
FAILURE MODE EFFECTS ANALYSIS/CRITICAL ITEMS LIST

FMEA NUMBER: EDFT-05-STBD7-7	ORIGINATOR: JSC	PROJECT: DTO 671
ART NAME: ACME SCREW LOCK DEVICE	LRU PART NUMBER: SED39128554-403	QUANTITY: 2
PART NUMBER: R076707-1	LRU PART NAME: BAY 7 STBD INSTALLATION	SYSTEM: EDFT-05
DRAWING: SEE P/N	SUBSYSTEM: N/A	EFFECTIVITY: STS-60

CRITICALITY:

CRITICAL ITEM? YES X NO

CRITICALITY CATEGORY: 1R/2

REDUNDANCY SCREENS:

A - Pass
B - N/A
C - Pass

FUNCTION: Two ACME Screws are used to attach and secure the Battery ORU Simulator Assembly to the CHIA Interface Plate Assembly for launch and landing. The ACME screw locking device consists of two tangs which engage a toothed gear (when the torquing device is removed) in order to prevent each screw from backing out.

FAILURE MODE: Inadvertent release of one locking tang

CAUSE: piece part failure, vibration, thermal distortion

FAILURE DETECTION: None. Locking tangs are not visible to crew.

REMAINING PATHS: One - remaining locking tang

EFFECT/MISSION PHASE: Launch

CORRECTIVE ACTION: None

-FAILURE EFFECTS-

END ITEM: One failure (tang) - no effect. ACME screw will remain locked.

INTERFACE: N/A

MISSION: None for single failure

CREW/VEHICLE: If both locking tangs release, screw could back out during ascent. The remaining screw may not be able to carry the load and prevent the Battery ORU (350 lbs) from coming free in the PLB and damaging the vehicle.

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FMEA NUMBER: EDFT-05-STBD7-7	ORIGINATOR: JSC	PROJECT: D70 671
PART NAME: ACME SCREW LOCK DEVICE	LRU PART NUMBER: SED39128554-401	QUANTITY: 2
PART NUMBER: R076707-1	LRU PART NAME: BAY 7 STBD INSTALLATION	SYSTEM: EDFT-05
DRAWING: SEE P/N	SUBSYSTEM: N/A	EFFECTIVITY: STS-80

HAZARD INFORMATION:

HAZARD: YES _____ NO X

HAZARD ORGANIZATION CODE:

HAZARD NUMBER: N/A

TIME TO EFFECT: Seconds
TIME TO DETECT: N/A
TIME TO CORRECT: Immediate

REMARKS:

-RETENTION RATIONALE-

(A) **DESIGN:** The ACME screw locking device consists of two tangs which engage a toothed gear (when the torquing device is removed) in order to prevent the screw from backing out. Both the drive rod and locking device are fabricated from fracture critical material and designed to the requirements specified in JSC-33481, "Certification and Acceptance Requirements, Orbital Replacement Unit Simulator and Carrier Assembly for the Detailed Test Objective 671 Program". The drive rod (with toothed gear) is fabricated from CRES 15-5 PH material while the tang material is Beryllium Copper, ASTM B194, UNS C 17200, Cond TD04 (cond H). Both screws are required to keep the ORU secure to the CHIA during launch. Tang will see a maximum backout torque of 88 in-lb transmitted from the ACME screw. Static tests showed failure with one tang engaged at torque of 141 in-lb and with two tangs engaged at 202 in-lb. For the 2 tang engaged case, the calculated $FS_{ULT} = 2.04$ and $FS_{YLD} = 1.48$ and the $MS_{ULT} = 0.46$ and $MS_{YLD} = 0.48$. For the 1 tang engaged case, the calculated $FS_{ULT} = 1.02$. Tangs are designed such that they are disengaged when a 7/16" socket is inserted on the bolt head. The tangs will disengage prior to the socket being on/around the bolt head, therefore the tangs will not be exposed to the load associated with torquing the bolt.

(B) **TEST:**

A battery ORU without any locking device was subjected to flight and qual level random vibration tests to measure ACME screw backout torque of 88 in-lb. Test-to-failure static torque tests were conducted on the locking device for one and two springs engaged cases. The device meets the life requirements for 2 flights and shows adequate margins of safety (see Rockwell International Structural Analysis Report EPS-5, INAD-2-XX-167 and Engineering Product Document ETD-MD-C00652).

Acceptance: Functional performed at predelivery acceptance, preinstallation acceptance, and pre post environmental test as specified in the Certification and Acceptance Requirements.

- 1) Torque required to actuate each ACME screw locking device verified to be between 50 - 55 ft-lbs
- 2) Engagement of tangs visually verified by ground inspection.

Manned Thermal Vacuum Test: Performed as specified in the Certification and Acceptance Requirements Document. ACME screw torque (50-55 ft-lb) functionally verified at minus 100 degrees F and 1×10^{-5} Torr.

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DRAWING: SEE P/N	SUBSYSTEM: N/A	EFFECTIVITY: STS-80

Protoflight Vibration Test:

1) Performed on the OSCA with both tangs engaged to the following levels for a duration of 1 minute in each axis:

X AXIS		Y AXIS		Z AXIS	
20 - 80 Hz	+3 db/oct	20 - 45 Hz	-10 db/oct	20 - 45 Hz	0.009 g ² /Hz
80 - 350 Hz	0.04 g ² /Hz	45 - 600 Hz	0.06 g ² /Hz	45 - 70 Hz	+12 db/oct
350-2000 Hz	-3 db/oct	600 - 2000Hz	-6 db/oct	70 - 600 Hz	0.05 g ² /Hz
				600-2000Hz	-6 db/oct
6.1 Grms overall		7.7 Grms overall		7.0 Grms overall	

A test was successfully performed on the flight battery to flight levels to verify that, with one tang engaged, the ACME Screws would not back out.

Proper equipment installation in the PLB verified to the requirements in EID 10959, SED 39128554 and by JSC TPS.

C) INSPECTION: All screw locking device components are individually verified to generally clean. The Battery ORU Assembly and CHIA Interface Plate Assembly are to be visually clean at predelivery acceptance.

- Test and Quality Assurance surveillance is required at all tests and inspections.
- Discrepancy reports are required to be written on all non-compliances.

• NDE Inspection: The fracture critical locking tangs are penetrant inspected per MIL-STD-6866, Method A, Level 3 with accept/reject criteria per MIL-STD-1907, Grade A after final machining only. The drive rods are ultrasonic inspected per MIL-STD-2154, Class A, except elongated stringer type indications not acceptable and are also mag particle inspected per MIL-STD-1949. Acceptance criteria per MIL-STD-1907, Grade A, after final machining.

(D) FAILURE HISTORY: None for this configuration. ACME screw backed out during vibration testing of prototype unit without any locking device.

(E) OPERATIONAL USE:

- 1) Operational Effect: Both battery ORU ACME screws are required to be torqued down during launch/landing. Loose equipment could impact and damage the vehicle.
- 2) Crew Action: If ORU cannot be secured to the CHIA with two latches, jettison ORU.
- 3) Crew Training: Crew trained in proper operation of securing ORU to CHIA and to torque screws to 50 - 55 ft-lb with power tool and checked with torque wrench.
- 4) Mission Constraint: None.
- 5) In-flight checkout: None for launch. Crew verifies ACME screw installation during EVA.

PREPARED BY: MURRAY EPSTEIN REVISION: DATE: 4/16/96