PREFERRED RELIABILITY PRACTICES

ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS SELECTION CRITERIA FOR FLIGHT SYSTEMS

Practice:

Use highest reliability EEE parts available, consistent with functional requirements, program cost, and schedule constraints, for spaceflight systems.

Benefit:

One of the most important considerations in designing reliable flight hardware is selection and use of the highest quality possible components. Proper selection, application, and testing of EEE components will generally contribute to mission success and provide long term program cost savings. An effective EEE parts program has helped many projects in achieving optimum safety, reliability, maintainability, on-time delivery, and performance of program hardware. The resulting reduction in parts and part-related failures saves program resources through decreased failure investigation and maintenance costs.

Programs That Certified Usage:

Many at all NASA Centers.

Center to Contact for More Information:

GSFC, JSC, LaRC, LeRC, KSC, or JPL

Implementation Method:

The selection of EEE parts should be driven by performance demands, environmental and circuit application, reliability, and maintenance allocations defined by the equipment specification. EEE parts should be selected based on the suitability for their applications and proven qualifications to the requirements of their specifications. Selection of standard EEE parts when required or where feasible, will help minimize the number of styles and generic types and will provide parts with proven technologies and inherent reliability features.

Program Requirements Documents (PRDs) for the various NASA hardware usually includes EEE parts selection criteria, including definitions of standard and nonstandard parts. There is an order of precedence for selection of EEE parts that range from MIL-STD-975 grade 1 parts down to commercial off-the-shelf parts / hardware. When standard parts are required by the PRDs, but the design requirements cannot accommodate any of the parts listed in MIL-STD-975, there is a provision for submittal of

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a nonstandard part approval request (NSPAR). A NSPAR request is made and approved prior to procurement and use of the part in the design.

1. ***Standard Parts***

a. **General**. The parts listed in MIL-STD-975 have been selected to meet the needs of a project while providing parts that are available, economical, and recognized within the parts industry as quality parts. The specifications for these parts are based largely on the Department of Defense (DoD) parts standardization program and methods. All users of MIL-STD-975 have a responsibility to inform the NASA Parts Project Office (NPPO) of the requirement for new or improved parts . NASA Headquarters has designated GSFC as the lead Center.

b. **Requirements**. Standard parts are listed in MIL-STD-975; procured in accordance with the specifications listed; processed in accordance with any special requirements shown; procured from the designated sources of supply; bear the specified part designations, and are properly classified. Parts exhibiting equivalent performance requirements and having the same generic part designation as the standard part, but not procured to the MIL-STD-975 specifications or from the qualified manufacturing sources, are not standard parts. These parts are treated as nonstandard parts. Assurance requirements for standard parts are included in the procurement specification for these parts. These requirements typically include qualification testing, in-process tests, inspections, quality conformance testing, screening, and any special processing requirements.

c. **Standard part grade levels**. MIL-STD-975 provides two levels of parts to accommodate part reliability, cost, availability, and delivery. Grade 1 parts are those which demonstrate a low failure rate. Grade 2 parts are available at a lower cost than grade 1 parts, but often exhibit higher failure rates. The requirements for grade 1 and grade 2 parts are contained in the controlling source control documents which describe the differences in part design, processing, qualification, quality conformance inspection, and screening to ensure appropriate reliability and performance.

d. **Screening.** The screening requirements for standard parts are included in the procurement specification for the part.

e. **Radiation effects**. The radiation requirements for standard parts are specified in the source control document for the part. For those parts that require radiation hardness, two important requirements need to be specified: total dose and single event effect (SEE) magnitudes.

f. **Derating.** Derating is the reduction of electrical, thermal, and mechanical stresses

applied to a part in order to decrease the degradation rate and prolong the expected life of the part. Derating increases the margin of safety between the operating stress level and the actual failure level for the part, providing added protection from system transients. All parts must be derated in their application in accordance with the PRDS derating requirements (usually MIL-STD-975, Appendix A).

2. ***Nonstandard Parts***:

a. **General.** Any part that is not listed in MIL-STD-975 is a nonstandard part. Nonstandard parts are submitted for review and final approval by the project office.

b. **Requirements**. All nonstandard parts must perform satisfactorily in the mission envelope. Risks using nonstandard parts are identified. The following steps are often taken when selecting a nonstandard part (i.e. data required to complete Form 4-15):

- Establish that the part is required for form, fit, and function.
- Prepare a source control drawing for the part if none are available.
- Identify screening and quality conformance requirements for the part.
- Develop a rationale for why the part is needed.
- Explain why this part has been accepted.
- Identify problems with the part (i.e., GIDEP ALERT or NASA TWX). (This should be completed for all parts.)
- Select and certify qualified manufacturers for the part.
- Identify radiation hardness requirements, if applicable.

c. **Processing nonstandard parts**. Nonstandard parts are divided into the following categories based upon their nearest equivalent part availability:

- *Nonstandard military parts.* Standard Military Drawing (SMD) parts that are listed in MIL-I-38535 Qualified Manufacturers List are non-standard parts unless they are listed in MIL-STD-975. Acceptance of this category of part should be considered if: (a) proper grade level of part is being used; (b) there is any reason a standard part cannot be used; (c) there are any reported problems with the part; (d) there are any additional tests, screening, or quality assurance provisions required by MIL-STD-

975 for the nearest equivalent standard part; or (e) the part meets the expected radiation environment.

- *Commercial parts.* A commercial part is any part for which the part requirements, processing, and tests are stipulated solely by the parts manufacturer and are exclusively under the manufacturer's control. Establishing qualification for these parts takes time, costs money and depends on the application, mission environment, and tailored test program. Items (a) through (e) from paragraph on nonstandard military parts should be reviewed even more carefully for these parts.

- *New improved or developed parts.* Accepting new-technology parts is somewhat difficult. It is important that their form, fit and function be necessary. They must also be qualified for the mission environment. A comprehensive qualification test program should be conducted and the test results must be examined carefully to ensure the new part meets the mission needs and that it will perform in the expected radiation environment.

- *Custom and limited-application parts.* Nonstandard parts that are intended for a custom use or for a limited application often do not have qualification data. Here again, careful study is important to ensure these parts are really necessary and if they have special form, fit or function that cannot be obtained from heritage parts. They must meet the mission environmental and radiation requirements.

The response to these items should be addressed prior to procurement and installment of the nonstandard part in the flight system.

d. **Acceptance of nonstandard parts.** If nonstandard parts are used in spaceflight systems, they should be qualified to meet the mission requirements. Nonstandard parts should be qualified to identify predominant failure modes and mechanisms. They should be screened against the known failure modes and mechanisms, to verify conformance of the electrical characteristics against the controlling procurement specification, and to assure the absence of workmanship defects. The evidence supporting their acceptance must be verified, documented, and approved by the project office. Final acceptance for procurement is the responsibility of the Project Office.

Technical Rationale:

One of the aspects affecting mission success of flight systems is the selection of standard EEE parts which have designed in reliability at the part level. This implies utilizing proven technol-

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ogy parts, procured from qualified manufacturers, and selected from an established program based on project approved parts lists which are, based on the requirements levied for the program.

A parts program assures that the selected parts, derating and testing activities are sufficient to achieve mission success for the application environment and expected life of the program. The projects are responsible for providing acceptable parts for their mission classification and for the circuit design, production, and testing to verify flight readiness.

The selection of mission classified parts for spaceflight systems is an essential part of the design of flight hardware. With the rapidly growing technologies in the microelectronics area, the selection of parts has become a challenge to designers. The selected part has to perform reliably in the application.

Impact of Nonpractice:

Selecting nonstandard parts for use in flight systems is definitely not recommended but is allowed depending on the hardware function, criticality, application, and environment. Unreliable components have delayed flight projects on the launch pad and have caused serious flight problems, adding significant expense to the flight operation.

Related Practices:

PD-EC-1101, PD-ED-1201, 1203, 1212, PD-AP-1303, 1306, PT-TE-1401, 1411, and. GD-ED-2202 and 2203.

References:

NHB 5300.4(1F)	"Electrical, Electronics, Electromechanical (EEE) Parts Management and Control Requirements for NASA Space Flight Programs," July 1989.
MIL-STD-975	"NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List," January 1994.
MIL-STD-978B	NASA Parts Application Handbook, Vol. 1 - 5, March 1988.