
FAILURE MODE EFFECTS ANALYSIS/CRITICAL ITEMS LIST

FMEA NUMBER: EC-BS-01	ORIGINATOR: JSC	PROJECT: EDFT-05
PART NAME: BALL STACK CABLE	LRU PART NUMBER: SEG33108756-301	QUANTITY: 1
PART NUMBER: 2188	LRU PART NAME: BALL STACK	SYSTEM: DTO 67:
DRAWING: SEE P/N	SUBSYSTEM: EVA	EFFECTIVITY: STS-80 & Subsequent

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

A - 1.) C/O PRELAUNCH: PASS
 B - 2.) DETECTION FLIGHT CREW: PASS
 C - 3.) LOSS OF REDUNDANCY FROM SINGLE CAUSE: PASS

FUNCTION: The ball stack cable is used to restrain the balls in the ball stack and to enable the ball stack 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 ball stack to be flexible.

FAILURE MODE: Failure of the ball stack cable.**CAUSE:** Piece part defect within cable and/or improper installation of thread plugs onto cable.**FAILURE DETECTION:** Tactile.**REMAINING PATHS:** One - Outer debris sleeve.**EFFECT/MISSION PHASE:** EVA**CORRECTIVE ACTION:** Discontinue use of the ball stack.**-FAILURE EFFECTS-****END ITEM:** Unable to rigidize 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. Loose hardware in the payload bay could either impact the crewmember/vehicle as in the case of translating 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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PART NUMBER: 2188	LRU PART NAME: BALL STACK	SYSTEM: DTO 671
DRAWING: SEE P/N	SUBSYSTEM: EVA	EFFECTIVITY: STS-80 & Subsequent

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 ball stack cable is proof load tested by applying a 100% design limit load to the cable assembly. This load is 60% of the minimum breaking strength of the cable or fittings. The cable uses threaded plugs which are swaged onto both ends of the cable. The limit load is 2,400 lbs in tension. The ball stack assembly incorporates load limiter which is designed to trip below 1800 in-lbs. Ball stack assembly analyzed to withstand a ultimate load of 150 % of 125 lbs.

(B) **TEST:** Applicable requirements from JSC 33794, "Certification and Acceptance Requirements Document, Ball Stack".

Acceptance:

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

- a.) Ball Stack cable was tested to a load of 125 lbs in tension. (PDA)
- b.) Five (5) actuation cycles was performed on all moving parts. (PDA)
- c.) Running torque required to rigidize the 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. PDA, PIA, pre/post functional environmental test.
- d.) Ball stack cable and end fitting tensioned to 1850 lb after swedging. A pull test was performed to 2400 lb for workmanship.
- e.) Load limiter verified to trip below 1800 in-lbs. PDA, PIA, pre/post functional environmental test.

2.) **Environmental:** Acceptance Vibration

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

20 to 80 Hz	+3.0 dB/Octave
80 to 350 Hz	0.04 G ² /Hz
350 to 2000 Hz	-3.0 dB/Octave

load factor 6.1 G rms

Acceptance Thermal

Ball stack functionally verified at -100 F.

Qualification:

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

(C) INSPECTION:

Fabrication - All ball stack components are verified to be built to print and generally clean individually. The ball stack assembly was verified to be visually clean at preinstallation acceptance. Cable and endfitting structural integrity test witnessed by QA representative. Test - Quality Assurance surveillance is required at all tests and inspections.

(D) FAILURE HISTORY: The ball stack is similar to the ORT which flew on STS-69 and STS-72 with no history of failures.

(E) OPERATIONAL USE:

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

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REVISION:

DATE: 8/15/96
