DOC. No. FAST TEV-001
DATE: MARCH 17, 1992

VERIFICATION PLAN

FOR THE

FAST AURORAL SNAPSHOT (FAST) MISSION

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

DOC No. FAST TEV-001

VERIFICATION PLAN

FOR THE

FAST AURORAL SNAPSHOT (FAST) MISSION

Prepared by: Peter D. Mule' — 3/17/92
Peter D. Mule'
Verification Manager
Date

Reviewed by: Roberto Aleman — 4-17-92
Roberto Aleman
Instrument Manager
Date

Reviewed by: Jim Watzin — 4/16/92
Jim Watzin
Systems Engineer
Date

Reviewed by: Ron Kolecki — 3/19/92
Ron Kolecki
Assurance Requirements Office
Date

Approved by: Tim Gehringer — 4/17/92
Tim Gehringer
Mission Manager
Date

TABLE OF CONTENTS

FIGURES

APPENDICES

1. General Information and Requirements

1.1 Scope and Purpose

This document specifies the requirements for verification of the FAST Spacecraft. It will consist of functional and environmental testing, supported by the appropriate analysis for the various levels of assembly. These levels of assembly will include components, instruments, and the spacecraft system. The overall objective is to ensure that the design and performance requirements of the space hardware are satisfied.

1.2 Small Explorer Description

The Small Explorer Study was begun to support a Planned Announcement of Opportunity (AO) by the Astrophysics Division at NASA Headquarters. This Announcement of Opportunity announced a series of Explorer missions using small satellites to be launched at a rate of one to two per year. Its purpose is to support scientific payloads covering the disciplines of astronomy, space plasma physics, high energy astrophysics, particles, and solar physics. A list of experiments selected by the Astrophysics Division is the basis for the design of a spacecraft for the Small Explorer Program.

The spacecrafts consist of a bus and an instrument module. The bus includes subsystems for attitude control, orbit control, communications, command and data handling, power, thermal control, and the structure. The instrument module includes the science instruments, their electronics, sensors, thermal control systems, and structural interfaces with the bus. Where necessary, mission unique designs will be used to satisfy mission specific requirements.

1.3 FAST Description

The FAST spacecraft will be the second in a series of Small Explorer missions and will be launched in September 1994 on the Pegasus launch vehicle. The purpose of the FAST mission is the high time resolution observation of the auroral plasma phenomena. High data rate particle and field measurements will be performed in the auroral region of the northern hemisphere. The scientific instruments will be integrated on a Small Explorer Platform, to be placed in an elliptical orbit, 350 km by 4200 km, at a 83° inclination. The FAST on-orbit configuration can be seen in Figure 1-1.

1.4 Launch Vehicle

The FAST spacecraft will be launched on the Pegasus launch vehicle manufactured by Orbital Sciences Corporation.

2.0 ORGANIZATION

2.1 Responsibilities

The responsibility and authority for decisions in connection with the applicability of the requirements of this plan rest with the Project Manager.

2.2 Policies and Methods

The management policies which govern the plan and the methods to implement the requirements are those currently in effect at the GSFC and outlined in the SMEX Project Management Plan. The applicable documents listed below govern the Verification Plan.

<u>Applicable Documents</u>

GSFC S-740-88-999	"Performance Assurance Requirements (PAR) For SMEX Spacecraft"
GSFC S-740-89-993	"Performance Assurance Requirements (PAR) For Instruments"
GEVS-SE (1/90)	"General Environmental Verification Specification For STS & ELV Payloads, Subsystems, and Components"
GSFC S-740-89-978	"System Safety Implementation Plan (SSIP)"
GSFC GMI 5330.7a	"Development and Implementation of Environmental Verification Requirements For Space Flight Hardware"
GSFC S-740-89-994	"Configuration Management Plan for Small Class Explorer Missions"
TBD	Pegasus Users Manual
GSFC S-740-91-956	"ESD Control Plan"

2.3 Documentation Requirements

2.3.1 Verification Specification Document

A Verification Specification Document (VSD) shall be prepared defining the specific environmental parameters that each hardware element is subjected to, either by test or analysis, in order to demonstrate its ability to meet the mission performance requirements.

2.3.2 Test Plans

Test plans shall be prepared to describe each verification activity required by the Verification Plan and Specification. The test plan will include the configuration of the item, test objectives, facility requirements, instrumentation, safety considerations, contamination control, test phases and profiles, necessary functional operations, test software descriptions, personnel responsibilities, and the requirements for procedures and reports. When appropriate, the interaction of test and analysis activity shall be described.

For each analysis activity, the plan shall include objectives, a description of the mathematical model, assumptions on which the models will be based, required output, criteria for assessing the acceptability of the results, the interaction with related test activity, if any, and requirements for reports.

2.3.3 Test Procedures

All flight hardware shall be verified and tested using procedures approved by the FAST Project. Procedures shall contain details such as test descriptions and purposes, identification of the test article, instrumentation monitoring, facility control sequences, test article functions, test parameters and tolerances, environmental levels, identification of hazards and hazardous operations, contamination control provisions, quality control checkpoints, data sheets, chronological procedures, pass/fail criteria, and data collection, processing, and reporting requirements.

2.3.4 Test Reports

Official reports will be prepared after the completion of test activities for FAST flight hardware. For each test activity, the report will contain, as a minimum, the information contained in the test report seen in Figures 2-1A and 2-1B. For each analysis activity, reports will describe the degree to which the objectives were accomplished, the degree of model validation by related test data, and other significant results. The Project will retain the reports and data.

2.4 Pre-Test Review

All tests of flight hardware shall be preceded by pretest reviews wherein readiness of flight hardware, facilities and test equipment, and procedures are verified. Reviews for major tests shall be conducted and chaired by the FAST Project Manager or his designated representative. For minor tests, the reviews may be held by the testing organization with other project representation, as needed.

VERIFICATION TEST REPORT

PROJECT: ______________________________

TEST ITEM: ______________________________

MANUFACTURER: ______________________________

SERIAL NUMBER: ______________________________

LEVEL OF ASSEMBLY: __ COMPONENT __ SUBSYSTEM __ PAYLOAD

TYPE HARDWARE: __ PROTOTYPE __ PROTOFLIGHT __ FLIGHT __ SPARE

TEST TYPE:

__ STRUCTURAL LOADS
__ VIBRATION
__ ACOUSTICS
__ MECHANICAL SHOCK
__ MECHANICAL FUNCTION
__ PRESSURE PROFILE
__ MASS PROPERTIES
__ EMC
__ MAGNETIC PROPERTIES
__ MODAL SURVEY
__ THERMAL VACUUM
__ THERMAL BALANCE
__ THERMAL CYCLING
__ TEMPERATURE-HUMIDITY
__ LEAKAGE
__ COMPREHENSIVE PERFORMANCE TEST
__ OTHER (explain) ______________________________

VERIFICATION PROCEDURE NO. ____________ REV. ____________ DATE ____________

__ INITIAL TEST

__ RETEST __ PARTIAL __ FULL: STARTING DATE OF INITIAL TEST ____________

APPLICABLE VERIFICATION PLAN: ______________________________

FACILITY DESCRIPTION: ______________________________

LOCATION: ______________________________

TEST LOG REFERENCE: ______________________________

COMMENTS:

SIGNATURE:

QUALITY ASSURANCE REPRESENTATIVE: ____________________ DATE: ____________

COGNIZANT ENGINEER FOR TEST ITEM: ____________________ DATE: ____________

VERIFICATION TEST REPORT (Continued)

Date (include time for thermal and temperature tests)	Note beginning and end of actual activity, deviations from the planned procedure, and discrepancies in test times performance. State if there were no deviations or discrepancies.	Malfunction Report Number and Date (if applicable)

The activities covered by these reports include tests and measurements performed for the purpose of verifying the flightworthiness of hardware at the component, subsystem, and payload levels of assembly. These reports shall also be provided for such other activities as the project may designate.

These reports shall be complete and transmitted to the GSFC Technical Officer or Contracting Officer (as appropriate) within 30 days after the completion of the activity. Legible, reproducible, handwritten completed forms are acceptable.

Material felt necessary to clarify this report may be attached. However, in general, test logs and data should be retained by those responsible for the test item unless they are specifically requested.

The forms shall be signed by the quality assurance representative and the person responsible for the test or his designated epresentative; the signatures represent concurrence that the data is as accurate as possible given the constraints of time imposed by quick-response reporting.

This report does not replace the need for maintaining complete logs, records, etc.; it is intended to document the implementation of the verification program and to provide a minimum amount of information as to the performance of the test item.

3.0 Verification Overview

3.1 Objectives

The objectives of the verification program for the FAST are as follows:

a. Provide assurance that the specified mission objectives will be met.

b. Provide assurance that hardware will meet specific performance, interface, and safety requirements.

c. Provide confidence that the spacecraft will survive the environments imposed during launch and mission sequence.

d. Determine operating and performance characteristics from simulated mission environments.

3.2 Verification Methods

Verification can be accomplished by analysis, test, inspection, similarity, or a combination thereof.

3.2.1 Analysis

Verification by analysis uses calculations or modeling to verify compliance with specifications. Analysis may be used when it is determined that rigorous and accurate analysis is possible. When verification is made by analysis, the following shall be identified: assumptions of the mathematical model, the limits of validity of the input parameters, and sensitivity of critical input parameters. Testing will be required to supplement or confirm the analysis.

3.2.2 Test

Verification by test consists of proof by doing to ensure that functional and/or environmental specifications for an item are met. Environmental tests may be performed on prototype or flight hardware in conjunction with verifying functional performance. Environmental testing shall provide assurance that the hardware will perform satisfactorily under conditions simulating the extremes of launch and on-orbit operations. Functional testing shall duplicate actual mission operations to the extent possible.

3.2.3 Inspection

Verification by inspection is a method of visually determining an item's qualitative or quantitative properties such as tolerances, finishes, identification, specific dimensions, envelopes, or other measurable properties.

3.2.4 Similarity

Verification by similarity is a method of qualifying an item which is identical to an item previously qualified for space flight application. Flight items qualified by similarity must still undergo verification testing to qualification levels due to the protoflight test approach taken on FAST thus similarity is not planned for qualifying items.

3.3 General Verification Approach

The general approach adopted for attaining the verification program objectives are:

a. The spacecraft shall be qualified by protoflight testing at the payload level except when constrained by significant limitation in technology or facilities. The project will ensure all lower levels of assemblies have been qualified for tests where protoflight levels are not applied at the spacecraft level.

b. A protoflight test approach will be used for the qualification of flight component and instrument types.

c. Verification will start at the component and instrument level. Instruments will be verified prior to delivery to Goddard for integration into the FAST spacecraft.

d. Engineering Test Units (ETUs) will be qualified by prototype testing using mass models where flight hardware is not available.

e. Components, instruments, and the spacecraft will receive both functional and environmental testing as described in this Verification Plan.

f. The thermal control design and thermal math model will be verified by thermal balance testing at the system level.

3.4 Verification Test Considerations

This Verification Plan considers environments of the ground mode, the launch mode, and the mission orbital mode in determining the test program.

3.4.1 Ground Mode

The ground mode environmental events are those which occur during the cycle of fabrication, integration and test, handling, transportation, and prelaunch activities. To ensure that these environmental conditions are not excessive, controls will be taken to protect the hardware from such loads, temperature, etc. If such protection is not provided, testing for susceptibility to such conditions will be a requirement.

3.4.2 Launch Mode

The test levels and durations that simulate the launch mode are based on the Pegasus launch vehicle induced environments.

3.4.3 Mission Orbital Mode

The environmental tests that simulate the orbital modes are based on space environments expected during the FAST mission.

3.5 Test Levels

Test levels are based on predicted maximum and minimum loads or on the conditions to be experienced during the expected life of the flight hardware, with appropriate factors of safety applied. For mechanically induced environments, limit loads (maximum expected flight loads) are the base to which appropriate factors of safety are applied. The test factors in the cases below are considered to define qualification level. Acceptance test levels are usually considered to be equal to limit loads or levels.

3.5.1 Quasi-Static Structural Loads

Quasi-Static Loads are a combination of steady state loads and low frequency dynamic loads. Test factors are as follows:

Test: 1.25 times limit load

3.5.2 Vibroacoustic Verification

The following test factors are used for random vibration or acoustic noise:

Test: Limit Levels Plus 3db

3.5.3 Mechanical Shock

The following test factors are to be used for mechanical shock:

Test: 1.4 times limit load

3.5.4 Sine Burst (Loads) Testing

The following test factors are to be used for sine burst testing:

Test: 1.25 time limit load

3.5.5 Temperature

The following margins are used during temperature testing:

Low Temperature Test:	10° C below the minimum predicted mission operating conditions
High Temperature Test:	10° C above the maximum predicted mission operating conditions.

3.5.6 Electromagnetic Compatibility

There are no margins applicable to electromagnetic compatibility (EMC) or electromagnetic interference (EMI) testing. Limits are based on specified values in military standards, or modified as appropriate to meet program requirements.

3.6 Test Sequence

Test programs will be arranged in the manner stated in this verification plan to disclose problems and failures associated with the hardware. Although no special environmental test sequence is required by the controlling document, a strong preference exists for performing mechanical loading, vibroacoustics, and EMI prior to thermal vacuum.

3.7 Waivers and Exceptions

Waivers of, or exceptions to the requirements of this document shall be granted only by direction of, or concurrence with, the FAST Project Manager or his authorized representative through the configuration management process.

3.8 Failures and Retest Requirements

Deterioration or any change in performance of any test item that prevents the test item from meeting its functional, operational, or design requirements throughout its mission shall be reason to consider the test item as having failed. If failures or malfunctions are encountered during a test, the test shall be discontinued until an appropriate course of action is established. If corrective action is taken, the test shall be repeated to demonstrate that the test item's performance is satisfactory.

3.9 Test Tolerances

The following tolerances will be used during verification and test.

Acoustics

Overall Level:	± 1 dB
One-Third Octave Band Center Frequencies From:	
< 40 Hz	+ 3 dB and - 6dB
40 to 3150 Hz	± 3 dB
≥ 3150 Hz	+ 3 dB and - 6 dB

Electromagnetic Compatibility

Voltage Magnitude:	± 5% of the peak value
Current Magnitude:	± 5% of the peak value
RF Amplitudes:	± 2 dB
Frequency:	± 2%
Distance:	± 5% of the specified distance

Humidity

Humidity Level:	± 5% relative humidity

Antenna Pattern Determination

Antenna Pattern:	± 2 dB

Loads

Steady State (acceleration):	± 5%
Static:	± 5%

Magnetic Properties

Mapping Distance Measurement:	± 1 cm
Displacement of Assembly center of Gravity (cg) from rotation axis:	± 5 cm
Vertical Displacement of single probe centerline from cg:	± 5 cm
Mapping Turntable from Angular Displ.:	± 3 degrees
Magnetic Field Strength:	± 1 nT
Repeatability of Magnetic measurements:	± 5% or ± 2 nT, whichever is greater
Demagnetizing and Magnetizing Field Level:	± 5% of nominal

Mass Properties

Weight:	± 0.2%
Center of Gravity:	± 0.15 cm
Moments of Inertia:	± 1.5%

Mechanical Shock

Response Spectrum:	+ 25% and - 10%
Time History:	± 10%

Pressure

> 100mm Hg:	± 5%
100mm Hg to 1 mm Hg:	± 10%
1mm Hg to 1 micron:	± 25%
< 1 micron:	± 80%

Temperature

Measurement:	± 2 °C

Vibration

Sinusoidal	
Amplitude:	± 10%
Frequency:	± 2%
Random	
RMS Level:	± 10%
Power Spectral Density:	± 3 dB

4.0 Verification

4.1 Component and Instrument Verification

The component (the term component also refers to instruments) verification program will be performed in accordance with the FAST Verification Matrix, Figure 4-1. Each item will undergo testing to protoflight levels and are planned to be subject to a full qualification test program which includes: random vibration, static loads, mechanical shock, sine sweep, EMI, magnetics, and thermal vacuum tests. Items performing a mechanical operation shall also receive mechanical function tests. Figure 4-2 shows the typical component test flow for FAST.

Instruments will be integrated at various contractor sites and delivered to the GSFC as a functional unit. The test program shall consist of the tests identified in the verification matrix, figure 4-1. The developer is also required to prepare a Performance Assurance Implementation Plan (PAIP) as well as a FAST Instrument Verification Plan which will describe the approach for accomplishing the verification program.

Each component will be performance tested at the beginning and the end of the test sequence to demonstrate continued compliance with requirements. Performance tests are detailed functional tests conducted under conditions of varying internal and external parameters with emphasis on all possible modes of operation for the test item. The test will demonstrate operation of all functional modes, within cost and schedule constraints, including the redundant circuitry.

Functional tests, limited performance tests, will be done periodically before, during and/or following tests, where appropriate, to show that no change or degradation has resulted from exposure to the test environment, handling, or transportation.

4.1.1 Mass Properties Measurements

Measurements of the weight and center of gravity will be required for each component.

4.1.2 Random Vibration Test

Each component will be subject to random vibration along each of three mutually perpendicular axis. The test items will be attached to a rigid vibration fixture with attachment points representative of the interface with the FAST spacecraft.

4.1.3 Static Loads (Sine Burst)

Strength verification of components will be demonstrated by subjecting the items to test conditions representative of quasi-steady state loads during the FAST launch. Generally, this will be performed on the components by subjecting the item to required loading conditions using a low frequency sine burst technique.

4.1.4 Sine Sweep Test

A sine sweep test may be performed on the component to obtain a resonance signature which will be analized for changes which may be a result of structural degradation. This test is not a requirement but only a tool to determine the components performance in test.

4.1.5 Shock Testing

The shock test will be performed on the components to simulate the shock of separation from the carrier aircraft, the separation of the spacecraft from the launch vehicle, and any pyro events in launch.

4.1.6 Mechanical Function

Mechanical function test will be performed on the deployable components and on any component with a moving mechanical mechanism to ensure proper motion occurs.

4.1.7 Acoustics

Acoustics testing will be performed to determine the components ability to withstand acoustic environments produced in the launch sequence.

4.1.8 Life Testing

Life testing will be performed on sample items to demonstrate the items ability to endure prolonged exposure to mission environments.

4.1.6 Electromagnetic Compatibility Test

Components which are electrically powered or generate electric or magnetic fields will be subjected to an electromagnetic compatibility test to ensure that they will neither be a source of electromagnetic interference (EMI) nor be susceptible to EMI when integrated with other FAST components.

The tests and limits called out in the GEVS-SE document are considered to be minimum requirements and more stringent levels may be imposed to meet the specific requirements for the FAST. For radiated and conducted emissions testing the test item will be in its noisiest mode and for susceptibility testing the unit will be in its most sensitive mode.

4.1.7 Magnetics Test

Components whose magnetic properties or fields must be controlled to satisfy operational scientific requirements will be subjected to a magnetics test.

4.1.8 Thermal Vacuum Test

Thermal vacuum testing of components will be performed to demonstrate satisfactory operation in the representative functional modes at temperature extremes and during transitions. The components shall undergo a minimum of 8 cycles before being integrated into the system level of assembly. The test duration shall be based on the time required to complete performance/functional testing of the component at each hot and cold temperature level but, as a minimum, four hour soak periods will be conducted. Components will be operated during the transition periods and two (2) turn on demonstrations at the hot and cold levels will be made. Proper operation after exposure to survival mode temperatures will also be demonstrated as well as survival heater operation.

4.1.9 Bakeout

A bakeout will be performed to improve cleanliness of the component pror to system level integration and test.

4.2 Subsystem Verification

Because there is no defined subsystem level of assembly, environmental testing will be done at the component and system levels of assembly only.

4.3 Engineering Test Unit

The FAST project will perform prototype testing to qualification levels on engineering test units. Because protoflight level testing will be performed on all flight units, no qualification, via ETU, is required.

4.4 Spacecraft

The spacecraft verification program will be performed in accordance with the FAST Verification Matrix, Figure 4-1. The tests shall be performed to demonstrate acceptance for flight and will be performed to protoflight levels. Figure 4-3 shows the system level test flow for the FAST.

The spacecraft shall undergo a comprehensive performance test to demonstrate compliance with requirements. This test shall be a detailed demonstration that the system meets specified requirements within allowable tolerances. The comprehensive performance tests will be conducted at the beginning of the test program, the end of the test program, and during the thermal vacuum test. The test will demonstrate operation of all redundant circuitry and satisfactory performance of all operational modes within cost and schedule limits and facility capabilities.

Functional tests, limited performance tests, will be done periodically during the test program to demonstrate that no change or degradation to the spacecraft has resulted from environmental exposure, handling, or transportation. Functional tests should be performed before and after each environmental test to ensure no degradation has occurred as a result of testing.

4.4.1 Mass Properties

The spacecraft will undergo mass properties testing to include the determination of weight, center of gravity, moments of inertia, products of inertia, and the performance of a spin balance. The mass properties shall be performed for launch and on orbit configurations.

4.4.2 Modal Survey

A modal survey shall be performed on the spacecraft to confirm the fundamental modes of the structure. Resulting data shall be used to verify or correct inaccuracies in the mathematical model used in the structural analysis program. If modifications are made to the mathematical model as a result of this survey, the flight dynamics loads analysis and the derived limit/qualification/design loads shall be adjusted accordingly.

4.4.3 Random Vibration Test

The spacecraft shall be subjected to a random vibration along each of three mutually perpendicular axis. The unit will be attached to a rigid vibration fixture designed to prevent the imposition of amplification factors on the test item. Attachment points will be representative of the interface with the spacecraft. During the test, the spacecraft shall be operated on as in a launch situation.

4.4.4 Static Loads (Sine Burst) Test

Strength verification will be demonstrated by subjecting the spacecraft to test conditions representative of quasi-steady state loads during the FAST launch. This will be performed by subjecting the test item to required loading conditions using a low frequency Sine Burst technique. Test frequencies will be selected that are low enough to ensure rigid body motion of the item under test and still be compatible with the low frequency limitations of the test shaker system.

4.4.5 Shock Testing

The separation/shock test will be performed on the spacecraft simulating the shock from separation from the carrier aircraft and spacecraft separation from the launch vehicle.

4.4.6 Sine Sweep Test

A sine sweep test will be performed on the spacecraft to develope a resonance signature for the spacecraft to be used to identify structural changes by comparing signatures after each vibration test.

4.4.7 Mechanical Function

Mechanical function tests shall be performed to demonstrate that the installation of each mechanical device is correct and that no problems exist that will prevent proper operation of the mechanism during mission life.

4.4.8 Acoustics

An acoustics noise test will be performed to demonstrate that the spacecraft will perform without degradation when exposed to an acoustic environment representative of that during launch.

4.4.9 Electromagnetic Compatibility

The spacecraft will be subjected to an electromagnetic compatibility (EMC) test to ensure that it does not generate electromagnetic interference (EMI) that will adversely affect its mission operational requirements and is not susceptible to EMI to which it may be exposed during its mission life.

The tests and limits called out by GEVS-SE are considered to be minimum requirements and tests and levels may be altered to meet specific requirements of the FAST mission. For radiated and conducted emissions testing, the test item will be in its noisiest mode as appropriate. For susceptibility testing, the unit will be in its most sensitive mode.

4.4.10 Magnetics

The magnetic properties of the spacecraft will be verified at the GSFC Magnetic Test Site. When such measurements are made, and if they are found to exceed allowable limits, the FAST project must make a determination regarding a corrective course of action or the acceptability of the deviation.

4.4.11 Thermal Balance Test

A thermal balance test will be performed to demonstrate the validity of the thermal design and the analytical model. This test will also verify the ability of the thermal control system to maintain the hardware within the established thermal limits for the FAST mission. Testing will include worst case hot and cold conditions for the mission orbit.

4.4.12 Thermal Vacuum Test

Thermal-vacuum testing of the spacecraft will be performed to demonstrate satisfactory operation in the representative functional modes at temperature extremes and during temperature transitions.

The spacecraft will be exposed to a minimum of 4 temperature cycles. The test duration depend on the time required for temperature transitions and the time to complete performance/functional testing of the unit at each hot and cold temperature level; as a minimum, 16 hour soaks will be conducted. Proper operation after exposure to survival mode temperatures will also be demonstrated as well as survival heater operation

4.4.13 End-To-End Compatibility Test

The spacecraft shall receive an end-to-end verification test. The purpose of this test is to verify the compatibility between the spacecraft, launch vehicle, and ground communications networks.

4.5 Software Verification

The FAST Software Performance Assurance Implementation Plan (PAIP) developed under the FAST Software Management Plan will address the software performance verification requirements. A software test plan consistent with the PAR document will be prepared that summarizes the acceptance testing procedures, documentation, reviews, and reports to be generated. As a minimum, the plan will list the tests that will be used to demonstrate that the requirements have been satisfied, the test environment, data required, expected results, any special operating conditions and special test support tools. The plan will be updated as needed.

13-Feb-92

FAST VERIFICATION MATRIX

HARDWARE DESCRIPTION				TESTS AND ANALYSIS																					
				ANAL.		ENVIRONMENTAL																	OTHER		
LEVEL OF ASSEMBLY	ITEM	UNIT TYPE	SUPPLIER	STRUCTURAL ANALYSIS	THERMAL ANALYSIS	MODAL SURVEY	RANDOM VIBRATION	LOADS (SINE BURST)	SINE SWEEP	SHOCK	MECHANICAL FUNCTION	ACOUSTICS	LIFE TEST	MASS PROPERTIES (1)	PRESSURE PROFILE	EMC (3)	MAGNETICS	THERMAL VACUUM	THERMAL BALANCE	BAKEOUT	LEAK		RADIATION	PULL TEST	
P	**PAYLOAD**	PF	GSFC	X	X		X	X	X	X	X	X		X		X	X	X	X	X					
S	**STRUCTURES**																								
C	S/C Structure	PF	741	X			X	X	X	X				X											
C	ETU S/A	PF	741	X			X	X	X	X		X													
S	**ATTITUDE CONTROL**																								
C	HCI	PF	745		X		O	O						O		O		O							
C	Sun Sensor	PF	745		X		O	O						O		O		O							
C	Magnetic Torquers	PF	745	X			8	8	8	8				X			X	9							
C	Magnetometer	PF	745		X		X	X	X	X				X			X	X							
C	Nutation Damper	PF	745	X			8	8	8	8				X						4					
S	**ELECTRICAL**																								
C	Wire Harnesses/Cabling	PF	743																	X				X	
C	Umbilical Interface																							X	
S	**POWER**																								
C	Flight Solar Array	PF	711	X	X		5	5	5	5		O		O			2	O		O					
C	Solar Array Qual Panel	PF	711				O						7							O			X		
C	Batteries	PF	711				O	O	O	O			6	O			2	O			O				
S	**COMMUNICATIONS**																								
C	Transponder	PF	Motorola				O		O					O		O	X	O							
C	Antennas	PF	727	X	X		X	X	X	X				X									X		
	INSTRUMENTS																								
I	Flight IDPU	PF	UCB	O	O		O	O	O	O				O		O	X	O							
I	ETU IDPU	PT	UCB													O									
I	Search Coil Magnetometer	PF	UCLA	O	X		O	O	O	O				O		O	X	O							
I	Flux Gate Magetometer	PF	UCLA	O	X		O	O	O	O				O		O	X	O							
I	TEAMS	PF	UNH/Loch	O	O		O	O	O	O	O	O		O	O	O	X	O							
I	ESA Stacks	PF	Berkley	O	O		O	O	O	O	O			O		O	X	O							
I	ETU ESA Stacks	PF	Berkley													O									
	DEPLOYABLES																								
I	Wire Booms & Assy	PF	UCB		O		O	O	O	O	O			O				O							
I	ETU Wire Booms & Assy	PT	UCB																						
I	Axial Booms & Assy	PF	UCB	O	O	O	O	O	O	O	O			O				O							
I	ETU Axial Booms & Assy	PT	UCB																						
I	Mag Booms & Assy	PF	UCB	O	O	O	O	O	O	O	O			O				O							
I	ETU Mag Booms & Assy	PT	UCB																						
S	**ELECTRONICS**																								
C	MUE	PF	745	X	X		X	X	X	X				X		X	X	X							
C	ETU MUE	PT	745													X									
C	Shunt Drivers	PF	745	X	X		X	X	X	X				X		X	X	X							
C	ETU Shunt Drivers	PT	745													X									
C	EEE Parts	PF	GSFC																				X		

Level of Assembly
C = Component
I = Instrument
S = Subsystem
P = Payload/Spacecraft

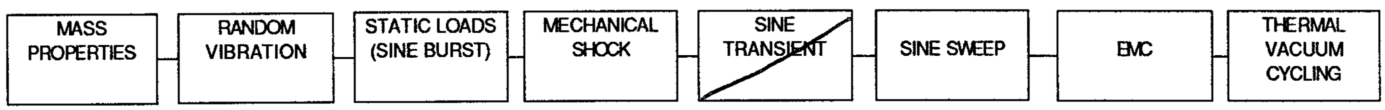
Unit Type
PT = Prototype
PF = Protoflight

Test Matrix
X = Internal Testing
O = Outside Facility

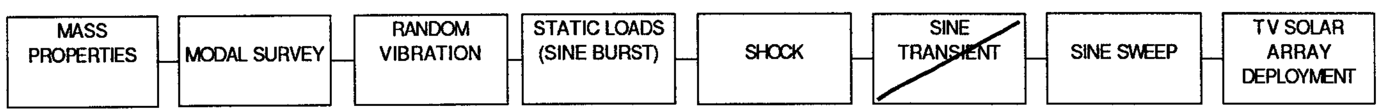
(1) WEIGHT, CG, AND MOI
(2) REQUIRED IF DEEMED NECESSARY BY ANALYSIS.
(3) EMC ON INSTRUMENTS NOT PRACTICAL WITHOUT VACUUM.
(4) BAKEOUT TO INCLUDE 2 THERMAL CYCLES
(5) ACOUSTICS TO SATISFY VIBRATION REQUIREMENTS?
(6) BATTERIES LIFE TESTED FOR USE ON SAMPEX
(7) THERMAL CYCLING
(8) DONE WITH SPACECRAFT STRUCTURE
(9) THERMAL CYCLING AT AMBIENT PRESSURE

FIGURE 4 - 2   FAST ENVIRONMENTAL TEST FLOW

COMPONENTS *



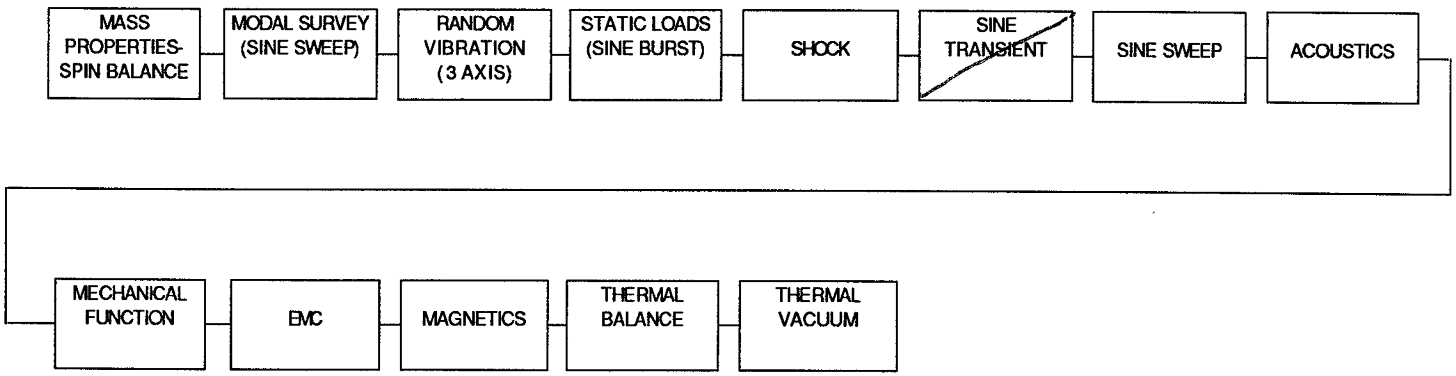
FLIGHT STRUCTURE *



* - ORDER OF CELLS MAY NOT INDICATIVE OF ORDER TESTS WILL BE PERFORMED

FIGURE 4 - 3 FAST ENVIRONMENTAL TEST FLOW

SPACECRAFT *



* - ORDER OF CELLS MAY NOT INDICATIVE OF ORDER TESTS WILL BE PERFORMED

5.0 Program Requirements

5.1 Safety

The FAST System Safety Implementation Plan submitted as part of the Performance Assurance Implementation Plan is structured to describe management responsibility, technical requirements, and methods to be followed to assure that design, assembly, test, transportation, and launch preparation of SMEX is accomplished in compliance with applicable safety requirements.

For all major tests and operations involving a high degree of risk, an Operations Hazards Analysis (OHA) will be performed on the test or operation. Results of the analysis will be presented to the project prior to testing along with appropriate recommendations.

5.2 Contamination

The FAST Contamination Plan will establish the contamination allowance for performance degradation of contamination-sensitive hardware. Specific requirements for particulate or molecular contamination control will be included in system/subsystem specifications and verification test procedures.

5.3 Test Facility Requirements

The facilities and test equipment used in conducting tests shall be capable of producing and maintaining, the test conditions required with the test specimen installed and operating or not operating as appropriate. In any major test, facility performance shall be verified prior to the test either by review of its performance during a test that occurred a short time earlier or by conducting a test with a substitute item.

5.4 Electrostatic Discharge (ESD) Requirements

To preclude the possible damage to electronic equipment from electrostatic discharges the requirements of the FAST ESD Control Plan shall be implemented for all aspects of the verification plan testing. As a minimum, static plugs will be used to protect electronic boxes from static electricity effects when they are not installed or cabled in a test configuration or cabled to other flight hardware.

APPENDIX A

DEFINITION OF TERMS

Acceptance Tests:	The process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen to detect deficiencies, and normally to provide the basis for delivery of an item under terms of a contract.
Analysis:	A verification method using techniques and tools such as math models, similarity assessments, validation of records, etc., to confirm that verification requirements have been satisfied.
Assembly:	A functional subdivision of a component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole.
Component:	A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation.
Demonstration:	A method of verification denoting the qualitative determination of properties of an end-item or component by observation. Demonstration is used with or without special test equipment or instrumentation to verify requirements characteristics.
Electromagnetic Compatibility (EMC):	The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.
Electromagnetic Interference (EMI):	Electromagnetic energy which interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.
End-to-End Tests:	Tests performed on the integrated ground and flight system, including all elements of the instrument, its control, communications and data processing to demonstrate that the entire system is operating in a manner to fulfill all mission requirements and objectives.
Functional Tests:	The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.
Inspection:	The process of measuring, examining, gaging, or otherwise comparing an article or service with specified requirements.

erformance Verification:	Determination by analysis, test, inspection demonstration or a combination of the four, that the payload or payload element can operate as intended in a particular mission without imposing an unacceptable safety risk on personnel or property; this includes being satisfied that the design of the payload or element has been qualified and that the particular item has been accepted as true to the design and ready for launch and flight operations.
Protoflight:	A concept which subjects flight hardware to environmental tests combining elements of flight acceptance and prototype testing (that is, the application of design qualification levels and flight acceptance durations).
Qualification:	The process of demonstrating that a given design and manufacturing approach will produce hardware that will meet all performance specifications when subjected to defined conditions more severe than expected during its intended use.
Similarity, Verification by:	A procedure of comparing an item to a similar one that has been verified. Configuration, test data, application, and environment should be evaluated. It should be determined that design differences are insignificant, environmental stress will not be greater in the new application, and that manufacturer and manufacturing methods are the same.
Subsystem:	A functional subdivision of a payload consisting of two or more components.
hermal Balance Test:	A test conducted to verify the adequacy of the thermal model, the adequacy of the thermal design, and the capability of the thermal control system to maintain thermal conditions within established mission limits.
Thermal-Vacuum Test:	A test to demonstrate the validity of the design in meeting functional goals; it also demonstrates the capability of the test item to operate satisfactorily in vacuum at temperatures based on those expected for the mission. The test can also uncover latent defects in design, parts, and workmanship.
Vibroacoustics:	An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout the payload in the form of directly transmitted acoustic excitation and as structure-borne random vibration excitation.
Workmanship Vibration:	A low-level random vibration test performed to verify adequate workmanship in the construction of the test item. It is used to uncover such things as bad solder joints, loose or missing fasteners, or improperly mounted parts.