PRINT DATE: 02/12/91

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: MO-AD1-M10-X

SUBSYSTEM NAME: REMOTELY OPERATED ELECTRICAL UMBILICAL

REVISION : 1 02/11/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ SRU :	BUNGEE ASSEMBLY	V751-544180-001

PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
BUNGEE ASSEMBLY - ORBITER POSITIONING MECHANISM (OPM)

■ QUANTITY OF LIKE ITEMS: 1
ONE PER ASSEMBLY
ONE PER VEHICLE

■ FUNCTION:
THE ARM DRIVE BUNGEE ALLOWS FOR CONTROLLED PRELOAD TO BE APPLIED TO THE PAYLOAD BY THE POSITIONING ARM DRIVE ASSEMBLY DURING MATE/STOW PROCESSES.

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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: MO-AD1-M10-01

REVISION# 1 02/11/91 R

SUBSYSTEM: REMOTELY OPERATED ELECTRICAL UMBILICAL

ITEM NAME: BUNGEE ASSEMBLY

CRITICALITY OF THIS FAILURE MODE:2/2

■ FAILURE MODE:
PHYSICAL BINDING/JAMMING

MISSION PHASE:
00 ON-ORBIT

■ VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
: 103 DISCOVERY
: 104 ATLANTIS
: 105 ENDEAVOUR

■ CAUSE:
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECTS/DEBRIS, LOSS OF LUBRICANT, FAILURE/DEFLECTION OF INTERNAL PARTS, TEMPERATURE, VIBRATION

■ CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

■ REDUNDANCY SCREEN A) N/A
■ B) N/A
■ C) N/A

PASS/FAIL RATIONALE:
■ A)

■ B)

■ C)

- FAILURE EFFECTS -

■ (A) SUBSYSTEM:
LOSS OF PRELOAD FORCE TO PAYLOAD OR ARM DOES NOT FULLY EXTEND.

■ (B) INTERFACING SUBSYSTEM(S):
THE MECHANISM MAY REACH A HARD STOP BEFORE LIMIT SWITCHES ARE ACTUATED TO INHIBIT THE DRIVE MOTORS. THIS MAY IMPOSE STRESS AT THE INTERFACE OR ARM MAY NOT EXTEND FAR ENOUGH TO PERFORM THE MATE FUNCTION.

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■ (C) MISSION:
LOSS OF MISSION OBJECTIVE.

■ (D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT

■ (E) FUNCTIONAL CRITICALITY EFFECTS:

- DISPOSITION RATIONALE -

■ (A) DESIGN:
BUNGEE IS SEALED TO EXCLUDE CONTAMINATION, FACTOR OF SAFETY IS 1.4 OVER LIMIT LOAD. POSITIVE MARGINS ON ALL COMPONENTS. COMPONENT VERIFIED FOR STRUCTURAL DEMONSTRATION.

ALL THE MECHANISM MATERIALS HAVE BEEN CHOSEN FOR HIGH STRENGTH/LOW WEAR CHARACTERISTICS. MECHANISM DESIGNED WITH POSITIVE MARGINS OF SAFETY FOR WORSE CASE THERMAL CONDITIONS. ALIGNMENT MECHANISM DESIGNED TO ENSURE PROPER CAPTURE ENVELOPE FOR WORSE CASE THERMAL CONDITIONS. DESIGN OF THE ACTUATION SYSTEM PERMITS PARTIAL WORKAROUND BY CREW EVA ACTIONS.

■ (B) TEST:
QUALIFICATION:
THE ROEU MECHANISM IS CERTIFIED PER CR 60-544100-001-C. SYSTEM QUALIFICATION TESTS INCLUDED:

* VISUAL EXAMINATION TO VERIFY CONFORMANCE TO DRAWINGS, IDENTIFICATION MARKINGS, AND CLEANLINESS.
* ENVIRONMENTAL TESTS - VIBRATION (BOOST) FOR 60 SEC/AXIS. FLIGHT VIBRATION FOR 140 SEC/AXIS. FIVE THERMAL/VACUUM CYCLES WITH SIMULATED ROEU/PAYLOAD DISPLACEMENTS.
* OPERATIONAL LIFE TESTS - 84 CYCLES ON ARM AND LATCH MECHANISM.
* QUALIFICATION ACCEPTANCE TESTS TO CERTIFY MECHANISM FOR FIVE ACCEPTANCE THERMAL AND FIVE ACCEPTANCE VIBRATION TESTS.
* MAXIMUM DISPLACEMENT TESTS TO VERIFY OPERATIONAL ENVELOPE.
* LIMIT, LIMIT PLUS LOADS TESTS TO VERIFY STATIC LOADING.
* ARM AND LATCH STALL LOAD TESTS.

ACCEPTANCE:
THE ARM AND LATCH MECHANISMS WERE RIGGED PER CONTROLLED SPECIFICATION ML0308-0185, PLUS:

* ACCEPTANCE VIBRATION RANDOM SPECTRUM 3 MIN/AXIS.
* ACCEPTANCE THERMAL ONE AND ONE-HALF THERMAL CYCLES.

CERTIFICATION BY ANALYSIS/SIMILARITY:

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FACTORS INCLUDE: HUMIDITY, FUNGUS, OZONE, SALTSPRAY, SAND/DUST, ACCELERATION, FACTORS OF SAFETY, HAIL, LIGHTNING, RAIN, SOLAR RADIATION (THERMAL AND NUCLEAR), STORAGE/OPERATING LIFE, METEOROIDS, ACOUSTICS, AND EXPLOSIVE ATMOSPHERE.

GROUND TURNAROUND:
THE ROEU IS USED AS PAYLOAD INTEGRATION HARDWARE FOR DESIGNATED PAYLOADS ONLY. THE ROEU IS CANDIDATE EQUIPMENT FOR ALL VEHICLES AND FOR ALL FLIGHTS AND AS SUCH IS EVALUATED DURING GROUND TURNAROUND WHEN REQUIRED. THIS EVALUATION INCLUDES VISUAL INSPECTION FOR EVIDENCE OF UNUSUAL OPERATION AND A COMPLETE FUNCTIONAL CHECK.

■ **(C) INSPECTION:**
RECEIVING INSPECTION
MATERIAL AND PROCESS CERTIFICATIONS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
INSPECTION VERIFIES CLEANLINESS IS MAINTAINED. INSPECTION VERIFIES CORROSION PROTECTION PER MA0608-301.

ASSEMBLY/INSTALLATION
DIMENSIONS OF DETAIL PARTS VERIFIED BY INSPECTION. FASTENER INSTALLATION IS VERIFIED BY INSPECTION. ASSEMBLY AND RIGGING OF BUNGEE ASSEMBLY IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
PENETRANT INSPECTION OF DETAIL PARTS IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
APPLICATION OF LB0140-005 DRY FILM LUBRICANT PER MA0112-302 IS VERIFIED BY INSPECTION. HEAT TREATING IS VERIFIED BY INSPECTION.

TESTING
ACCEPTANCE TESTING OF THE BUNGEE ASSEMBLY PRIOR TO DELIVERY IS VERIFIED BY INSPECTION PER APPLICABLE PROCEDURE.

HANDLING/PACKAGING
HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

■ **(D) FAILURE HISTORY:**
NONE. FIRST USAGE OF BUNGEE OF THIS TYPE AND APPLICATION.

■ **(E) OPERATIONAL USE:**
CONDUCT EVA AND MANUALLY POSITION THE ARM TO COMPLETE THE INTENDED FUNCTION.

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NUMBER: MO-AD1-M10-01

- APPROVALS -

RELIABILITY ENGINEERING	M. P. RAGUSA	
DESIGN ENGINEERING	G. CAMPBELL	
QUALITY ENGINEERING	M. F. MERGEN	
NASA RELIABILITY		
NASA SUBSYSTEM MANAGER		6/20/91
NASA QUALITY ASSURANCE		6/12/91