
FAILURE MODE EFFECTS ANALYSIS/CRITICAL ITEMS LIST

FMEA NUMBER: EC-MUT-01	ORIGINATOR: JSC	PROJECT: EDFT-04
PART NAME: BALL STACK ASSY	LRU PART NUMBER: SEG33106880-301,303,305,307	QUANTITY: 1
PART NUMBER: SEG33107110-701	LRU PART NAME: MUT	SYSTEM: DTO 671
DRAWING: SEE P/N	SUBSYSTEM: EVA	EFFECTIVITY: STS-76 & Subsequent

CRITICALITY:CRITICAL ITEM? YES * NO SUCCESS PATHS: 2
SUCCESS PATHS REMAINING: 1CRITICALITY CATEGORY: 1R/2 **REDUNDANCY SCREENS:**

- A - 1.) C/O PRELAUNCH: PASS
- 2.) C/O ON ORBIT: N/A for NSTS
- B - 3.) DETECTION FLIGHT CREW: PASS
- 4.) DETECTION GROUND CREW: N/A for NSTS
- C - 5.) LOSS OF REDUNDANCY FROM SINGLE CAUSE: PASS

FUNCTION: The ball stack cable is use to restrain the balls in the ball stack and to enable the MUT to be rigidized and derigidized by tightening the locking collar, which in turn, tightens the cable and compresses the balls together for rigidization, or loosening the collar which eases tension off of the cable allowing the MUT to be flexible.

FAILURE MODE: Failure of the ball stack cable.

CAUSE: Piece part defect.

FAILURE DETECTION: Tactile.

REMAINING PATHS: One - Outer debris sleeve.

EFFECT/MISSION PHASE: EVA

CORRECTIVE ACTION: Discontinue use of the MUT.

-FAILURE EFFECTS-

END ITEM: Unable to rigidize MUT ball stack. Discontinue use.

INTERFACE: None.

MISSION: Partial loss of remaining DTO objectives.

CREW/VEHICLE: None for a single failure, however, if 2 failures were to occur possible loose ORUs and/or hardware from the ball stack would possibly be free to drift in the cargo bay whether the MUT is used for ORU translation or as a crew restraint device. Loose hardware in the payload bay could either impact the crewmember/vehicle as in the case of translating the ORUs, or could prevent the payload bay doors from closing. Also the possibility of loose hardware impacting the vehicle during landing exists.

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HAZARD INFORMATION:

HAZARD: YES _____ NO _____ *

HAZARD ORGANIZATION CODE: N/A

HAZARD NUMBER: N/A

TIME TO EFFECT: Seconds.

TIME TO DETECT: Seconds.

TIME TO CORRECT: Immediate.

REMARKS:

-RETENTION RATIONALE-

(A) **DESIGN:** The MUT is designed to withstand a 300 in-lb torsional load at the interface of the end effector and handrail, and a 100 lb tensile load along it's long axis, and it can also withstand a 125 lb kick load without degradation. If cable failure were to occur, the debris sleeve is designed to prevent any of the loose parts from becoming free in the payload bay. Stress analysis indicates that the minimum margin of safety is .010 with a safety factor of 2.0 due to a 125 lb kick load in a worse case configuration including a cable preload of 600 lb.

(B) **TEST:** Applicable requirements from JSC 33498A.

Acceptance:

1.) **Functional:** Verified at Predelivery Acceptance Test, Preinstallation acceptance and Pre/Post environmental test.

- a.) MUT assembly was load tested to withstand 100 lbs. in tension at PDA only.
- b.) Minimum of 50 actuation cycles was performed on all moving parts.
- c.) Torque required to rigidize ball stack not to exceed 30 in-lbs and the final tension torque to produce minimum required level of stabilization shall not exceed 50 in-lbs.

2.) Environmental: Acceptance Vibration

The MUT is subjected to the following vibration in each axis for a duration of 1 minute per TPS.

20 Hz	0.01 G ² /Hz
20 to 80 Hz	+3.0 dB/octave
80 to 350 Hz	0.04 G ² /Hz
500 to 2000 Hz	-3.0 dB/octave
2000 Hz	0.007 G ² /Hz
load factor 6.1 G rms	

Qualification:

- 1.) Vibration: N/A
- 2.) Thermal: Functional verification performed at -100 F and + 200 F per TPS.

(C) INSPECTION:

Fabrication - All MUT components are verified to be built to print and generally clean individually. The MUT assembly was verified to be visually clean at preinstallation acceptance. Test - Quality Assurance surveillance is required at all tests and inspections.

- (D) FAILURE HISTORY: This is the first time the MUT has flown and therefore has no failure history. The MUT is similar to the BRT which has successfully flown on STS-69 and STS-72.

(E) OPERATIONAL USE:

- 1.) Operational Effect - For cable failure - loss of MUT function.
Possible loose debris in payload bay.
- 2.) Crew Action - Discontinue use of the MUT. Restow in middeck/spacehab.
- 3.) Crew Training - Crew trained in proper operation of MUT at WETF.
- 4.) Mission constraint - When fully extended or placed into a singularity, the crew will not continue to pull against the MUT.
- 5.) In Flight Checkout - If MUT fails to rigidize, discontinue use of the MUT.

(F) MAINTAINABILITY: The MUT has a shelf life of 5 years. The MUT can be removed and replaced if a failure occurs. No on-orbit repair is planned.

PREPARED BY: M. D. Garner

REVISION:

DATE: 2/22/96
