Designation: E 1997 – 99 (Reapproved 2003)$^{\epsilon 1}$

Standard Practice for the Selection of Spacecraft Materials[1]

This standard is issued under the fixed designation E 1997; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

ϵ[1] NOTE—Keywords were added editorially in October 2003.

1. Scope

1.1 The purpose of this practice is to aid engineers, designers, quality and reliability control engineers, materials specialists, and systems designers in the selection and control of materials and processes for spacecraft, external portion of manned systems, or man-tended systems. Spacecraft systems are very different from most other applications. Space environments are very different from terrestrial environments and can dramatically alter the performance and survivability of many materials. Reliability, long life, and inability to repair defective systems (or high cost and difficultly of repairs for manned applications) are characteristic of space applications. This practice also is intended to identify materials processes or applications that may result in degraded or unsatisfactory performance of systems, subsystems, or components. Examples of successful and unsuccessful materials selections and uses are given in the appendices.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E 595 Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

G 64 Classification of Resistance to Stress-Corrosion Cracking of Heat-Treatable Aluminum Alloys

2.2 *Marshall Space Flight Center (MSFC) Standard:*

MSFC-SPEC-522 Design Criteria for Controlling Stress Corrosion Cracking[3]

2.3 *Military Standards:*

MIL-STD-889 Dissimilar Materials[4]

MIL-HDBK-5 Metallic Materials and Elements for Aerospace Vehicle Structures[4]

2.4 *European Space Agency (ESA) Standard:*

PSS-07/QRM-0 Guidelines for Space Materials Selection[5]

2.5 *Federal Standard:*

QQ-A-250 Aluminum and Aluminum Alloy Plate and Sheet, Federal Specification for[4]

3. Significance and Use

3.1 This practice is a guideline for proper materials and process selection and application. The specific application of these guidelines must take into account contractual agreements, functional performance requirements for particular programs and missions, and the actual environments and exposures anticipated for each material and the equipment in which the materials are used. Guidelines are not replacements for careful and informed engineering judgment and evaluations and all possible performance and design constraints and requirements cannot be foreseen. This practice is limited to unmanned systems and unmanned or external portions of manned systems, such as the Space Station. Generally, it is applicable to systems in low earth orbit, synchronous orbit, and interplanetary missions. Although many of the suggestions and cautions are applicable to both unmanned and manned spacecraft, manned systems have additional constraints and requirements for crew safety which may not be addressed adequately in unmanned designs. Because of the added constraints and concerns for human-rated systems, these systems are not addressed in this practice.

4. Design Constraints

4.1 *Orbital Environment*—The actual environment in which the equipment is expected to operate must be identified and defined. The exposures and requirements for material performance differ for various missions. Environment definition includes defining the range of temperature exposure, number and rate of thermal cycles, extent of vacuum exposure, solar electromagnetic radiation particulate radiation, (trapped by the earth's magnetosphere, solar wind, solar flares, and gamma rays) micrometeroids, launch loads and vibration, structural loads, and so forth. Materials suitable for one orbit or mission

[1] This practice is under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.05 on Contamination.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Marshall Space Flight Center, AL 35812.

[4] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[5] European Space Agency, 8–10, Rue Mario-Nikis, 75738 Paris Cedex, France.

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