JSC Design and Procedural Standards

Engineering Directorate

October 2011

(This document supersedes JPR 8080.5 JSC Design and Procedural Standards, dated February, 2005.)

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Lyndon B. Johnson Space Center
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Revision	Date	Description of Change	Originator
Basic	2011_090 1	Initial Release of Document as a JSC Standard, Reference JTS CB CR# 3001	Danny Punch
DCN 1	2012_06	G-10 - Title change for clarification, G-22 Title and content change, Reference JTS CB CR# 3002	Dale Huls

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PREFACE

This document is a compilation of technical policies for human spacecraft as released through the Lyndon B. Johnson Space Center (JSC) Design and Procedural Standards activity.

The Design and Procedural Standards are located in Section 2 of this manual and are identified according to the applicable discipline or category, with letter codes as follows:

Letter Codes for Standards

G	General
E	Electrical
F	Fluids
M/P	Materials and Processes
M/S	Mechanical and Structural
P	Pyrotechnics

Comments and questions regarding this document should be directed to the JSC Technical Standards Control Board (JTS) Executive Secretary or the JTS Chair, mail code EA4, Houston, Texas 77058.

/s/ Danny Punch for

Director, Engineering

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SECTION 1

INTRODUCTION

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1.0 INTRODUCTION

1.1 PURPOSE

This document provides design and procedural requirements appropriate for inclusion in specifications for any human spaceflight program, project, spacecraft, system, or end item. The term “spacecraft” as used in the standards includes launch vehicles, orbital vehicles, non-terrestrial surface vehicles, and modules. The standards are developed and maintained as directed by Johnson Space Center (JSC) Policy Directive JPD 8080.2, JSC Design and Procedural Standards for Human Space Flight Equipment.

1.2 SCOPE

The Design and Procedural Standards contained in this manual represent human spacecraft design and operational knowledge applicable to a wide range of spaceflight activities. These standards are imposed on JSC human spaceflight equipment through JPD 8080.2. Designers shall comply with all design standards applicable to their design effort.

1.3 BACKGROUND

The Design and Procedural Standards activity was established to develop technical and procedural policies for human spaceflight programs. Originally published in 1964, the Standards manual has been revised periodically. Because of agency document management changes over the years, the letters in front of 8080.5 have changed many times over the years without affecting the standards contained within the document.

1.4 JSC TECHNICAL STANDARDS CHANGE BOARD

The JSC Technical Standards (JTS) Change Board was established by JPD 8080.2 and charters by EPC 2104.00, Charter of the JSC Technical Standards Control Board, EA-07-028 to perform and administer the technical standards activity at the Johnson Space Center.

The JTS membership represents the various technical and operations disciplines involved in past and present human spaceflight activities at JSC. Each standard is assigned to the most knowledgeable and appropriate organization and the organization assigns a Lead Engineer for ownership.

1.5 DEVELOPMENT OF STANDARDS

Any JSC employee may propose a new JSC standard or a revision to an existing standard. Proposed new standards and revisions to existing standards will be submitted to the JTS. A Lead Engineer and Lead Organization will be identified for each new standard.

Standards will be submitted on the appropriate JTS change form. The change form identifies a revision, a proposed cancellation, or the inclusion of a new standard.

Supporting or background information should be enclosed with the change.

1.6 CANCELLED STANDARDS

Standards may be cancelled following the same process for new and revised standards. Cancelled standards are not deleted from this document so that the standard can be returned to active status. All cancelled standards are removed from the main body of this document and placed in Appendix B. The rationale for canceling the standard is documented on the standard itself, as well as in the JTS configuration management records.

1.7 WAIVERS

Standards may be waived by obtaining approval of the NASA Technical Authority and the Program/Customer Control Board (CCB) that controls the requirements specification for the project or program. The waiver process is defined in other agency documentation. Waivers are not required for

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standards that are determined to be "not applicable." This applicability is coordinated with the Safety and Mission Assurance Directorate.

1.8 JSC DESIGN AND PROCEDURAL STANDARDS NUMBERING

JSC Design and Procedural Standards are categorized into logical groupings and numbered consecutively, within their respective categories, as they are released, revised, or cancelled. The standards are listed in this manual in numerical order within their respective categories (see paragraph 1.11 below as well as the sections comprising Section 2). Standards appear in only one category and are not repeated, even if appropriate for another category. As an example, some electrical standards are found in the general section. The user should be familiar with all standards.

1.9 ISSUE DATES AND REVISION HISTORY

For updated standards, the information block at the top of each standard reads: “Effective as of”. For cancelled standards, the information block reads: “Cancelled”.

To trace the revision history of each standard, please refer to Appendix A where original effective dates and revision dates are located for each standard.

1.10 LISTING IN KEY WORD INDEX

Key words selected to aid in searching for relevant standards are presented in alphabetical order as a Key Word Index (see Section 3) with a listing of the standards applicable to each word. For each standard, the Statement of Standard provides the requirements. The fact that a standard may not be listed under a specific word or category does not relieve JSC organizational elements of the responsibility for applying the requirement.

1.11 LIST OF STANDARDS

JSC Design and Procedural Standards are listed below in numerical order within their respective categories. The categories are General (G), Electrical (E), Fluids (F), Materials and Processes (M/P), Mechanical and Structural (M/S), and Pyrotechnics (P). Active standards are located in the Section 2. Cancelled standards are located in Appendix B Cancelled Standards.

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SECTION 2

DESIGN AND PROCEDURAL STANDARDS

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2.1. General

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Equipment Accessibility for Maintenance	Document No. JSC-STD-8080.5	Standard No. G-1	Page 1 of 1
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STATEMENT OF STANDARD

Systems, subsystems, equipment, and components shall be designed with features that contribute to the ease and rapidity of maintenance.

Equipment expected to require servicing, replacement, or maintenance shall be designed to be accessible without removal of other equipment, wire bundles, and fluid lines. This should include accessibility during ground operations (horizontal and vertical) as well as on orbit.

Electrical connections and cable installations shall be designed with sufficient flexibility, length, and protection to permit disconnection and reconnection without damage to wiring or connectors.

Panel-mounted displays and controls that are inside the habitable areas shall be capable of being totally maintained from the habitable area. Each display and control installation shall be designed to permit removal and replacement without disturbing the validity and integrity of other components or subsystems.

REMARKS

The version updated in October 2004 modifies the text to align better with longer-term maintenance activities encountered on longer duration space missions such as the International Space Station or exploration missions

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Separation of Redundant Systems	Document No. JSC-STD-8080.5	Standard No. G-2	Page 1 of 1
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STATEMENT OF STANDARD

Redundant systems, redundant subsystems, and redundant major elements of subsystems (such as assemblies, panels, power supplies, tanks, controls, and associated interconnecting wiring and fluid lines) shall be separated or protected to ensure that an unexpected event which damages one is not likely to prevent the other from performing the functions.

Electrical wiring of redundant systems, redundant subsystems, or redundant major elements of subsystems shall not be routed in the same wire bundle or through the same connector with wiring of the other redundant system, subsystem, or subsystem element.

This standard is not applicable to redundant components or piece parts mounted in common housings within redundant systems, subsystems, or subsystem elements.

This standard does not apply to redundant explosive charges that are located adjacent to each other in order to sever structural members at a given point or along a given line. However, the electrical wiring of redundant systems and routing shall apply.

REMARKS

For purposes of this standard, "redundancy" is defined as the ability to perform a function by more than one means.

This recommended separation for electrical wiring also applies to fluid lines.

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Electrical and Fluid Systems Checkout Provisions	Document No. JSC-STD-8080.5	Standard No. G-3	Page 1 of 1
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Electrical and fluid systems and subsystems shall be designed to permit checkout tests and shall include provisions (e.g., test points) that permit these checkout tests to be conducted without disconnecting any tubing, mated flight couplings, or any other mated flight connectors.

Test points shall allow checkout of the system without loss of integrity (e.g., loss of pressure, leakage, loss of continuity, etc.).

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Protection From Debris - Electrical & Mechanical Systems	Document No. JSC-STD-8080.5	Standard No. G-4	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005:	

STATEMENT OF STANDARD

Electrical and mechanical systems shall be shielded in such a way that encounters with debris or foreign material do not cause a malfunction. Acceptable methods include, but are not limited to, the following:

1. Design and fabricate electrical circuitry to prevent the establishment of unwanted current paths from such debris.
2. Provide critical electrical items with debris-proof covers, suitable containers, housings, potting, or conformal coatings.
3. Provide critical mechanical systems with debris-proof covers, shrouds, or containers that protect the entire system prior to use, or that prevent debris from entering into critical areas of the mechanism where the debris could cause binding, jamming, or seizing.
4. Incorporate filters, strainers, traps, screens, or other devices in moving-fluid components of electrical or mechanical systems to trap debris in a manner that will eliminate it as a threat to critical mechanical or electrical components. In systems where flow reversal may occur, install such devices on both sides of critical components. Make sure all such devices are able to be cleaned in-flight and/or are able to be replaced as part of the maintenance program.

REMARKS

Refer to G-5 for prevention of debris.

Crew cabin module ventilation fans are low pressure-drop devices with small clearances between blades and duct to maximize efficiency and minimize power consumption. Under microgravity conditions ventilation systems are particularly prone to blockage due to particulates. International Space Station ventilation systems suffered up to 80% reduction in flow due to the entrainment of clusters of particulate or fibrous debris in the ventilation systems. This debris penetrated through a protective screen with .02-inch diameter hole size, but then combined to block internal flow paths with .125-inch diameter. Because simple screens have been shown to be ineffective in long duration protection of ventilation systems in microgravity, depth filters should be used to protect ventilation systems from particulate fouling for long-duration missions. A similar phenomenon can occur in liquid media systems where particulates chemically combine downstream of the filter to produce larger than screen-size debris clumps. These systems should be assessed for the use of depth filters or more effective chemical filters.

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Prevention Of Debris - Electrical & Mechanical Systems	Document No. JSC-STD-8080.5	Standard No. G-5	Page 1 of 1
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STATEMENT OF STANDARD

A Foreign Object Debris (FOD) prevention program shall be established for all ground operations of mechanical and electrical systems of flight hardware including the design, development, manufacturing, assembly, repair, processing, testing, maintenance, operation, and check out of the equipment to ensure the highest practical level of cleanliness.

The FOD prevention program shall conform to NAS 412 "Foreign Object Damage/ Foreign Object Debris (FOD) Prevention".

REMARKS

Refer to G-4 for protection from FOD.

NAS 412 is available through NASA Technical Standards Program at Marshall Space Flight Center.

Refer to JSC 49774 "Standard Manned Spacecraft Requirements for Materials and Processes", paragraph 4.2.9 for selection of materials to prevent growth of biological contaminants.

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G-6 – G-7 have been cancelled.

See Appendix B for standard text and rationale for cancellation.

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Design for Redundancy Verification	Document No. JSC-STD-8080.5	Standard No. G-8	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005:	

STATEMENT OF STANDARD

Spacecraft systems, subsystems, and equipment shall be designed to permit verification of redundant functions or operational modes any time the system, subsystem, or equipment requires testing prior to launch or during the mission.

REMARKS

This standard is not to be interpreted to require verification of redundancy every time the system, subsystem, or equipment is tested but merely to require that the systems/subsystems/equipment be designed in a manner to allow redundancy verification if it is deemed necessary. Verification of redundancy may occur at any time from acceptance testing through launch processing, mission operations, and post flight.

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Shatterable Material - Exclusion	Document No. JSC-STD-8080.5	Standard No. G-9	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005:	

STATEMENT OF STANDARD

Shatterable materials shall not be used in the habitable compartment unless positive protection is provided to prevent fragments from entering the cabin environment.

Photographic, optoelectronic, and television lenses are exempt from this standard when in use, but they shall be protected by suitable covers when not in use.

This standard is also applicable to nonflight hardware or ground support equipment (GSE), including wiring and tubing that is carried on or used in the habitable compartment subsequent to start of equipment installation, at the contractor's facility or in a Government facility.

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Time/Cycle Critical Part Control	Document No. JSC-STD-8080.5	Standard No. G-10	Page 1 of 1
	Previous Revision 2011_101	Current as of 2012_06	

STATEMENT OF STANDARD

Spacecraft components which are time-critical and/or cycle-critical or which have limited storage life shall be subject to the following controls:

1. Each time-critical or limited-life assembly, subassembly, component, and spare shall be clearly and indelibly marked with a serial number.
2. Appropriate documentation shall accompany all time-critical and limited-life items and shall include the date of manufacture of the item and of its most time-critical component. Realistic life limits shall be assigned and documented for each item and shall be suitably altered as new data and new evidence are obtained.
3. Status records shall be maintained on all such items after installation in the spacecraft. Operating-time logs shall be maintained for all items having limited operating lives. Components shall have sufficient life remaining to adequately support mission requirements.
4. Special storage requirements shall be carefully defined and strictly observed.

A time-age-life cycle database shall be maintained for verification (and notification) of time-age-life component status.

REMARKS

This requirement may be satisfied by the inventory management subsystem of the onboard data management system.

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Procurement Document Identification For Human Spaceflight Items	Document No. JSC-STD-8080.5	Standard No. G-11	Page 1 of 2
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Purchase requests (PRs), requests for proposal (RFPs), purchase orders (POs), credit card purchases, contracts, and subcontracts for items procured for use in human spaceflight shall be submitted with the statement shown below.

The information shall be printed, stamped, or added in boldface type.

> FOR USE IN HUMAN SPACEFLIGHT, MATERIALS, MANUFACTURING, AND WORKMANSHIP OF HIGHEST QUALITY STANDARDS ARE ESSENTIAL TO ASTRONAUT SAFETY.
>
> IF YOU ARE ABLE TO SUPPLY THE DESIRED ITEMS WITH A QUALITY WHICH IS HIGHER THAN THAT OF THE ITEMS SPECIFIED OR PROPOSED, YOU ARE REQUESTED TO BRING THIS FACT TO THE IMMEDIATE ATTENTION OF THE PURCHASER.

Procedures shall assure that new PRs, RFPs, POs, contracts, and subcontracts issued by prime contractors and their subcontractors down to the lowest tier include this information. Present contracts and subcontracts involving such hardware shall be amended at the earliest possible date to require the prime contractor or subcontractor to establish such procedures in all actions covering new procurement.

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Procurement Document Identification For Human Spaceflight Items	Document No. JSC-STD-8080.5	Standard No. G-11	Page 2 of 2
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REMARKS

For referral, here is the content of NASA FAR Supplement clause 1852.246-73, Human Space Flight Item.

1852.246-73 Human Space Flight Item.

As prescribed in 1846.370(b), insert the following clause:

HUMAN SPACE FLIGHT ITEM

(MARCH 1997)

The Contractor shall include the following statement in all subcontracts and purchase orders placed by it in support of this contract, without exception as to amount or subcontract level:

"FOR USE IN HUMAN SPACE FLIGHT; MATERIALS, MANUFACTURING, AND WORKMANSHIP OF HIGHEST QUALITY STANDARDS ARE ESSENTIAL TO ASTRONAUT SAFETY.

IF YOU ARE ABLE TO SUPPLY THE DESIRED ITEM WITH A HIGHER QUALITY THAN THAT OF THE ITEMS SPECIFIED OR PROPOSED, YOU ARE REQUESTED TO BRING THIS FACT TO THE IMMEDIATE ATTENTION OF THE PURCHASER."

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Application Of Previous Qualification Test Data	Document No. JSC-STD-8080.5	Standard No. G-12	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

When certifying an item for a new application, use of qualification test data obtained during a previous certification shall meet the following conditions prior to use:

1. There is no change in design and specifications from the original item certified including operating limits, weight, dimensions, materials, performance and tolerance, reliability, and quality.

2. The configuration (part number and dash number) previously tested is identical to the configuration proposed for the new application.

3. Manufacturing/Fabrication methods and process have not changed and are certified

4. Previous environmental test conditions are greater than or equal to the environmental extremities and exposure durations required for the new application.

5. Previous functional/performance test results are greater than or equal to the accuracy, input-output, sensitivity, and other performance/operational characteristics required for the new application.

6. The previous test configuration is documented and is considered an adequate methodology/technology to provide test results for the new application.

7. Previous test equipment tolerances and data resolution are documented.

8. Inspection methods, inspection points, and acceptance test procedures are greater than or equal to the rigor of previous methodologies.

9. Previous operating environments, exposure duration, cycling, and usage are greater than or equal to the operations concept required for the new application.

10. Previous failures have been evaluated for impact to the validity of test and analysis data

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Application Of Previous Qualification Test Data	Document No. JSC-STD-8080.5	Standard No. G-12	Page 2 of 2
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REMARKS

Flight Certification of any item involves evaluation of verification data to determine if customer requirements have been met. When some of that data is already available from a prior flight certification program, and the appropriate technical evaluation determines that the data can be used to support a new certification program, it is cost effective to use existing data instead of performing additional testing. Previous failures and waivers must be reconsidered or resubmitted for approval by the authorizing organization. Environmental testing typically refers to vibration, thermal, thermal vacuum, radiation, loads, and electromagnetics.

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See Appendix B for standard text and rationale for cancellation.

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Classification of Flight and Non-Flight Equipment	Document No. JSC-STD-8080.5	Standard No. G-14	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

The status of flight equipment and nonflight equipment (equipment which is not suitable for use in flight but which could be accidentally substituted for flight articles) shall be identified and classified as follows:

CLASS I Equipment acceptable for flight use. Identification shall be in accordance with drawings and specifications.

CLASS II Equipment acceptable for use in ground tests or training in a hazardous environment. The nameplate or a label adjacent to the nameplate shall be conspicuously marked "CLASS II, CONTROLLED EQUIPMENT" with flight compatible material.

CLASS III Equipment acceptable for nonhazardous training or display purposes. This equipment shall be conspicuously identified by red (or orange) stripes alternating with a contrasting base color or painted solid red. Red paint no. 28913 as specified by Federal standard 595A is the preferred color. An alternative to the paint method of identification is a red (or orange) striped nameplate or label marked "CLASS III, NOT FOR FLIGHT" applied to the equipment. The identification shall be visible when the equipment is installed.

In addition, equipment not readily identifiable as nonflight equipment, as well as nonflight equipment hidden from view in a major module, shall have a red (or orange) serialized streamer attached to, or in the immediate vicinity of the installation. The streamer shall be of a size and material compatible with the environment under which it will be used. Streamers are to be traceable to the major module which identifies and controls the item. A record of nonflight equipment and, if appropriate, associated streamer serial numbers shall accompany each major module upon formal transfer (i.e., DD250/1149) from one organization to another.

Appropriate instructions shall be printed on each streamer. Streamers shall be numbered and accounted for prior to launch.

The color coding requirements of this standard do not apply to explosive devices.

REMARKS

Nonflight equipment or hardware must be identified to preclude possible use during a flight mission.

Hazardous environment is defined as a chamber environment (such as vacuum, high temperature, low temperature, and oxygen-rich atmosphere) or any other environmental condition that could subject the user of the equipment to a hazard of any kind.

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Resolution of Flight Equipment Failures/Anomalies Prior to Launch	Document No. JSC-STD-8080.5	Standard No. G-15	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Where flight or flight-like equipment has failed or otherwise exhibited anomalous performance or intermittent operation, launch-to-orbit of identical or like equipment, either as part of the flight vehicle or as a replacement, shall not be permitted unless one of the following occurs:

1. It is verified that the basic deficiency which caused the failure or anomalous performance is not present in the flight equipment or its replacement.
2. The basic deficiency has been counteracted by changes in operational procedures to a degree that eliminates it as an unacceptable risk to the success of the mission or the safety of the crew.
3. The basic deficiency does not present an unacceptable risk to the success of the mission and safety of the crew.

Do not use equipment that exhibits or has exhibited intermittent malfunctions, failures, or anomalies for flight until the malfunction, failure, or anomaly has been corrected or resolved to the satisfaction of the Flight Readiness Review Board.

REMARKS

This standard supports the current philosophy that all failures or anomalous performance must be resolved before launch.

Where the cause of an inconsistency remains unresolved, equipment is unreliable.

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Operational Limits On Temperature-Controlled Equipment	Document No. JSC-STD-8080.5	Standard No. G-16	Page 1 of 2
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

For spacecraft equipment where the operating temperature is normally controlled by heating or cooling equipment and the temperature is monitored in ground test and flight, the test program and/or appropriate analyses shall define the following:

1. The maximum and minimum temperatures expected in normal operations

2. The maximum and minimum temperatures (including duration and temperature rate of change, as appropriate) at which equipment may be expected to:

   a. Fail to meet specified performance until temperature is restored to normal range.

   b. Be permanently rendered inoperative.

For critical components, automatic safing with manual override only shall be used.

Information used to satisfy requirements 1 and 2 above shall be provided in operational constraints documentation.

REMARKS

Knowing the maximum and minimum operating limits of spacecraft equipment is essential for flight and mission management. This information needs to be readily available for real time decision-making.

Item #1:
This information is needed for equipment characterization and could be used for recognizing a thermal malfunction within the spacecraft equipment.

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Operational Limits On Temperature-Controlled Equipment	Document No. JSC-STD-8080.5	Standard No. G-16	Page 2 of 2
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REMARKS CONTINUED

Item #2
This information provides guidance to NASA in an unlikely, off-nominal mission scenario that normal operating temperatures may need to be exceeded due to malfunction(s) either external or internal to the equipment. In such a scenario it may become necessary to operate equipment beyond the qualification limits and mission manager's need to know how far the equipment can be pushed and reasonably expect that the equipment can be turned off and subsequently reactivated to support the safe return of the crew. The ultimate purpose of this information is to enable flight and mission management to make the best decisions possible in an off-nominal situation to maximize the probability of safely returning the crew.

Relevant information used to form the guidelines may include data or analysis from other program or manufacturer development (from DoD to COTS), data from operational programs due to unplanned thermal conditions, similar hardware data (document similarities and contrasts, e.g. non-screened parts data), sub-part data, bench testing that was not previously documented in reports, inadvertent test conditions, etc.

The desired outcome is a set of useful temperature and duration guidelines for the deliverable units at the lowest cost. Therefore, deriving the guidelines from the best available information is preferred and supplemental high-cost testing must be approved by the Program. Engineering judgment should also be applied and documented as appropriate in meeting this requirement.

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Separate Stock For Spaceflight Parts And Materials	Document No. JSC-STD-8080.5	Standard No. G-17	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Assemblies, parts, and materials procured or designated specifically for use in space shall be:

- positively identified
- stored in controlled access areas
- physically separated from nonflight parts and materials to avoid mixing.

REMARKS

This standard is to prevent nonstandard, nonspaceflight, nonsegregated stock from being unintentionally used in space or in the fabrication of spaceflight equipment.

For purposes of this standard, the term "controlled access area" is defined as: stock areas or areas of rooms which are separated from nonflight stock areas or rooms by fences, walls, or other physical separations and which have access control to ensure the following:

1. Access by authorized personnel only

2. Proper parts and materials storage, maintenance, and withdrawal

3. Compliance with applicable quality assurance directives

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Safety Precautions - Test And Operating Procedures	Document No. JSC-STD-8080.5	Standard No. G-18	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Procedures developed for testing and operating spaceflight equipment or ground support equipment shall clearly indicate any step which, if not correctly followed, would result in injury to personnel, damage to a system or equipment, or an environmental impact.

The cover sheet of the procedure shall indicate if the test or operation is hazardous.

REMARKS

A warning statement, preceded by the word WARNING in upper use letters, is commonly used to emphasize any instructions which, if not correctly followed, would result in injury to personnel, damage to a system or equipment, or an environmental impact. The statement usually indicates the reason for the warning.

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Special Processes - Identification of Drawings	Document No. JSC-STD-8080.5	Standard No. G-19	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005:	

STATEMENT OF STANDARD

Manufacturing, assembly, or installation drawings for spacecraft, space flight equipment, experiments, and ground support equipment shall identify all special processes required to manufacture, assemble, and install the equipment.

Process specifications shall be referenced, or the processes shall be specified in detail on the respective drawings.

All referenced specifications not normally available shall be submitted upon request.

REMARKS

The requirements of this standard are in addition to other requirements of the drawing system used. The preferred method of documenting the special processes is to release separate process specifications and to make reference to the specifications on the drawings.

Examples of special processes are cleaning, potting, etching, wire splicing, soldering, welding, brazing, and bonding.

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Spacecraft Equipment - Protection From Liquids During Ground Operations	Document No. JSC-STD-8080.5	Standard No. G-20	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Equipment sensitive to moisture and located where it is subject to liquid leaks during ground operations shall be identified in the design documentation. This documentation shall also include:

- The rationale for positioning the equipment in that location.
- A plan for implementing protection of this equipment.

REMARKS

Major damage to spacecraft and serious delay of programs can result from small, easily correctable leaks that would be of minor significance except for the effect of the leakage on exposed equipment. Experience has shown that fluid system leaks are particularly prevalent during initial ground testing of new spacecraft.

Sources of moisture and liquid leaks may include systems fluids, water condensation, fluid from GSE or facilities, and natural phenomena.

Protection from damage by leakage may include one or more of these methods:

1. Designing the equipment to be insensitive to the liquid leakage
2. Designing the plumbing or equipment containing the liquid to locate couplings, vents, service points, and other items where leakage from them could not reach the sensitive equipment
3. Providing ground support equipment or devices to protect the sensitive equipment from leakage during ground operation
4. Providing proper insulation to prevent condensate from forming and subsequently falling on the equipment

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Spacecraft Equipment - Moisture Protection	Document No. JSC-STD-8080.5	Standard No. G-21	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Spacecraft equipment within a pressurized compartment shall be designed so that performance of the equipment will not be degraded by humidity or moisture droplets in the spacecraft atmosphere or by condensation of moisture from the spacecraft atmosphere.

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Product Identification and Traceability	Document No. JSC-STD-8080.5	Standard No. G-22	Page 1 of 2
	Previous Revision 2011_10	Current as of 2012_06	

STATEMENT OF STANDARD

1. Product shall be identified by suitable means throughout its lifecycle in accordance with customer and/or regulatory requirements.
2. Where traceability is a customer and/or regulatory requirement, the organization controls and records for the unique identification of the product shall be documented in accordance with JPR 1440.3.
3. For all JSC GFE for which JSC is the design authority, serial and/or lot numbers shall be provided by the Engineering Document Control Center (EDCC) per JPR 8500.3H. EDCC-controlled serial and lot numbers may be assigned to engineering drawings with non-JSC numbers only if the design authority and the configuration management of the design has been transferred to JSC.
4. Records shall be maintained to preclude duplication of serial or lot numbers. Reference JPR 8500.4 for policies defining allowable values for serial and lot number assignment for JSC GFE.
5. Requirements on GFE products for a serial and/or lot number shall be established per NASA-STD-0005.
6. The engineering drawing shall document the method of marking and desired location for part identification on GFE parts, if applicable, per JPR 8500.4.
7. The organization initiating the manufacturing or purchase request shall obtain serial and/or lot numbers from the EDCC and specify specific serial and/or lot numbers on manufacturing or purchase requests, but not on drawings.
8. For critical and complex GFE hardware, the following additional requirements shall be met:
   a) The design authority/hardware owner maintains the identification of the configuration of the product in order to identify any differences between the actual configuration and the agreed configuration.
   b) According to the level of traceability required, the design authority/ hardware owner provides for:
      (1) Identification to be maintained throughout the product life;
      (2) All of the products manufactured from the same batch of raw material or from the same manufacturing batch to be traced, as well as the destination (delivery and scrap) of all products of the same batch;
      (3) An assembly, the identity of its components, and those of the next higher assembly to be traced;
      (4) For a given product, a sequential record of its production (manufacture, assembly, inspection) to be retrievable.

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G-22 Parts Identification	Document No. JSC-STD-8080.5	Standard No. G-22	Page 2 of 2
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Continued from previous page

9. Parts used in flight hardware shall be identified by physical part marking or container marking per requirements defined on the applicable drawing.

10. Hardware drawings shall include identification processes necessary to control parts until installed in an assembly.

REMARKS

These requirements are intended to meet system engineering configuration management practices, the JSC quality system requirements (including ISO and AS9100), and FAR requirements.

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Pressure Garment Wiring - Ignition Of Materials By Electrical Current	Document No. JSC-STD-8080.5	Standard No. G-23	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Electrical current entering a crew member's pressure garment shall be limited to a level that will not ignite or damage materials that would contact damaged wiring within the garment under the worst combination of short-circuit current and environment.

Energy storage or conversion devices capable of producing short-circuit current of a magnitude and discharge rate sufficient to ignite materials shall not be located inside pressure garments, unless:

1. adequate current limiting is provided, or
2. there is no contact between potentially damaged wires and the material in question

REMARKS

In this standard, "no contact" is defined as no electrically conductive path.

The fire hazard associated with inclusion of communications and bioinstrumentation wiring in the oxygen-rich environment of pressure garments necessitates the analysis and selection of suitable materials to minimize the potential flammability hazard. It is necessary to confirm the compatibility of the materials and electrical currents under failure conditions in the planned oxygen environment.

Current limiting may be required to assure values below the threshold level for ignition of materials caused by arcing or heating from high-resistance heat sources. An alternative to current limiting is strategic materials placement to ensure that flammable materials, that are demonstrated to ignite at the use conditions, are prevented from contacting potentially damaged electrical wiring or componentry.

Selection of materials with suitable flammability characteristics is constrained by other requirements, such as flexibility, bulk, weight, and comfort of the crew.

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Protecting Flight Equipment From Support Equipment	Document No. JSC-STD-8080.5	Standard No. G-24	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Ground support equipment (GSE), airborne support equipment (ASE), facility equipment, or test equipment used in ground or flight operations shall be equipped with protective devices to preserve safe operation margins of the flight equipment.

REMARKS

GSE or ASE, as a result of misuse or malfunction, has the potential for causing irreparable damage to spacecraft flight systems if the GSE or ASE does not incorporate design features for protecting against such eventualities.

All GSE and ASE designs should be evaluated from the standpoints of inadvertent operator error and hardware (component) malfunction to ensure that protective features are adequate to safeguard spacecraft subsystems. Consideration should be given to the need for not only static overload protection (such as pressure relief, electrical fuses, etc.) but also protection from such elements as dynamic or transient conditions (e.g., electronic filters, accumulators) or contaminants (e.g., contaminant filters).

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Thermal Design And Analysis	Document No. JSC-STD-8080.5	Standard No. G-25	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Hardware shall be designed to function in the full range of the thermal environment to which it will be exposed.

Thermal analyses shall be performed for nominal and worst-case conditions for all temperature-sensitive components and structures.

Worst hot and cold cases shall be analyzed using realistic combinations of thermal parameters which produce the worst-case conditions.

REMARKS

Example: A solar constant with 3 percent seasonal variation will be used. Other heat flux impacts, solar absorptances, emittances, conductances, etc. will be varied to include measurement uncertainties, variations in application of coatings, and degradation. Boundary temperatures and heater voltages will be varied over the ranges expected.

Thermal analysis includes both transient and steady state.

This standard incorporates SSP 30213 no. G-25.

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Internally-Generated Radiation	Document No. JSC-STD-8080.5	Standard No. G-26	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Laser sources sufficiently powerful to be a hazard shall be positioned to preclude the possibility of looking directly at the source.

Sources emitting electromagnetic wavelengths between x-ray and visible light, sufficiently strong to pose a hazard, shall be positioned to preclude crew exposure or touch.

Hazard distance shall be marked.

REMARKS

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Fire Control	Document No. JSC-STD-8080.5	Standard No. G-27	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

The primary means of fire control shall be the selection of materials that are nonflammable or nonpropagating in their use configuration. Materials flammability control is addressed in Standard M/P-1.

The capability for fire detection and suppression shall be provided.

The material used to extinguish fires shall be nontoxic to humans and shall be capable of being easily cleaned up after it is used.

REMARKS

Fire, particularly in a space vehicle, can be catastrophic. Special precautions are necessary, more so than on earth, because countermeasures must be self-contained within the space vehicle.

In microgravity conditions, fires that are not actively fed with oxygen will self-extinguish. One fire control strategy is to eliminate ventilation, remove electrical power, evacuate personnel, and allow the fire to self-extinguish.

Fire-resistant storage should be provided for hardware that is controlled for flammability by stowage when not in use.

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Sealing - Solid Propellant Rocket Motors	Document No. JSC-STD-8080.5	Standard No. G-28	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

On completion of final inspection following manufacture, each solid propellant rocket motor shall be sealed and pressurized to prevent damage due to entry of moisture or foreign material.

The pressurant shall be dry N_2 gas.

The pressure applied shall be sufficient to ensure against entry of contaminants under any anticipated storage conditions.

The seal shall be designed to withstand internal pressure corresponding to the maximum anticipated storage temperature with an adequate safety factor or shall include a relief device.

The seal shall be installed such that it can be expelled during normal rocket ignition without damage to the nozzle. If no other provisions can be made to inspect the grain, access shall be provided through the seal.

REMARKS

The seal may contain provisions for relief of pressure, pressurizing, and pressure gauge installation as necessary.

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Reentry Propulsion Subsystem In-Flight Test	Document No. JSC-STD-8080.5	Standard No. G-29	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Crewed spacecraft which use a separate propulsion subsystem for reentry attitude control shall include means for testing this subsystem before jettisoning the last of any other attitude control systems which could be used to position the spacecraft in a reentry attitude.

REMARKS

Control circuitry and attitude cues should be developed to enable the crew to test the reentry propulsion subsystem of the reentry module before abandoning an operating attitude control subsystem.

This standard is not applicable for spacecraft without a separate propulsion subsystem for reentry attitude control. For such cases, refer to the following document and sections:

NPR 8705.2 Human-Rating Requirements and Guidelines for Space Flight Systems w/Change 2 (6/25/04) [Effective Date: June 19, 2003, Expiration Date: June 19, 2008]:

1. Preface, Applicability, p.2.
2. Section 2.5.3 Failure Tolerance and Reliability:
    a. Subsections 2.5.3.1
    b. Subsection 2.5.4.4

This standard does not preclude the need for redundant reentry attitude control systems.

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G-30 has been cancelled.

See Appendix B for standard text and rationale for cancellation.

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Detachable Crew-Operated Actuating Tools	Document No. JSC-STD-8080.5	Standard No. G-31	Page 1 of 1
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Where possible, actuating devices shall be made an integral part of the equipment to be operated.

Detachable actuating tools, such as handles, pins, and ratchets, shall not be permitted in applications where tool nonavailability could compromise crew safety or primary mission objectives.

Where tools are allowed for system controls, provisions shall be made whereby the position of the control is readily apparent to the responsible crew member without the tool in place.

REMARKS

Detachable tools are generally undesirable for all applications in the crew compartment under zero-gravity conditions, but such devices may be used if a significant advantage in operation, weight reduction, or volume reduction is assured and if their application does not conflict with the constraints outlined above.

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Standards G-32 – G-36 have been cancelled.

See Appendix B for standard text and rationale for cancellation.

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Verification Of External Visibility	Document No. JSC-STD-8080.5	Standard No. G-37	Page 1 of 2
	Previous Revision 04/01/1991	Current as of 08 March 2005	

STATEMENT OF STANDARD

Visibility verification for crewed spacecraft shall include tests, simulations, or analyses to verify visibility during all anticipated phases and environmental conditions of the planned mission and contingencies.

Simulations shall include mockups or high-fidelity computer simulation to ensure the view (picture) seen by the crew during each phase of the simulated mission will be comparable to that which will be seen in flight.

REMARKS

Whenever possible, visibility verification tests should incorporate actual flight hardware.

The external visibility may be provided using windows, external cameras, or alternative capability.

During previous crewed spaceflight missions, visibility problems have occurred. Deposits have covered windows. Visibility has been restricted by parts of the spacecraft during certain mission phases. Light gathering properties of some optical instruments have not been satisfactory. Reflections and parallax have caused difficulty. Moisture has condensed between inner and outer panes of windows. Fingerprints and smear marks have compromised optical surfaces.

Factors affecting satisfactory visibility include but are not limited to:

1. Visibility and field-of-view requirements during each phase of the intended mission and for all anticipated contingencies.

2. Protection or preventive measures to avoid unsatisfactory degradation of visibility due to buildup of solid or liquid deposits on all window surfaces, viewing ports, or other optical devices.

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