

SECTION 2.1

SYSTEM PERFORMANCE VERIFICATION

2.I SYSTEM PERFORMANCE VERIFICATION

This section applies to all payloads (spacecraft), subsystems (including instruments), and components. The basic provisions apply to all flight hardware, and associated software, that will fly in the STS cargo bay and to spacecraft that will be launched by expendable launch vehicles (ELVs).

The GEVS, as its name implies, provides basic requirements and guidelines for an environmental verification program. This represents only a portion of the overall system verification and must be integrated into the total system program which verifies that the system will meet the mission requirements. A system performance verification program documenting the overall verification plan, implementation, and results is required which will provide traceability from mission specification requirements to launch and initial on-orbit capability. This will also provide the baseline for tracking on-orbit performance versus pre-launch capability.

2.1.1 Documentation Requirements

The following documents are required and shall be delivered and approved in accordance with the Contracts Schedule.

2.1.1.1 System Performance Verification Plan

A system performance verification plan shall be prepared defining the tasks and methods required to determine the ability of the system (or instrument) to meet each program-level performance requirement (structural, thermal, optical, electrical, guidance/control, RF/telemetry, science, mission operational, etc.) and to measure specification compliance. Limitations in the ability to verify any performance requirement shall be addressed, including the addition of supplemental tests and/or analyses that will be performed and a risk assessment of the inability to verify the requirement.

The plan shall address how compliance with each specification requirement will be verified. If verification relies on the results of measurements and/or analyses performed at lower (or other) levels of assembly, this dependence 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. Analysis results shall take into account tolerance build-ups in the parameters being used.

2.1.1.1.1 Environmental Verification Plan

An environmental verification plan shall be prepared, either as part of the System Verification Plan or as a separate document, that prescribes the tests and analyses that will collectively demonstrate that the hardware and software comply with the environmental verification requirements

The environmental verification plan shall provide the overall approach to accomplishing the environmental verification program. For each test, it shall include the level of assembly, the configuration of the item, objectives, facilities, instrumentation, safety considerations, contamination control, test phases and profiles, necessary functional operations, personnel responsibilities, and requirement for procedures and reports. It shall also define a rationale for retest determination that does not invalidate previous verification activities. When appropriate, the interaction of the test and analysis activity shall be described.

Limitations in the environmental verification program which preclude the verification by test of any system requirement shall be documented. Examples of limitations in the ability to demonstrate requirements include:

- Inability to deploy hardware in a 1-g environment.
- Facility limitations which do not allow testing at system level of assembly.
- Inability to perform certain tests because of contamination control requirements.
- Inability to perform powered-on testing because of voltage breakdown concerns.

Alternative tests and analyses shall be evaluated and implemented as appropriate, and an assessment of program risk shall be included in the System Performance Verification Plan.

2.1.1.2 System Performance Verification Matrix

A System Performance Verification Matrix shall be prepared, and maintained, to show each specification requirement, the reference source (to the specific paragraph or line item), the method of compliance, applicable procedure references, results, report reference numbers, etc. This matrix shall be included in the system review data packages showing the current verification status as applicable

2.1.1.2.1 Environmental Test Matrix

As an adjunct to the environmental verification plan, an environmental test matrix shall be prepared that summarizes all tests that will be performed on each component, each subsystem, and the payload. The purpose is to provide a ready reference to the contents of the test program in order to prevent the deletion of a portion thereof without an alternative means of accomplishing the objectives; it has the additional purpose of ensuring that all flight hardware has been subjected to environmental exposures that are sufficient to demonstrate acceptable workmanship. In addition, the matrix shall provide traceability of the qualification heritage of hardware. All flight hardware, spares and prototypes (when appropriate) shall be included in the matrix. Details of each test shall be provided (e.g., number of thermal cycles, temperature extremes, vibration levels). It shall also relate the design environments to the test environments and to the anticipated mission environments. The matrix shall be prepared in conjunction with the initial environmental verification plan and shall be updated as changes occur.

A sample test matrix is given in Figure 2.1-1. The electrical performance tests that are required to be performed before, during, and following the environmental verification test program are not shown in this sample matrix. Other performance tests, measurements, demonstrations, alignments, etc. (electrical, mechanical, optical, etc.), that must be performed to verify hardware/software requirements are also not included in this Environmental Test Matrix. However they shall be included in the System Performance Verification Plan.

The test matrix does not have to conform to this format; any format that clearly displays the pertinent information is acceptable.

A complementary matrix shall be kept showing the tests that have been performed on each component, subsystem, or payload (or applicable level of assembly). This should include tests performed on prototypes or engineering units used in the qualification program, and should indicate test results (pass/fail or malfunctions).

2.1.1.3 Environmental Verification Specification

An environmental verification specification shall be prepared that defines 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. Such things as payload peculiarities and interaction with the launch vehicle (STS or ELV) shall be taken into account.

2.1.1.4 Performance Verification Procedures

For each verification test activity conducted at the component, subsystem, and payload levels (or other appropriate levels) of assembly, a verification procedure shall be prepared that describes the configuration of the test article, how each test activity contained in the verification plan and specification will be implemented.

Test procedures shall contain details such as instrumentation monitoring, facility control sequences, test article functions, test parameters, pass/fail criteria, quality control checkpoints, data collection and reporting requirements. The procedures also shall address safety and contamination control provisions.

2.1.1.5 Verification Reports

After each component, subsystem, payload, etc., verification activity has been completed, a report shall be submitted in accordance with the Contract Schedule. For each environmental test activity, the report shall contain, as a minimum, the information in the sample test report contained in Figure 2.1-2a and 2.1-2b. For each analysis activity, the report shall describe the degree to which the objectives were accomplished, how well the mathematical model was validated by related test data, and other such significant results. In addition, as-run verification procedures and all test and analysis data shall be retained for review.

2.1.1.6 System Performance Verification Report

At the conclusion of the verification program, a final System Performance Verification Report shall be delivered comparing the hardware/software specifications with the final verified values (whether measured or computed). It is recommended that this report be subdivided by subsystem/instrument.

The System Performance Verification Report shall be maintained "real-time" throughout the program summarizing the successful completion of verification activities, and showing that the applicable system performance specifications have been acceptably complied with prior to integration of hardware/software into the next higher level of assembly.

The initial report shall be provided for the PDR. Current versions shall then be provided for review at major systems reviews.

The final pre-launch System Verification Report shall be available for approval for the FRR (Flight Readiness Review).

Following initial on-orbit checkout, the System Verification Report shall be completed, and delivered in accordance with the contract schedule.

2.1.1.7 Instrument Verification Documentation

The documentation requirements of sections 2.1.1.1 through 2.1.1.6 also apply to instruments. Following integration of the instruments onto the spacecraft, the spacecraft System Verification Report will include the instrument information.

Figure 2.1-1

SYSTEM PERFORMANCE VERIFICATION

REVISION DATE _____

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| | HARD |
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| LEVEL OF ASSEMBLY | HARDWARE DESCRIPTION | | | | STRUCTURAL MECHANICAL | | | | | | | | | | | | | | | | EMC & MAGNETICS | | | | | | | | | | | | | | | | THERMAL | | | | | | | | | | | |
|-------------------|----------------------|-----|-----------|----------|-----------------------|--------------|--------------|--------------|------------|------------------|-----------|----------------------|----------------|----------------|------------------|------------|------------|------------|---------------|----------------|-----------------|------------------|------------------|----------------|-------------------|-------------------------------|----------------------------------|----------|------------------------------|-----------------------|---------------------------|--------------------------|------------------|-----------------------|--------------------|----------------------------|------------------------------|-------------------------------|-------------------------|------|---------------------------------|---------------------------|----------------------|--------------------|------------------|-------------|--------|---------|
| | ITEM | S/N | UNIT TYPE | SUPPLIER | QUALIFICATION STATUS | MODAL SURVEY | STATIC LOADS | ACCELERATION | SINE BURST | RANDOM VIBRATION | ACOUSTICS | MECHANICAL VIBRATION | PRESSURE SHOCK | TORQUE PROFILE | MECHANICAL SHOCK | LIFE CYCLE | LIFE RATIO | MASS TESTS | DC PROPERTIES | AC POWER LEADS | POWER LEADS | SPRINGS ON LEADS | SPRINGS ON OTHER | DC POWER LINES | ANTENNA TERMINALS | MAGNETIC FIELD DC POWER LINES | AC MAGNETIC FIELD DC POWER LINES | E-FIELDS | PAYLOAD FIELD (SIS PYRAMIDS) | SPURIOUS TRANSMITTERS | POWER LINE (AMTR ANTENNA) | INTERMODULATION PRODUCTS | CROSS REFLECTION | POWER LINE MODULATION | E-FIELD GENERATION | COMPATIBILITY WITH ORBITER | MAGNETIC FIELD COMPATIBILITY | MAGNETIC-FIELD ORBITER XMITTS | MAGNETIC SUSCEPTIBILITY | LEAK | NUMBER OF THERMAL VACUUM CYCLES | THERMAL BALANCE (NON-VAC) | TEMPERATURE-HUMIDITY | FLIGHT TEMPERATURE | TEST TEMPERATURE | PREDICTIONS | LIMITS | REMARKS |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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LEGEND

LEVEL OF ASSEMBLY

S/C - SPACECRAFT
P/L - PAYLOAD
MOD - MODULE
S - SUBSYSTEM
I - INSTRUMENT
SEC - SECTION
C - COMPONENT

UNIT TYPE

- D - DEVELOPMENT MODEL
- DEM - ENGINEERING MODEL
- PT - PROTOTYPE
- PF - PROTOFLIGHT
- F - FLIGHT
- S - SPARE

QUALIFICATION STATUS

1. - COMPLETE QUAL. REQUIRED
2. - PARTIAL QUAL. REQUIRED (SEE REMARKS)
3. - OTHERWISE QUALIFIED (SEE REMARKS)

NOTES:

| VERIFICATION TEST REPORT | | Page ____ of ____ |
|--|---|--|
| PROJECT _____ | | |
| TEST ITEM _____ | | |
| MANUFACTURER _____ | | |
| SERIAL NUMBER _____ | | |
| <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> LEVEL OF ASSEMBLY <input type="checkbox"/> SUBASSEMBLY or ASSEMBLY <input type="checkbox"/> UNIT/COMPONENT <input type="checkbox"/> SECTION <input type="checkbox"/> SUBSYSTEM/INSTRUMENT <input type="checkbox"/> MODULE <input type="checkbox"/> SPACECRAFT/PAYLOAD </div> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> HARDWARE <input type="checkbox"/> ENGINEERING MODEL <input type="checkbox"/> PROTOTYPE <input type="checkbox"/> PROTOFLIGHT <input type="checkbox"/> FLIGHT <input type="checkbox"/> SPARE </div> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> TEST <input type="checkbox"/> INITIAL TEST <div style="margin-left: 20px;">STARTING DATE OF INITIAL TEST _____</div> <input type="checkbox"/> RETEST <div style="margin-left: 20px;"> <input type="checkbox"/> PARTIAL <input type="checkbox"/> FULL </div> </div> |
| <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> STRUCTURAL - MECHANICAL <input type="checkbox"/> STRUCTURAL LOADS <div style="margin-left: 20px;"> <input type="checkbox"/> STATIC <input type="checkbox"/> ACCEL. <input type="checkbox"/> SINE BURST </div> <input type="checkbox"/> VIBRATION <div style="margin-left: 20px;"> <input type="checkbox"/> RANDOM <input type="checkbox"/> SINE </div> <input type="checkbox"/> ACOUSTICS <input type="checkbox"/> MECHANICAL SHOCK <div style="margin-left: 20px;"> <input type="checkbox"/> ACTUATION <input type="checkbox"/> SIMULATED </div> <input type="checkbox"/> MECHANICAL FUNCTION <input type="checkbox"/> MODAL SURVEY <input type="checkbox"/> PRESSURE PROFILE <input type="checkbox"/> MASS PROPERTIES <input type="checkbox"/> OTHER (explain) </div> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> ELECTROMAGNETIC COMPATIBILITY <input type="checkbox"/> CONDUCTED EMISSIONS <input type="checkbox"/> RADIATED EMISSION <input type="checkbox"/> CONDUCTED SUSCEPTIBILITY <input type="checkbox"/> RADIATED SUSCEPTIBILITY <input type="checkbox"/> MAGNETIC PROPERTIES </div> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> THERMAL <input type="checkbox"/> THERMAL-VACUUM <div style="margin-left: 20px;">(no. of cycles ____)</div> <input type="checkbox"/> THERMAL CYCLING <div style="margin-left: 20px;">(no. of cycles ____)</div> <input type="checkbox"/> THERMAL BALANCE <input type="checkbox"/> TEMPERATURE-HUMIDITY <input type="checkbox"/> LEAKAGE <input type="checkbox"/> OTHER (explain) </div> |
| <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> ELECTRICAL PERFORMANCE <input type="checkbox"/> LPT <input type="checkbox"/> CPT <input type="checkbox"/> END-TO-END <div style="margin-left: 20px;"> <input type="checkbox"/> COMPATIBILITY TEST <input type="checkbox"/> MISSION SIMULATIONS </div> </div> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> OPTICAL <input type="checkbox"/> EXPLAIN </div> | |
| VERIFICATION PROCEDURE NO.: _____ REV. _____ DATE _____ APPLICABLE VERIFICATION PLAN: _____ FACILITY DESCRIPTION: _____ LOCATION: _____ TEST LOG REFERENCE: _____ COMMENTS: _____ | | |
| SIGNATURES COGNIZANT ENGINEER FOR TEST ITEM: _____ DATE: _____ QUALITY ASSURANCE REPRESENTATIVE: _____ DATE: _____ (if required) | | |

Figure 2.1-2a Verification Test Report

VERIFICATION TEST REPORT (Continued)

Page_____of_____

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

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 completed and transmitted to the GSFC Technical Officer or Contracting Officer (as appropriate) within 30 days after completion of an 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 representative; 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.

Figure 2.1-2b Verification Test Report (cont.)