PREFERRED RELIABILITY PRACTICES

FASTENER STANDARDIZATION AND SELECTION CONSIDERATIONS

Guideline:

Verify that a structured, multidisciplinary approach to parts selection, design evaluation, and procurement has been applied prior to committing to a final design.

Benefit:

One of the most important considerations when mechanical fasteners are required is the selection of fasteners of certified quality that meet the requirements of the hardware assembly. Proper fastener selection and application is the first step toward building reliable hardware; therefore, a standard approved parts list consisting of a limited number of types and styles will result in optimum performance, reliability, maintainability, and economy.

Center to Contact for More Information:

Johnson Space Center (JSC)

Implementation Method:

Fastener reliability begins with the preparation of an approved parts list (APL), consisting of certified parts with proven performance, selected for the appropriate application, and procured only from approved suppliers. To ensure certified quality and reliability, fastener types and styles should be kept to a minimum, with fasteners obtained from an approved source. Fastener cost can be better controlled by implementing, in the initial phases of a program, a plan of consolidation and centralization of efforts related to fastener selection, receiving inspection, testing, and traceability.

Providing sufficiently detailed design selection and procurement information for an APL requires that the fasteners be identified, described, and controlled by a Government specification or standard, an industry standard formally adopted by the Government for general applications, or a contractor specification or standard acceptable to the Government. Additionally, precautions should be exercised to ensure, as a minimum, that fasteners are procured from only qualified suppliers based upon surveyed performance. Critical fasteners, generally defined as used in either the primary or secondary load path of a structure, together with specialty fasteners, should be given particular attention to ensure that selection and procurement is only from approved manufacturers. An example of a specialty fastener would be a design

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created either in-house or by a manufacturer for a very specific and limited application (high strength, temperature, configuration).

Care and good engineering judgment should be used at all times during design selection and procurement of fasteners for flight hardware, safety-critical facilities, and mission-essential ground support equipment to ensure that each design is examined from a reliability, maintainability, and produceability aspect.

General criteria that should be examined for a suitable selection of fasteners include:

Materials.

1. Fasteners intended for critical applications should be made from corrosion and heat resistant steels or alloys such as A286 corrosion resistant steel (CRES), titanium, Inconel 718, or MP35N. Fasteners intended for GSE, noncritical, or non-flight hardware may be made from either 300 series or A286 CRES. The tensile strength for noncritical types of fasteners should be 130 ksi minimum. The maximum expected load (tensile and shear) and criticality for the applicable joint is important in the selection of fastener material. Stress corrosion sensitive fasteners should be avoided (refer to MSFC-Spec-522).

2. Fasteners considered for use in composite structure must be selected to ensure conformance to requirements of material compatibility, acceptable installation procedures, and part configuration.

3. Corrosion resistant steel fasteners should be passivated per MIL-S-5002 or QQ-P-35 during the manufacturing process. The passivation process will prevent rust spots from forming on corrosion resistant steel parts by removing embedded iron particles. Passivation must always be the last operation performed.

4. Environmental conditions (salt spray, temperature, vibration, etc.) both for storage and operation should be considered so that material and finish requirements can be evaluated for galvanic couples. Spacecraft hardware may spend a considerable amount of time on earth due to factors such as assembly, test, and storage due to launch scheduling.

5. Fastener selection should be based upon considerations of weight, cost, and availability.

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6. The operational aspects of the installation, extravehicular activity (EVA), intravehicular activity (IVA), maintenance and repair, together with initial assembly may require a unique or specialty fastener. An analysis should be performed early in the design and selection phase as a considerable impact may result to both the hardware design and cost if a specialty fastener is required.

EVA/IVA and Torque requirements.

1. External wrenching fasteners should have a 12 point head for applications with tensile strengths above 180 ksi. Hexagonal heads (6 point) should be used for fasteners of 180 ksi UTS or less. Threads should also conform to MIL-S-8879 requirements "Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for".

2. Captive fasteners should be used whenever possible for flight hardware. All nuts, nut plates, and threaded inserts should have an integral prevailing torque locking device.

3. The minimum fastener head size for suited glove operation should be 1.5 inch diameter and .75 inch high. Sizes larger than 2 inches in diameter should be avoided to prevent the fastener from being larger than the maximum grip size of the smallest crewman. Fasteners that will be manipulated by tools or robots in space should have a standardized head size of 7/16 inch (measured from flat to flat) for 1/4 inch threaded fasteners, and 3/4 inch head for 1/2 inch threads. The thread sizes may be varied independently from the fastener head, thereby reducing or eliminating the requirement for different tool or end effector sizes, but allowing the fastener to be tailored to the application. The minimum head size must be considered in relation to the maximum torque required upon assembly.

4. The assembly and operational aspects of the fastener may require lubrication or a special finish to insure reuse of the fastener during these phases.

Lubrication.

1. Silver plating should not be used on any fastener that would be removed and reinstalled more than twice as part of normal operation or maintenance procedures. Silver reacts rapidly with atomic oxygen to form silver oxide, therefore silver plated components should not be used in any application in which the part is directly exposed to atomic oxygen. Due to corrosion potential, silver plated parts must not contact titanium.

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2. Dry film lubricant is the preferred method of coating fasteners. Lubricants for fasteners should meet the vacuum stability requirements of JSC SP-R-0022, "Vacuum Stability Requirements of Polymeric Material for Spacecraft Application".

Fastener procurement and testing.

All received fastener shipments should contain reports of tests conducted on the parts at an accredited laboratory in compliance with Public Law 101-592 "Fastener Safety Act". All test reports require a similar format such as stated in Public Law 101-592, Section 5. Critical fasteners procured from sources other than the original manufacturer should only be accepted if original chemical and physical certifications can be validated and the lot traceability can be documented.

Together with fastener testing, a system for providing traceability of parts to the initial assembly should be maintained, to reduce the time and associated costs of tracking problems concerning suspect hardware. Without traceability, the location of suspect hardware becomes difficult and may make dispositions very subjective and complex, perhaps leading to extensive disassembling of structure or other hardware. To maintain such a level of traceability, lot segregation should be implemented.

Technical Rationale:

Substandard and counterfeit fasteners in industry have heightened the government’s concern about the reliability of hardware procured for use on various projects and programs. In response to this concern about the integrity of fasteners, Public Law 101-592, "Fastener Safety Act", has been enacted to provide an improved level of confidence in fasteners by requiring improved manufacturing, testing, certification, and quality assurance for all fasteners sold or delivered within the United States.

Impact of Nonpractice:

If the guidelines recommended are not followed, greater numbers of fastener types, sizes, materials, and finishes may be specified or procured resulting in excessive cost. Mission performance may be also degraded due to incompatibility of materials and finishes, or due to substandard hardware that lacks sufficient screening and testing.

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References:

10107-70915, *EVA Bolthead & Socket Interface Study & Definition*, ILC Space Systems, Houston, Texas.

MSFC-Spec-522, *Design Criteria for Controlling Stress Corrosion Cracking*, Marshall Space Flight Center.