NOT MEASUREMENT SENSITIVE

National Aeronautics and
Space Administration

NASA-STD-7002A
SEPTEMBER 10, 2004

PAYLOAD TEST REQUIREMENTS

NASA TECHNICAL STANDARD

DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		7-10-1996	Baseline Release
Revision	A	9-10-2004	Revised as indicated below
			General formatting and editorial changes. Added Distribution Statement and Document History Log. Foreword: General revision for clarity. Added "NASA-STD-7002A supersedes NASA-STD-7002 and provides additional clarification of test conditions and durations for hardware operating in Low Earth Orbit." 1.1 Added to 1st sentence: "for hardware operating in earth orbit." 1.3 Added in 1st paragraph, 4th sentence: "Subject to approval by the assigned Technical Authority" before "individual". Added in 2nd paragraph, next to last sentence: "and the assigned Technical Authority" after "the project manager". 2.2.1: Corrected MIL-STD-461 title. Deleted MIL-STD-462, "Electromagnetic Interference Characteristics, Measurement of." Replaced MIL-STD-1818, "Electromagnetic Effects for Systems" with MIL-STD-464, "Electromagnetic Environmental Effects Requirements for Systems." 3. DEFINITIONS – Replaced "None" with: 3.1 <u>Protoflight hardware</u>: Flight Hardware of a new design; it is subject to a qualification test program that combines elements of prototype and flight acceptance verification; i.e., the application of design qualification test levels and flight acceptance test durations. 3.2 <u>Prototype hardware:</u> Hardware of a new design; it is subject to a design qualification test program, and is not intended for flight.
			4.2.1: Added "for Space Transportation System (STS) payloads" in "The minimum probability level used to define the flight-limit level is $P_{99.87/50}$ for Space Transportation System (STS) payloads,…" Added the following sentences: "For expendable launch vehicle (ELV) payloads, the minimum probability level used to define the flight-limit level is $P_{97.72/50}$, which corresponds to 97.72 percent probability of not exceeding the level and is estimated with 50 percent confidence. This is equal to the mean plus 2 sigma for normal distributions."

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Revision	A	9-10-2004	Revised as indicated below (Continued)
			4.2.2: Added “and STS payloads” to paragraph heading. Added “for ELV payloads” in 4th sentence. Added the following sentences: “Sine vibration applies to STS payloads only if required to simulate sustained periodic environment from upper stages or apogee motors, etc. For STS payloads, the minimum probability level used to define the flight-limit level is $P_{99.87/50}$. This is equal to the mean plus 3 sigma for normal distributions.” 4.3.1 Added “predicted” in first sentence: “These tests shall demonstrate performance and survival under temperature conditions which exceed predicted flight temperature levels….” Added “the expected,” deleted “component temperature,” and changed “may” to “shall” in “If the expected flight variation is small, then component test temperature levels shall be established to provide a minimum temperature differential between test levels to adequately stress the component.” Changed paragraph from “The number of cumulative cycles shall be no less than 10 with the test levels at maximum/minimum predicted temperature levels +/-10° Celsius (C) respectively, with a minimum temperature differential of 55°C for component level testing” to “The thermal vacuum tests shall include a number of cycles from nominal to maximum temperatures, to minimum, and then back to nominal with the test levels at temperatures of at least +/-10 Celsius (C) above/below the respective maximum/minimum predicted flight temperatures.” Added the following sentence and paragraph: “The number of cycles is to be determined by the user considering the type of mission profile and temperature margin employed. For deep-space, interplanetary, or other non-earth orbiting missions, temperature exposure criteria must be developed on a mission-unique basis.” 4.3.2 Changed from “This test, normally performed at the subsystem and payload levels, shall be used to verify the analytical thermal model and provide confidence that the thermal control system can maintain components, subsystems, etc., within the specified operational temperature limits. The test data and the verified thermal analytical model shall be used to demonstrate the design margins in the thermal design” to “This test is normally performed at the subsystem and payload levels. The test data shall be used to demonstrate that the thermal control system can maintain components, subsystems, etc., within required temperature limits under simulated worst-case flight environments. The

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Revision	A	9-10-2004	Revised as indicated below (Continued)
			4.3.2 Continued: test shall also be used to verify analytical thermal models. The test data and the verified analytical thermal model shall demonstrate design margins in the thermal control system." Changed 2nd paragraph from "…The boundary conditions for evaluating the thermal design shall include, as a minimum, a worst-case hot and a worst-case cold scenario. The actual requirements, stabilization criteria, etc., shall be established in such a manner as to provide a conservative assessment of the thermal control system" to "…The test shall be designed to provide boundary conditions simulating a worst-case hot and a worst-case cold scenario. Other test requirements, such as stabilization criteria, shall be established to provide a conservative assessment of the thermal control system and ensure verification of the analytical thermal model." 4.3.3: Added "without damaging the hardware" to "… Outgassing testing shall have sufficient margins to ensure a conservative contamination assessment without damaging the hardware." 4.4: In 1st sentence changed "expected" to "predicted." In 2nd paragraph, 4th sentence, deleted "MIL-STD-462" and replaced "MIL-STD-1818" with "MIL-STD-464". In 7th sentence, replaced "MIL-STD-1818" with "MIL-STD-464." In 2nd paragraph, last sentence, added "approved by the Program Manager and the assigned Technical Authority" after "Waivers". 4.5.2 Added "and thermal-cycling" in "Additional CPTs shall be conducted during the hot and cold extremes of thermal-vacuum and thermal-cycling tests; …" 4.5.3: Changed "trouble-free" to "failure-free" in "Programs shall set a total hour "failure-free" performance requirement …" Added "or software" to "Major hardware or software changes during.…" 4.5.4 a: Changed "that encompass the entire chain of payload operations" to "End-to-end compatibility tests encompassing all payload operations.…" Added the following: "The software development schedule for delivery of fully qualified flight software shall be based on the end-to-end compatibility test need date, and not the launch date. This is to allow for compatibility testing of the flight hardware with the flight software in comprehensive performance tests."

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Revision	A	9-10-2004	Revised as indicated below (Continued)
			4.5.4 b: Changed “from the early stages” to “To provide sufficient time for checkout of the Payload Operations Control Center, it is essential that users participate in mission simulations throughout all stages of the process.”

FOREWORD

This standard is approved for use by NASA Headquarters, and all NASA Centers and Facilities. This standard is intended to provide a common framework for consistent practices across NASA programs.

In early 1994, the NASA Engineering Management Board (EMB) chartered a panel to develop this standard in response to a need for a common set of standard test program requirements for NASA payloads.

The NASA Standard Payload Test Panel was assembled and chaired by the Goddard Space Flight Center. Members were nominated by EMB representatives of the Centers. To provide additional technical expert guidance in the thermal-vacuum and electromagnetic interference (EMI)/electromagnetic compatibility testing disciplines, the Panel established two corresponding subgroups. These subgroups were chaired by personnel from the Marshall Space Flight Center and the Glenn Research Center, respectively.

NASA-STD-7002A supersedes NASA-STD-7002 and provides additional clarification of test conditions and durations for hardware operating in Low Earth Orbit.

Requests for general information concerning NASA Technical Standards should be submitted via "Feedback" on the NASA Technical Standards Homepage: http://standards.nasa.gov.

Original Signed By

Theron M. Bradley, Jr.
NASA Chief Engineer

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLES

PAYLOAD TEST REQUIREMENTS

1. SCOPE

1.1 Scope. This standard includes selected environmental exposure tests for hardware operating in earth orbit. The tests included are generally regarded as the most critical and the ones having the highest cost and schedule impact. This standard also includes functional demonstration tests necessary to verify the capability of the hardware to perform its intended function (with and without environmental exposure as appropriate). This standard specifies test levels, factors, margins, durations, and other parameters where appropriate. In some cases, these specifics are expressed statistically or are referenced in other NASA standards.

1.2 Purpose. This standard provides a NASA-wide common basis from which test programs shall be developed for NASA payloads. The document defines a standard set of flight hardware test requirements, which provide the necessary verification of design adequacy and flight worthiness of NASA spacecraft. Compliance provides consistency across the Agency and its contractors, facilitating the sharing of hardware between Centers and programs. Compliance also provides a basis for establishing a baseline pedigree for the "qualification by similarity" evaluation process for "heritage" hardware without the need to consider the variability of test requirements.

1.3 Applicability. This standard recommends engineering practices for NASA programs and projects. This standard may be cited in contracts and program documents as a technical requirement or as a reference for guidance. Determining the suitability of this standard and its provisions is the responsibility of program/project management and the performing organization. Subject to approval by the assigned Technical Authority, individual provisions of this standard may be tailored (i.e., modified or deleted) by contract or program specifications to meet specific program/project needs and constraints.

This standard applies to all NASA payload hardware developed in-house or under contract that is launched on expendable or reusable launch vehicles (both free-flyer and attached payloads). The levels of assembly for which the standard applies are the payload, modular subsystem (which includes large instruments), and component levels. Small instruments may be treated as components. This standard excludes payloads launched on sounding rockets, balloons, and aircraft, as well as the launch vehicle hardware itself. This standard is developed for the typical NASA protoflight payload wherein one payload is built and serves to qualify the design and is also the flight article. This standard recognizes the need to define the mission-unique environment for each test discipline. This environmental definition shall ensure the tailoring of test requirements to the environmental envelope encountered during the payload's total lifetime considering phases such as ground handling, launch, and in-space operations. The principal objective of the test program is to demonstrate the system's ability to collect scientific data and perform specific remote operations, rather than meet rigid general requirements. Certain environments and functions cannot reasonably be simulated on earth because of factors such as size, zero-gravity limitations, and interface boundary conditions. Tailoring the test program, with supplemental analysis, is appropriate in such cases. When tailoring is utilized or when deviations are deemed necessary, the project manager and the assigned Technical Authority shall review and approve such tailoring and deviations and assure that a documented record, including the rationale, is maintained. This standard is generally not retroactive from the approval date for hardware already under contract.

2. APPLICABLE DOCUMENTS

2.1 General. The applicable documents cited in this standard are listed in this section. The specified technical requirements listed in the body of this document must be met.

2.2 Government documents.

2.2.1 Standards. The following standards form a part of this document to the extent specified herein. Unless otherwise specified, the issuances in effect on date of invitation for bids or request for proposals shall apply.

DEPARTMENT OF DEFENSE

MIL-STD-461	-	*Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment*
MIL-STD-464	-	*Electromagnetic Environmental Effects Requirements for Systems*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA-STD-5001	-	*Structural Design and Test Factors of Safety for Spaceflight Hardware*
NASA-STD-5002	-	*Load Analyses of Spacecraft and Payloads*
NASA-STD-7001	-	*Payload Vibroacoustic Test Criteria*

The above documents may be downloaded from the NASA Technical Standards Website: http://standards.nasa.gov/

2.3 Order of precedence. When this document is adopted or imposed by contract on a program or project, this document shall take precedence over other referenced documents in the case of conflict. However, this document shall not supersede applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Protoflight hardware. Flight hardware of a new design; it is subject to a qualification test program that combines elements of prototype and flight acceptance verification; i.e., the application of design qualification test levels and flight acceptance test durations.

3.2 Prototype hardware. Hardware of a new design; it is subject to a design qualification test program and is not intended for flight.

4. REQUIREMENTS

4.1 Payload test requirements matrix (protoflight program). The standard tests required for payload hardware are identified in Table I. Tests are divided into four categories: mechanical, thermal, EMI, and functional tests. The requirements are defined for each of the three levels of assembly (component, modular subsystem/large instrument, and spacecraft/ payload). Small spacecraft, typically those under 455 kilograms (1000 pounds), are usually fabricated from components (with the exception of the structure which may be a subsystem). Thus, only two levels of assembly are appropriate for this case. The matrix is appropriate for the NASA baseline spacecraft program, that is, a "protoflight" program.

4.2 Mechanical tests.

4.2.1 Strength. Requirements for structural strength test factors, restrictive conditions concerning testing of non-metallic structures, the use of "no test" factors for analysis, and test approaches are specified in NASA-STD-5001, *Structural Design and Test Factors of Safety for Spaceflight Hardware.* The test factors shall be applied to the flight-limit level. The minimum probability level used to define the flight-limit level is $P_{99.87/50}$ for Space Transportation System (STS) payloads, which corresponds to a 99.87 percent probability of not exceeding the level and is estimated with 50 percent confidence. This is equal to the mean plus 3 sigma for normal distributions. For expendable launch vehicle (ELV) payloads, the minimum probability level used to define the flight-limit level is $P_{97.72/50}$, which corresponds to 97.72 percent probability of not exceeding the level and is estimated with 50 percent confidence. This is equal to the mean plus 2 sigma for normal distributions.

4.2.2 Sinusoidal sweep vibration (5 to 50 hertz [Hz]) ELV and STS payloads. Sinusoidal sweep vibration testing shall be performed to qualify hardware for the low-frequency (less than 50 Hz) sinusoidal transients or the sustained sinusoidal environments when they are present in flight. These tests shall be conducted at levels that are 1.25 times the flight-limit levels and at a sweep rate of 4 octaves per minute. Other sweep rates may be used to provide simulations of specific flight events. The minimum probability level used to define the flight-limit level is $P_{97.72/50}$ for ELV payloads. This is equal to the mean plus 2 sigma for normal distributions. Sine vibration applies to STS payloads only if required to simulate sustained periodic environment from upper stages or apogee motors, etc. For STS payloads, the minimum probability level used to define the flight-limit level is $P_{99.87/50}$. This is equal to the mean plus 3 sigma for normal distributions.

4.2.3 Random vibration and acoustics. Random vibration and acoustics tests shall be performed to qualify the hardware for the expected mission environment and to provide workmanship screening for all electrical, electronic, and electromechanical components. Test margins, durations, and minimum workmanship requirements are defined in NASA-STD-7001, *Payload Vibroacoustic Test Criteria*.

4.2.4 Shock (mechanical and pyro).

a. Self-induced shock. This shock occurs principally when pyrotechnic and pneumatic devices are actuated to release booms, solar arrays, protective covers, etc. Also, the impact of deployable devices as they reach their operational position at the "end of travel" is a likely source of significant shock. When hardware contains such devices, as a minimum, it shall be exposed to each shock source twice.

b. Externally induced shock. This shock, both mechanical and pyro shock, originates from other subsystems, payloads, or launch vehicle operations. When the most severe shock is externally induced, a suitable simulation of that shock shall be applied at the hardware interface. When it is feasible to apply this shock with a controllable shock-generating device, the qualification level shall be 1.4 times the flight-limit level at the hardware interface, applied once

TABLE I. Payload Test Requirements Matrix (Protoflight Program)

MECHANICAL TESTS	COMPONENT	MODULAR SUBSYSTEM/ LARGE INSTRUMENT	SPACECRAFT/ PAYLOAD
Strength	■ ❶	■ ❶	■ ❶
Sinusoidal Sweep Vibration (5 to 50 Hz) ELV	■ ❶	■ ❶	■
Random Vibration	■	■	❷ <456 Kg
Acoustics	❷ ▷	❷ ▷	■
Shock (Mechanical and Pyro)			
A. Self-induced	■	■	■
B. Externally induced	❷ ▷	❷ ▷	■
Modal Survey		■	■
Pressure Profile	❷	❷	❷
Appendage Deployment		■ ▷	■
THERMAL TESTS			
Thermal/Vacuum Thermal Cycle ❸	■	■	■
Ambient Pressure Thermal Cycle ❹	■	■	
Thermal Balance		■ ▷	■
Temperature-Humidity	❷	❷	❷
Bakeout (Contamination Sensitive Applications)	■	■	■
Leak Test for Sealed Components	■		
EMI TESTS			
Conducted Emissions	■	■	❺
Radiated Emissions	■	■	■
Conducted Susceptibility	■	■	❺
Radiated Susceptibility	■	■	■
FUNCTIONAL TESTS			
Electrical Interface	■	■	■
Comprehensive Performance	■	■	■
Failure-free Performance	■ ▷	■ ▷	■
Mechanical Interface	■	■	■
Calibrations	■	■	■
End-To-End Compatibility Tests & Mission Simulations			■
Life Test Program (Critical Components)	■		
Optical Alignment	■	■	■
Mass Properties Verification	■	■	■ ❶

■ Required Test
▷ Can be accomplished at a higher level of assembly
❶ May be accomplished by analysis
❷ Test if assessed to be sensitive to the environment
❸ If operation required in vacuum
❹ If operation required in pressurized environment
❺ For attached payloads or payloads that derive power from an off-board source

in each of three axes. The minimum probability level used to define the flight-limit level is $P_{95/50}$. If it is not feasible to apply the shock with a controllable shock-generating device, the test may be conducted at the payload level by actuating the devices in the payload that produce the shocks external to the hardware to be tested. The shock-producing device must be actuated a minimum of two times for this test.

4.2.5 Modal survey. Requirements for modal survey testing and mathematical model verification are specified in NASA-STD-5002, *Load Analyses of Spacecraft and Payloads*.

4.2.6 Pressure profile. A qualification test may be required if analysis does not indicate a positive margin at loads equal to those induced by the maximum expected pressure differential during launch. If a test is required, the limit-pressure profile shall be derived from the predicted pressure-time profile for the nominal trajectory of the particular mission. The test shall be performed using the test factor for loads as specified in NASA-STD-5001, *Structural Design and Test Factors of Safety for Spaceflight Hardware*.

4.2.7 Appendage deployment. A test shall be conducted under the most probable conditions expected during normal flight. A high-energy test and a low-energy test shall also be conducted to prove positive margins of strength and function. The levels for this test shall demonstrate margins beyond the most probable conditions by considering adverse interaction of potential extremes of parameters such as temperature, friction, spring forces, stiffness of electrical cabling or thermal insulation, and spin rate.

4.3 Thermal tests.

4.3.1 Thermal/vacuum and ambient pressure thermal cycle. These tests shall demonstrate performance and survival under temperature conditions which exceed predicted flight temperature levels, and shall act as an environmental stress screen to stimulate latent defects to minimize infant mortality failures. Emulation of the flight thermal conditions is to be manifested at test temperature levels which shall be based on worst-case, high-and low-temperature extremes, with added margins. These added margins shall be sufficient to act as a workmanship screen while also demonstrating thermal capabilities beyond expected flight levels. If the expected flight variation is small, then component test temperature levels shall be established to provide a minimum temperature differential between test levels to adequately stress the component.

The thermal vacuum tests shall include a number of cycles from nominal to maximum temperatures, to minimum, and then back to nominal with the test levels at temperatures of at least +/-10 Celsius (C) above/below the respective maximum/minimum predicted flight temperatures. The number of cycles is to be determined by the user considering the type of mission profile and temperature margin employed.

For deep-space, interplanetary or other non-earth orbiting missions, temperature exposure criteria must be developed on a mission-unique basis.

4.3.2 Thermal balance. This test is normally performed at the subsystem and payload levels. The test data shall be used to demonstrate that the thermal control system can maintain components, subsystems, etc., within required temperature limits under simulated worst-case flight environments. The test shall also be used to verify analytical thermal models. The test data and the verified analytical thermal model shall demonstrate design margins in the thermal control system.

Test conditions and durations are dependent upon the test article's configuration, design, and mission requirements. The test shall be designed to provide boundary conditions simulating a worst-case hot and a worst-case cold scenario. Other test requirements, such as stabilization criteria, shall be established to provide a conservative assessment of the thermal control system and ensure verification of the analytical thermal model.

4.3.3 Bakeout. Components or higher levels of assembly which pose a contamination threat to contamination-sensitive hardware shall be thermal-vacuum baked to achieve an acceptable level of molecular outgassing, as defined in a contamination control plan. Outgassing testing shall have sufficient margins to ensure a conservative contamination assessment without damaging the hardware.

4.3.4 Leak test for sealed components. Leak rates shall be determined prior to stress-inducing environmental tests and periodically during subsequent testing.

4.4 EMI tests. The EMI test program shall ensure that the total payload/vehicle system performs its intended functions when operating in the predicted electromagnetic environment. The test regime shall be composed of a variety of conducted and radiated emissions, as well as susceptibility tests with both being steady-state and transient in nature. Mission-unique environmental requirements, to be defined, shall include intentional transmitters and receivers; ground handling and space-charging electrostatic discharge; and lightning-induced effects in the prelaunch mode.

A structured EMC program shall be defined early in the design phase and shall require a definition of the mission environment and an appropriate mix of component, subsystem, and payload qualification tests dependent on the complexity of payloads. Test limits shall be based on the knowledge of the payload system mission environment and the payload's sensitivity. Military standards (MIL-STDs) or NASA mission-specific specifications shall be used for setting test levels and defining consistent test procedures. All EMI requirements shall be derived from MIL-STD-461 and MIL-STD-464. MIL-STD-461 specifies the limit values used for qualification of electronic hardware, and specifies the test methods to be used to perform the measurements required by MIL-STD-461. Both specifications permit the use of tailoring as needed. MIL-STD-464 shall be used to derive system performance requirements. Pass-fail levels are generally the same for developmental and qualification hardware. Tests at the developmental level shall result in test passage or be redesigned. Waivers approved by the Program Manager and the assigned Technical Authority may be invoked for tests at the qualification level, but they shall be evaluated to ensure that program/mission-level EMI safety margins are maintained.

Critical circuits shall have safety margins of not less than 6 decibels (dB), and pyrotechnic devices shall have test margins of 20 dB imposed.

4.5 Functional tests.

4.5.1 Electrical interface. Before the integration of an assembly into the next higher hardware assembly level, electrical interface tests shall be performed to verify that all interface signals are within acceptable limits of applicable performance specifications. Prior to mating with other hardware, electrical harnessing shall be tested to verify proper characteristics such as routing of electrical signals, impedance, isolation, and overall workmanship.

4.5.2 Comprehensive performance. A comprehensive performance test (CPT) demonstrating that hardware and software meet performance requirements within allowable tolerances shall be conducted on each hardware element after each stage of assembly (component, subsystem, and payload). Additional CPTs shall be conducted during the hot and cold extremes of thermal-vacuum and thermal-cycling tests; at the conclusion of the environmental test sequence; and at other times prescribed in the verification plan. At the payload level, the CPT shall demonstrate that, with the application of known stimuli, the payload will produce the expected responses. At lower levels of assembly, the test shall demonstrate that, when provided with appropriate inputs, internal performance is satisfactory and outputs are within acceptable limits. Redundant circuit performance and critical-fault protection shall be verified.

4.5.3 Failure-free performance. Programs shall set a total hour "failure-free" performance requirement tailored to hardware classification, criticality, and mission-reliability goals. At the conclusion of the performance verification program, payloads shall have demonstrated this failure-free performance. Subsystem testing may be included. Failure-free operation during the thermal-vacuum test exposure may also be included. Major hardware or software changes during or after verification shall require re-verification of the affected items.

4.5.4 End-to-end compatibility tests and mission simulations.

a. Compatibility tests. End-to-end compatibility tests encompassing all payload operations occurring during all mission modes shall be conducted to ensure the system will fulfill mission requirements. The mission environment shall be simulated as realistically as possible, and the instruments shall receive stimuli similar to that to be received during the mission. The radio frequency links, ground-station operations, and software functions shall be exercised. Acceptable simulation facilities may be used for the test of portions of the operational systems. The software development schedule for delivery of fully qualified flight software shall be based on the end-to-end compatibility test need date, and not the launch date. This is to allow for compatibility testing of the flight hardware with the flight software in comprehensive performance tests.

b. Mission simulations. After compatibility between the network and the user facility has been verified, data flow tests shall be performed that exercise the total system. Once the data flow paths have been verified, mission simulations shall be enacted to validate nominal and contingency mission operating procedures and to provide for operator training. To provide sufficient time for checkout of the Payload Operations Control Center, it is essential that users participate in mission simulations throughout all stages of the process.

4.5.5 Life test program. A life test program on a dedicated article shall be implemented for critical mechanical and electrical elements that have limited lifetimes. Such elements include mechanical items that move or rotate repetitively and electrical items, such as motors, batteries, solar arrays, and lamps, having usefulness which is limited to a specified time or number of cycles. The verification plan shall address the life test programs by specifying the elements that require such testing, and by describing the test hardware and methods that shall be used.

4.5.6 Mass properties verification. Hardware mass property requirements (weight, center of gravity, moments of inertia, balance) are mission-dependent and shall be determined on a case-by-case basis. The mass properties program shall include an analytical assessment of the payload's ability to comply with the mission requirements, supplemented as necessary by measurement.

5. GUIDANCE

(This section contains information of a general or explanatory nature which may be helpful but is not mandatory.)

5.1 Intended use. This standard defines a common basis from which test programs are to be developed for NASA payloads. The “common basis” is presented in the form of a test requirements matrix that defines the types of tests that are required and at which level of assembly; where the analysis may be employed in lieu of testing; and the special conditions that apply in some cases for a test to be required. This standard is directed to the protoflight project approach, which is the NASA baseline for payloads, and includes hardware developed in-house or under contract, and payloads launched on expendable or reusable launch vehicles.

Excluded from this standard are payloads launched on sounding rockets, balloons, and aircraft, as well as the launch vehicle hardware itself. Under specified conditions, tailoring of a test program is allowed, but the Project must document all deviations and the rationale for taking such action.

5.2 Key word listing

EMC
Functional
Mechanical
Payload
Protoflight
Spacecraft
Test requirements
Thermal