

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- HARDWARE
NUMBER: M0-AG1-M08 -X

SUBSYSTEM NAME: REMOTELY OPERATED FLUID UMBILICAL (ROFU)
REVISION: 01/23/03

PART DATA

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
: ROFU	V847-544100-001
: EVA BALL LOCK MECHANISM	V751-544170

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
OVERRIDE MECHANISM, EVA LATCH/UNLATCH MECHANISM

REFERENCE DESIGNATORS: N/A

QUANTITY OF LIKE ITEMS:
ONE PER ASSEMBLY
ONE PER VEHICLE

FUNCTION:
PROVIDES CREW WITH THE EVA CAPABILITY TO OVERRIDE THE ACTUATOR AND MANUALLY LATCH/UNLATCH THE ORBITER/PAYLOAD DISCONNECT HALVES. CREW CAN ACTIVATE THE MECHANISM BY LIFTING EVA OVERRIDE COVER WHICH MOVES A PLUNGER TO DISENGAGE MOTOR/GEARBOX OUTPUT, ENGAGE RATCHET, AND BY USING A 7/16 SOCKET WRENCH, TURN THE EVA DRIVESHAFT TO TRANSMIT TORQUE TO POSITION THE MECHANISM. THIS OVERRIDE MECHANISM INCORPORATES A RATCHET TO TRANSFER TORQUE IN ONE DIRECTION ONLY.

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LRU:

CRITICALITY OF THIS

ITEM NAME: EVA BALL LOCK MECHANISM

FAILURE MODE: 2R3

FAILURE MODE:

FAILS TO DISCONNECT ACTUATOR FROM SECONDARY GEARBOX OR GEAR CAM (CONTINGENCY EVA OPERATION ONLY). FAILS TO DRIVE MECHANISM WHEN MANUALLY OPERATED.

MISSION PHASE: OO ON-ORBIT

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

CAUSE:

SPRING FAILURE, EXCESSIVE FRICTION, JAMMED COUPLING, BEARING, OR COVER, CONTAMINATION, DEBRIS, TOLERANCE VARIATION, SHEARED BOLT.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:

A)
FAILS REDANDANCY SCREEN "A" SINCE THERE IS NO VISUAL OR INSTRUMENTED WAY OF DETECTING A FAILURE OF THE EVA DRIVE ASSEMBLY ON GROUND

B)
STANDBY SYSTEM

C)
LOSS OF FUNCTION DUE TO SINGLE FAILURE IN THE GEAR CAM

- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF CONTINGENCY EVA CAPABILITY TO MANUALLY MATE/DEMATE THE ORBITER-PAYLOAD DISCONENCT HALVES.

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PAYLOAD CANNOT BE DEPLOYED DUE TO THE ORBITER DISCONNECT ASSEMBLY AND PAYLOAD DISCONNECT ASSEMBLY CANNOT BE SEPARATED MANUALLY.
RETRIEVED PAYLOAD CANNOT BE REMATED FOR ENTRY.

(C) MISSION:

LOSS OF MISSION OBJECTIVE.

(D) CREW, VEHICLE, AND ELEMENT(S):

NO EFFECT. STRESS ANALYSIS INDICATED THAT THE ROFU SHOWS NO STRUCTURAL FAILURE WITH CONTINGENCY LANDING SINK RATE OF 7.2 FT/SEC IN THE MID-TRAVEL POSITION.

(E) FUNCTIONAL CRITICALITY EFFECTS:

PRIOR FAILURE(S) ARE REQUIRED BEFORE USE OF OVERRIDE IS MANDATORY. FAILURE WHEN USE WILL RESULT IN LOSS OF MISSION OBJECTIVE.

SUCCESS PATHS REMAINING AFTER FIRST FAILURE: 0

- TIME TO EFFECT -

REACTION TIME: SECONDS

-DISPOSITION RATIONALE-

(A) DESIGN:

DESIGN IS PROTECTED BY COVER FROM FOREIGN OBJECTS OR DEBRIS. COVER PREVENTS PREMATURE/INADVERTENT USE OF EVA DISCONNECT, COUPLING FOR LATCH DRIVE CAN BE DISCONNECTED FROM GEARBOX BY LIFTING AND ROTATING COVER 120 DEG. DESIGN FACTOR OF SAFETY IS 1.4 X LIMIT LOAD. ALL COMPONENTS SHOW POSITIVE MARGINS BY ANALYSIS.

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

(B) TEST:

QUALIFICATION:

THE ROFU MECHANISM IS CERTIFIED PER CR 60-44-544100-001-C. SYSTEM QUALIFICATION TESTS INCLUDED:

- * VISUAL EXAMINATION TO VERIFY CONFORMANCE TO DRAWINGS, IDENTIFICATION MARKINGS, AND CLEANLINESS.

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- * ENVIRONMENTAL TESTS - VIBRATION FOR 600 SEC/AXIS (STOWED). VIBRATION FOR 1400 SEC/AXIS (MATED) BY THE ROFU QUALIFICATION TEST. FIVE THERMAL / VACUUM CYCLES.
- * OPERATIONAL LIFE TESTS - 500 CYCLES, BY THE ROFU QUALIFICATION TEST, 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 LATCH MECHANISMS WERE RIGGED PER CONTROLLED SPECIFICATION ML0308-0187, PLUS:

- * ACCEPTANCE VIBRATION RANDOM SPECTRUM 3 MIN/AXIS.
- * FIVE ACCEPTANCE THERMAL CYCLES.

CERTIFICATION BY ANALYSIS/SIMILARITY:

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:

OMRSD - ANY TURNAROUND TEST CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD

(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 BALL LOCK MECHANISM 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 BALL LOCK MECHANISM ASSEMBLY PRIOR TO DELIVERY IS VERIFIED BY INSPECTION PER APPLICABLE PROCEDURE.

HANDLING/PACKAGING

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HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

(E) OPERATIONAL USE:

NONE

- APPROVALS -

S&R ENGINEER	:A. NGUYEN	:/s/ Anh Nguyen_____
CARGO/INTEG ITM.	:J. CAPALENI	:/s/ Bob Dueuease for_____
DESIGN ENGINEER	:P. HOE	:/S/ PHAM HOE_____
SSM	:L. J. SALVADOR	:/s/ Pham Hoe for_____
MOD	:K. SMITH	:/s/ K. Smith_____
SR&QA	:H. MALTBY	:/s/ Harry Maltby_____
USA/SAM	:R. SMITH	:/s/ R. Smith_____
USA CARGO/INTG ELEMENT	:S. KUNKEL	:/s/ S. Kunkel_____
USA ORBITER ELEMENT	:S. LITTLE	:/s/ Suzanne Little_____