

SRB CRITICAL ITEMS LIST

SUBSYSTEM: SEPARATION

ITEM NAME: Forward ET Attachment Fitting

PART NO.: 10160-0135

FM CODE: A02

ITEM CODE: 30-03-03

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Immediate

NO. REQUIRED: 1

DATE: March 1, 2002

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: March 31, 1999

FMEA PAGE NO.: B-49

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SHEET 1 OF 4

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FAILURE MODE AND CAUSES: Assembly fails to rotate at ball assembly/ET insert interface caused by:

- o Galling
- o Corrosion
- o Inadequate dry film lubricant on the spherical surfaces
- o Damaged bearing surfaces

FAILURE EFFECT SUMMARY: Failure of the fitting to rotate at SSME ignition and/or boost will overstress and fracture the SRB/ET fittings and adjoining structure resulting in vehicle breakup and loss of mission, vehicle and crew.

RATIONALE FOR RETENTION:

- A. DESIGN: The SRB forward attachment thrust fittings consist of two inserts (with matching spherical surfaces), two spherical washers, a spherical nut, and a separation bolt.

The insert on the ET side is fabricated from PH13-8MO, H1000 corrosion resistant steel. The ball assembly, on the SRB side of the interface, is fabricated from Inconel 718, heat treated to 180,000 PSI. It is lubricated with a dry film lubricant. To prevent damage to the bearing surfaces during vehicle assembly a tapered guide pin is used to guide the ET onto the SRB. After the ET is correctly positioned on the SRB the guide pins are removed.

The rotating assembly is designed to be a minimum moment joint. The forward attachment fittings transmit only axial loads into the separation bolt.

No additional moment type load is introduced into the forward separation bolt until the joint relative rotation angle exceeds 2 degrees with the maximum shim thickness installed, and the minimum radial gap occurring. Maximum normal operating range is 1 1/2 degrees.

The materials used in the design were selected in accordance with 10PLN-0150 (Materials Control and Verification Program Management Plan for SS SRB Program) and MSFC-SPEC-522 (Design Criteria for Controlling Stress Corrosion Cracking).

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The design allowables are in compliance with MIL-HDBK-5 (Metallic Materials and Elements for Aerospace Vehicle Structures) and MSFC-HDBK-505 (Structural Strength Program Requirements).

Heat treat operations are in compliance with AMS 5664 (Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant).

Strength, thermal, and functional analyses were performed. Structural factors of safety of 1.4 on ultimate and 1.1 on yield were used in the analyses. In addition, a maximum operating temperature range of -40 to +140°F was considered in the analysis.

The SRB forward attachment thrust fittings are qualified for use by test and analysis as documented in Certificate of Qualification A-STR-7113 (Part of forward skirt subassembly).

Structural tests were performed for critical ground and flight load condition. These tests represent maximum frictional loads due to rotation in the washers. Functional tests were performed during verification testing per document SE-019-106-2H. Lubrication tests were made on the lubricant to determine the coefficient of friction (static or dynamic) under applied pressure up to 110,000 psi.

Structural qualification tests that are equivalent to flight ultimate loads or loads that produce equivalent flight stresses were performed for critical ground and flight load conditions. These tests are outlined in MSFC document 10A00552 and Martin Marietta Company document 826-2100. A component test of the ET attach fitting with insert was tested to limit load. Lubrication tests were made to determine the static and kinetic coefficients of friction with interface bearing pressure of 110,000 psi and 3 degree joint rotation.

B. TESTING: None

C. INSPECTION:

VENDOR RELATED INSPECTIONS

- o USA SRBE Source Inspection Plan SIP 1453, controls the USA SRBE PQAR inspection criteria at the vendor's facility. (All Failure Causes)
- o Materials are controlled by specification AMS 5664. Vendor QA and USA SRBE PQAR verify material certification and test results in accordance with SIP 1453. (Galling, Corrosion)
- o The first article is subjected to precision inspection by vendor QA and verified by USA SRBE in accordance with SIP 1453. (Damaged Bearing Surfaces)
- o Parts are dimensionally inspected to the drawing requirements by vendor QA and verified by USA SRBE PQAR in accordance with SIP 1453. (Damaged Bearing Surfaces)

- o USA SRBE PQAR verifies lubricant and transportation protection in accordance with SIP 1453. (Inadequate Lubricant)
- o Vendor QA and USA SRBE PQAR verifies heat treat data and charts in accordance with SIP 1453. (Galling)
- o Eddy current, dye penetrant, and ultrasonic tests are verified by vendor QA and USA SRBE PQAR in accordance with SIP 1453. (Damaged Bearing Surfaces)

The following critical processes, inspections and operations have been identified:

- o Heat treat operations are performed in accordance with AMS 5664. (Galling)
- o Eddy current testing is in accordance with ASTM E-426. (Damaged Bearing Surfaces)
- o Application of the dry film lubricant is in accordance with the vendors proprietary process or BOOSTERLUBE™ dry film lubricant application is per 10PRC-0647. Alternately, the application of the ceramic-bonded lubricant is per 10PRC-0575. (Inadequate Lubricant, Galling)
- o Dye penetrant inspection is in accordance with MIL-STD-6866. (Damaged Bearing Surfaces)
- o Ultrasonic inspected operations are in accordance with MIL-STD-2154. (Damaged Bearing Surfaces)

PRELAUNCH CHECKOUT RELATED INSPECTIONS

The OMRSD, File V, Vol. 1, requirement number B08SB0.050 requires that the condition of dry film lube on the SRB mating surfaces is verified to be free of grease or foreign materials and no individual nicks, gouges, scratches or voids exceeding 1 percent of the total surface area.

Verify by visual inspection and record all discrepancies per OMRSD, File V Vol. I, requirement no. B08ST0.010. (Damaged Bearing Surfaces)

The installation of the thrust post ball fitting is as follows:

- Install thrust post ball fitting to SRB thrust post. Torque fasteners.
- Verify condition of dry film lubricated surface of thrust post ball fitting per OMRSD, File V, Vol. 1 requirement no. B08SBO.050 and verify condition of the exposed non-lubricated surfaces per OMRSD, File II, Vol. I, requirement no. S00HBO.010.
- ET thrust fitting-install washer assembly. Verify fully seated.
- o Verify condition of the dry film lube on SRB mating surfaces per 10REQ-0021, paragraph 4.6.1.

USA SRBE 10SPC-0131 (Refurbishment Engineering Specifications for Space Shuttle Solid Rocket Booster Assembly Project) defines the following inspection points:

Visually examine thrust post internally and externally for possible structural damage. Ball fitting and thrust post cavity.

Inspect ET attach ball for cracks. Inspect solid lubricant for breaks in coating, lubrication, breakdown, or galling.

D. FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

E. OPERATIONAL USE

- o Not applicable to this failure mode.