

SRB CRITICAL ITEMS LIST

SUBSYSTEM: Structures

ITEM NAME: Frangible Nut

PART NO.: 10306-0001-801, -802, -803
10306-0003

FM CODE: A01

ITEM CODE: 60-04-03

REVISION: Basic

CRITICALITY CATEGORY: 1

REACTION TIME: Immediate

NO. REQUIRED: 4 per SRB

DATE: March 1, 2001

CRITICAL PHASES: Boost

SUPERCEDES: March 31, 1998

FMEA PAGE NO.: E-55

ANALYST: S. Parvathaneni

SHEET 1 OF 4

APPROVED: S. Parvathaneni

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FAILURE MODE AND CAUSES: Fails to fracture caused by:

- Incorrectly fabricated nut
(Excessive web material)
- Improper Heat Treatment

FAILURE EFFECT SUMMARY: Loss of mission, vehicle and crew due to vehicle out of control at lift-off.

RATIONALE FOR RETENTION:

A. DESIGN

- The design specification is USA SRBE 10SPC-0030.
 - Must separate into halves with web 10 percent thicker than design maximum from output of one booster cartridge (paragraph 3.3.3). (Excessive Web)
- Material is Inconel 718 per AMS 5662 or AMS 5664. (Improper Material)
- Heat treat per MIL-H-6875 and 10PRC-0631. (Improper Heat Treatment)
- Qualification
 - Functional test under load at high (+150^oF) and low (+20^oF) temperature. (All Failure Causes)
 - Functional test alternate frangible nut 10306-0003 to ambient temperature (70°F ± 18°F)
 - Functional test with 10 percent thicker web using one cartridge. (All Failure Causes)

- o Qualification is documented in Space Ordnance Systems Test Report QTR 8660/9210 or Pacific Scientific Energy Systems Division report QTR ER-PYR-002-96. (All Failure Causes)
- o Qualification of alternate source (UPCO) frangible nut manufactured using existing SOS documentation is documented in ER-PYR-91-001. (All Failure Causes)
- o Qualification of alternate frangible nut 10306-0003 is documented in Pacific Scientific Energy Systems Division report ER-PYR-96-002.
- Analysis shows that re-performance of frangible nut functional tests with a 540,000 pound stud preload and web thickness of 110% of actual thickness shows that the frangible nut will perform per specification requirements in flight. (BI-1992)

B. TESTING

- Lot acceptance test per Space Ordnance Systems Procedure ATP 8793 or Pacific Scientific Energy Systems Division ATP 10306-0003
 - o Dimensional examination of entire lot. (Excessive Web)
 - o Firing test at ambient temperature of 10 percent of lot. (All Failure Causes)

C. INSPECTION

VENDOR RELATED INSPECTIONS

○ RECEIVING

- o Raw material certification and test reports are verified by USA SRBE Quality Assurance and Contractor Quality Assurance. (Improper Heat Treat)
 - o USA SRBE Quality Assurance
 - USA SRBE SIP 1469
 - o Contractor Quality Assurance
 - Space Ordnance Systems Manufacturing Procedures 114850-9 114850-11 and 114850-13.
 - Pacific Scientific Energy Systems Division Inspection operation sheet 10306-0005
- o Web dimension, nut dimension, heat treatment (coupons), and threads are inspected one hundred percent by Contractor Quality Assurance and verified by USA SRBE Quality Assurance per: (Excessive Web)
 - o USA SRBE Quality Assurance
 - USA SRBE SIP 1469
 - o Contractor Quality Assurance
 - Space Ordnance Systems Quality Acceptance Inspection Procedure USA SRBE-0014 and 0015.
 - Pacific Scientific Energy Systems Division Inspection operation sheet 10306-0005
- Microstructure evaluation at 500X magnification of either the nut forging or "A" forging coupon is performed one hundred percent by Contractor Quality Assurance per: (Improper Heat Treat)
 - o SOS MP 114841-5, 114841-9
 - o USA SRBE Drawing 10306-0005.

- O Assembly operations: Acceptance load test and penetrant inspection are witnessed one hundred percent by Contractor Quality Assurance and verified by USA SRBE Quality Assurance per: (Improper Heat Treat)
 - o USA SRBE Quality Assurance
 - USA SRBE SIP 1469
 - o Contractor Quality Assurance
 - Space Ordnance Systems Manufacturing Procedure 114850-9 and ATP 8793.
 - Pacific Scientific Energy Systems Division Inspection operation sheet 10306-0004 and ATP 10306-0003.
- O Lot Acceptance Test

Firing test is witnessed one hundred percent by USA SRBE Quality Assurance and Contractor Quality Assurance per: (All Failure Causes)

 - o USA SRBE Quality Assurance
 - USA SRBE SIP 1155/1469
 - o Contractor Quality Assurance
 - Space Ordnance Systems Acceptance Test Procedure 8793.
 - Pacific Scientific Energy System Division ATP 10306-0003.
- O Lot review and certification per USA SRBE Plan 10PLN-0030. (Improper Material)
- O Critical Processes/Inspections: The following critical processes/inspections are used to assure structural integrity of the Frangible Nut: (Improper Heat Treat)
 - o Heat Treatment per MIL-H-6875 and 10PRC-0631.
 - o Ultrasonic Inspection per MIL-STD-2154.
 - o Penetrant Inspection per MIL-STD-6866.
 - o Microstructure evaluation at 500X magnification per SOS MP 114841-5, -9 or USA SRBE DWG 10306-0005. (Defective Material Improper Heat Treat).

KSC RELATED INSPECTION

- O Receiving Inspection
 - o Lot and serial number verify that each pyro device is listed on the certification statement document per OMRSD File V, Vol. 1 Requirement Number B000FL.002. (Improper Treat)
- O Frangible Nuts Inspection is performed per 10REQ-0021 Para. 4.9 prior to transfer. (Defective Material)

D. FAILURE HISTORY

- o Criticality Category 1:
 - Failure histories maybe obtained from the PRACA database.

E. OPERATIONAL USE

- o Not applicable to this failure mode.

F. WAIVERS

- o BI-1992, 6-25-97, CCBDB SB3-01-5166
 - o Requirements: 10CEI-0001 para 3.2.1.9.2.9 requires that "the Frangible nut shall meet the requirements of 10SPC-0030." 10SPC-0030 para 3.2.1.2 requires that upon detonation of one or both booster cartridges, the nut shall be completely severed into at least two sections, producing a minimum of fragmentation when separated. The stud shall be completely free from the nut upon detonation of one or both cartridges.
 - o Departure: During Lot Acceptance Test firings for Lot AAN Frangible Nuts, S/N 2000302 "Clam Shelled" open 2.7 inches but did not break into two sections. The stud was released.
 - o Rational: The web dimensions based on largest web in Lot AAN is equal to 109.8% of the maximum web dimension allowed by the engineering drawings. Re-performance of Frangible nut functional tests with a 540,000 pound stud preload and web thickness of 110% of actual thickness shows that Lot AAN will perform per specification requirements in flight.
- o BI-1998, 10-6-98, CCBDB SB3-01-5254, Effectivity: BI 103 – BI 110
 - o Requirements: 10CEI-0001 para 4.0 requires that "SRB and Associated launch essential support equipment shall meet the requirements of 10SPC-0030. 10SPC-0030 paragraph 4.1 states that the quality assurance program shall be in accordance with the requirements of NHB 5300.4(1C) and NSTS 5300.4(1D-2). NHB 5300.4(1C) section 1C310, defines "Measurement standards and equipment shall be selected and controlled to the degree necessary to meet contract requirements" Para 4.G also states "controls shall be established to ensure the immediate recalibration or removal from service of those (standards and equipment) found to exceed the established interval or which for any reason may have an adverse affect on quality".
 - o Departure: The Gilmore universal test fixture at MSFC was calibrated for a range of tensile load up to 1.2 million pounds. Qualification testing for the SRB Holddown system Frangible Nut requires loads of 1.602 Million Pounds minimum.

o Rational:

The Gilmore machine was calibrated on March 3, 1998 by MSFC and tagged with a loading accuracy of <1% of range. Prior to each Frangible Nut test, the shunt calibration check point verifies the integrity of the load cells. Verification of the check point and calibration linearity from the load cell manufacturers guarantees a loading accuracy error of <1% to 3 Million pounds, tension or compression on the Gilmore.

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