SUBSYSTEM: SEPARATION

ITEM NAME: Separation Bolt, Forward

PART NO.: 10301-0001-801

FM CODE: A01

ITEM CODE: 30-03-02

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Immediate

NO. REQUIRED: 1

DATE: March 31, 1998 DCN 033

CRITICAL PHASES: Boost

SUPERCEDES: March 1, 1996 DCN 033

FMEA PAGE NO.: B-46

ANALYST: T. Burke/V. Patel DCN 033

SHEET 1 OF 4

APPROVED: P. Kalia

FAILURE MODE AND CAUSES: Premature release or separation caused by:

- Defective material
- Improper heat treat
- Cracked fracture groove
- Improper fracture groove (housing material too thin)
- Corrosion

FAILURE EFFECT SUMMARY: During boost this failure will lead to loss of mission, vehicle, and crew from fire and explosion during thrust tailoff. DCN 033

RATIONALE FOR RETENTION:

A. DESIGN

- Design specification USBI 10SPC-0025

  - Materials are selected in accordance with JSC SE-R-0006 and MSFC-SPEC-522A and MIL-S-8844 per paragraphs 3.1.1, 3.1.1.6 and 3.2.3.1 (Defective Material)

  - Heat treat of the 4340 steel is controlled by MIL-H-6875 per para. 3.2.3.1 (Heat Treat)

  - The bolt shall be capable of operating under a Static Axial limit tension load of 189,000 pounds and a limit bending moment of 55,344 inch-pounds per paragraph 3.3.1. (Improper Fracture Groove)

  - The bolt shall meet an overall minimum safety factor of 1.1 on yield strength and 1.4 on ultimate strength per paragraph 3.3.1. (Improper Fracture Groove)

- The safety factor on ultimate strength on the fracture groove shall not be less than 1.34 per paragraph 3.3.1. (Improper Fracture Groove)
- Nickel plating per MIL-STD-868, Type I or MIL-C-26074 Class 2 per paragraph 3.1.1.9. (Corrosion)

o Qualification

- 30 days stress corrosion test while torqued to 1000 foot pounds. (Corrosion)
- Failure load test to demonstrate design loads. (Improper Fracture Groove)
- Salt Fog (Corrosion)
- Vibration (Cracked fracture groove/corrosion)

o Qualification of design is documented in Hi-Shear test report QTR 9362793-1364. (All Failure Causes)

B. TESTING

o Lot acceptance test is conducted per Hi-Shear acceptance test procedure ATP 9362793-1102.

- Hardness test of all housings per the above and ICS 9362793-1104 and dissecting of critical areas per the above and 9362793-1071. (Improper Heat Treat/Corrosion)
- Proof load all housing per the above procedure and 9362793-940. (All Failure Causes)
- X-ray examination of entire lot of separation bolts. (Cracked Fracture Groove and Defective Material)

o Bolt housing lot acceptance test is conducted per Hi-Shear acceptance test procedure 9362793-940.

- Independent Chemical Analysis on one sample from each lot of housing material. (Defective Material)
- Ultrasonic inspection of each bar of housing material. (Defective Material)
- Stress corrosion/ultimate load test housings (Corrosion)

- Tensile test of a minimum of three heat treated bar specimens. (Defective Material and Improper Heat Treatment)
- Hardness test 100% of the housings. (Improper Heat Treatment)
- Groove determination of six housings per lot. (Improper Fracture Groove)
- Proof Load 100% of the bolt housings. (All Failure Causes)
- Magnetic particle inspection 100% of the bolt housings before and after proof load . (Cracked Fracture Groove)

C. INSPECTION

The following inspections are performed.

VENDOR RELATED INSPECTION

o Receiving Inspection. Raw material certifications, test reports and heat treatment data are verified one hundred percent per: (Defective Material and Improper Heat Treat)

- USBI Quality Assurance
  - o USBI Source Inspection Plan (SIP) 1118.
- Contractor Quality Assurance
  - o Hi-Shear Corporation Inspection Check Sheet 9362793-1104

o Lot Acceptance Test. X-ray film is examined by certified vendor personnel and verified by USBI personnel. Groove determination, ultimate load test, proof load test, stress corrosion test and magnetic particle inspection o housing are witnessed one hundred percent. Stress corrosion test is monitored by USBI QAR during the 30 day tes (All Failure Causes)

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- USBI Quality Assurance
  - o USBI Source Inspection Plan (SIP) 1118.
- Contractor Quality Assurance
  - o Hi-Shear Corporation Assembly Operation Sheet 9362793-3 and Acceptance test Procedure 9362793-940

o Lot review and certification per USBI plan 10PLN-0040.

o Critical Processes/Inspections/Operations: The following critical processes, inspections and operations are used to assure structural and performance integrity of the Forward Separation Bolt.

- X-ray per HSC ATP 9362793-1102. (Material Defects)
- Ultrasonic Inspection per MIL-STD-2154. (Material Defects)

- Magnetic particle inspection per ASTM-E-1444. (Cracked Fracture Groove and Defective Material)
- Nickel plating per HSC 9362793-1445 (Corrosion)
- Groove determination per HSC ATP 9362793-940. (Improper Fracture Groove)

KSC RELATED INSPECTION

o Receiving Inspection

- Each forward separation bolt is visually inspected for blisters, pits, scrapes, nicks or gouges per OMRSD File II, Volume 1, requirement number S00HB0.020. (Corrosion)
- Verify visual inspection of forward separation bolt per OMRSD File V, Vol. I requirement number B000FL.005. (Corrosion)
- Verify forward separation bolt torque values per OMRSD File II, Vol. I requirement number S00HB0.060. (Cracked Fracture Groove)
- Verify that Forward separation bolt received has been flight certified by MSFC as required by NSTS 08060 per OMRSD File V, Volume 1, requirement no. B000FL.002. (All Failure Causes)

o Installation Inspection

- Installation of each forward separation bolt is witnessed by SPC Quality Assurance per OMRSD File II, Vol.1 requirement no. S00HB0.020. (Corrosion)

D. FAILURE HISTORY

o Failure Histories may be obtained from the PRACA database

E. OPERATIONAL USE

o Not applicable to this failure mode.