Hz	3.2 g (peak)
11 to 15 Hz	1.4 g (peak)
15 to 20 Hz	0.6 g (peak)
20 to 35 Hz	0.25 g (peak)

The control accelerometer will be mounted on the NR side of the UVS/NR bracket interface.

7.3.5.2 Random - To simulate repeated acceptance testing, the UVS will withstand the following exposures:

All Axes

20 to 80 Hz	+3 dB/octave
80 to 350 Hz	0.067 g^2/Hz
350 to 2,000 Hz	-3 dB/octave

Duration: 1 1/2 minutes per axis repeated each axis.

To simulate boost phase conditions, the UVS will withstand the following exposures:

Y Axis

20 to 200 Hz	+6 dB/octave
200 to 1,000 Hz	0.07 g^2/Hz
1,000 to 2,000 Hz	-9 dB/octave

X and Z Axes

20 to 60 Hz	+3 dB/octave
60 to 160 Hz	0.03 g^2/Hz
160 to 240 Hz	+12 dB/octave
240 to 1,000 Hz	0.15 g^2/Hz
1,000 to 2,000 Hz	-9 dB/octave

Duration: 1.5 minutes per axis.

The control accelerometer will be located on the NR side of the UVS/NR bracket interface.

In order to demonstrate capability to withstand transonic flight conditions, the UVS will be exposed to the above spectra increased by a factor of 2.5 for ten seconds in each axis.

7.3.6 Shock

7.3.6.1 To demonstrate the capability of withstanding shocks encountered during ground handling (while the instrument is mounted in its shipping container), the UVS instrument will be exposed to the shock test described in MIL-STD-810B, Method 516.1, Procedure I, and using the configuration tolerance shown in 516.1-1. The peak acceleration shall be 15 g with a duration of 50 milliseconds. The instrument will not be operated during this exposure but shall demonstrate satisfactory operation after the exposure.

7.3.6.2 To demonstrate the capability to withstand the pyrotechnic shocks associated with SIM door jettison, the UVS will be exposed to the following shock spectra based on a 1/6 octave band analysis and Q = 10:

20 to 900 Hz	+12 dB/octave
900 to 10,000 Hz	2,400 g peak

Shock at these levels will be applied to the NR side of the UVS/NR bracket interface in each of the X, Y, and Z axes.

7.3.7 Temperature-Vacuum

The UVS will be exposed to a temperature-vacuum test consisting of two phases. The first phase, simulating repeated acceptance tests will consist of 4 1/2 cycles between maximum temperature limits with a four-hour soak at each

extreme. The second phase will follow immediately and will simulate a 15.3-day lunar mission including the following:

a. Moon radiation and albedo simulation.

b. Simulation of rotational modes in which the SIM opening will be pointed at the moon, the sun, or space.

c. The internal environment of the SIM compartment will be simulated for those UVS surfaces facing the SIM walls.

d. Operational duty cycles will be as specified in ICD MH01-12463-434, CSM/UV Spectrometer Functional Requirements.

The 15.3-day test will include as a minimum, simulations of the following critical phases of the mission:

a. Portion of translunar coast to establish initial conditions.

b. SIM door jettison (hot), including inertial hold time.

c. SIM door jettison (cold), including inertial hold time.

d. Lunar orbit (hot) to equilibrium.

e. Lunar orbit (hot), inertial hold.

f. Lunar orbit (cold) to equilibrium.

g. Lunar orbit (cold), inertial hold.

h. Transearth coast, hot soaks.

i. Transearth coast, cold soaks.

Prior to the temperature-vacuum test, the spectrometer will be tested under ambient conditions for operation within specifications. UVS operation will be verified one hour after thermal stabilization at the temperature extremes of the temperature cycling test at both hot and cold temperatures. The instrument will be excited by simulated UV radiation input during each operational period, and the data and housekeeping outputs will be monitored for operation within specifications.

7.3.8 Electromagnetic Interference

The UVS will be subjected to operating radio frequency interference emissions as specified in MC999-0002C while operating and demonstrate the capability to perform electronic and optical functions in accordance with the CEI Specification 7232-0009. All tests will be in accordance with the Test Plan, Electromagnetic Interference, SSE-72-001.

Prior to performing the tests below, every effort must be made to first isolate the effects the BTE might have on the EMI environment. Everything possible will then be done to reduce the disturbing uncontrolled test environment to within reasonable limits with the UVS turned off. Once

this has been accomplished, the following tests will be performed:

a. Conducted Interference (Power Lines) (30 Hz - 25 MHz)

   1. Composite Ripple

   2. Transient Interference

   3. Narrowband Interference

   4. Wideband Interference

b. Radiated Interference (15 KHz - 10 GHz)

   1. Narrowband

   2. Wideband

c. Conducted Susceptibility (Power Lines) (20 Hz - 400 MHz)

   1. Radio Frequency

   2. Audio Frequency

   3. Transient

d. Radiated Susceptibility (400 Hz, 140 KHz - 10 GHz)

   1. Radio Frequency

   2. Audio Frequency