

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- HARDWARE**NUMBER: M0-AG1-M12 -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
:ARM ACTUATOR TELAIR (FORMELY HOOVER ELECTRIC)	MC287-0057-0002 17820-2

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

DUAL MOTOR/BRAKE ASSEMBLY, 3 PHASE AC, 400 HZ.

REFERENCE DESIGNATORS: N/A**QUANTITY OF LIKE ITEMS:**ONE PER ROFU ASSEMBLY
17820-1 (LATCH ACTUATOR) IS A SIMILAR ITEM.**FUNCTION:**

THE ARM ACTUATOR USES REDUNDANT MOTORS DRIVING THROUGH A DIFFERENTIAL/GEARBOX TO PROVIDE THE FORCE NECESSARY TO MATE, RELAX AND STOW THE SWING ARM.

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE

NUMBER: MO-AG1-M12-02

REVISION#: 1/23/03

SUBSYSTEM NAME: REMOTELY OPERATED FLUID UMBILICAL (ROFU)

LRU:

CRITICALITY OF THIS

ITEM NAME: ARM ACTURATOR

FAILURE MODE: 2R3

FAILURE MODE:

BRAKE FAILS TO ENGAGE (DRIVE MOTOR)

MISSION PHASE: OO ON-ORBIT

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

CAUSE:

ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, FAILURE/DEFLECTION OF INTERNAL PART OR BROKEN PART.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

- A) PASS
- B) FAIL
- C) PASS

PASS/FAIL RATIONALE:

A)

PRELAUNCH INSTALLATION AND CHECKOUT

B)

THERE IS NO SPECIFIC IN-FLIGHT INSTRUMENTATION TO SIGNAL BRAKE OPERATION OR CONDITION

C)

PHYSICAL SEPARATION OF REDUNDANT PARTS

- FAILURE EFFECTS -

(A) SUBSYSTEM:

DEGRADED FUNCTIONAL OPTIONS. LOSS OF ABILITY TO USE THE REDUNDANT DRIVE MOTOR ALONE IF THE MOTOR ALSO FAILS.

(B) INTERFACING SUBSYSTEM(S):

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NO EFFECT. NORMAL MODE OF OPERATION IS WITH BOTH DRIVE MOTORS OPERATING.

(C) MISSION:

FIRST FAILURE - NO EFFECT.

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

FIRST FAILURE - NO EFFECT.

(E) FUNCTIONAL CRITICALITY EFFECTS:

1. WITH ONE MOTOR BRAKE INOPERATIVE AND WITH AC POWER APPLIED TO BOTH MOTORS THE SYSTEM WILL PERFORM ITS ARM MOVEMENT FUNCTION.
2. IF BOTH BRAKE AND MOTOR FAILURES OCCUR, ON THE SAME MOTOR/BRAKE ASSEMBLY, THE GOOD MOTOR WILL BACK DRIVE THE FAILED MOTOR THROUGH THE GEAR TRAIN DIFERENTIAL AND THERE WOULD BE NO ACTUATOR OUTPUT. AN EVA WORKAROUND WOULD BE NECESSARY TO ACCOMPLISH ARM MOVEMENT.
3. IN THE ABSENCE OF ANY APPLIED AC POWER BUT WITH A PHYSICAL FORCE APPLIED ON THE OUTPUT SIDE OF THE ACTUATOR, THAT FORCE WOULD CAUSE THE SYSTEM TO MOVE BY BACKDRIVING THROUGH THE GEAR TRAIN DIFFERENTIAL. BOTH MOTOR BRAKES ARE REQUIRED TO MAINTAIN THE GEAR TRAIN IN AN IMMOBILE STATE.

SUCCESS PATHS REMAINING AFTER FIRST FAILURE: 2

- TIME TO EFFECT -

REACTION TIME: SECONDS

-DISPOSITION RATIONALE-

(A) DESIGN:

BRAKE DESIGNED TO FAIL IN ENGAGED POSITON. PARTS CLEANED TO LEVEL 300, ASSEMBLED IN A CLASS 100,000 CLEAN ROOM. SHEILDING FROM CONTAMINATION. MOTORSARE STRESSED FOR OPERATION LOADS WITH MINIMUM S.F.=1.4 DUAL BEARING SURFACES EMPLOYED. BRAKE SPRING OVERDESIGNED FOR FUNCTION, CENTERED TO PRECLUDE COCKING. POSITION SWITCHES ARE HIGH REL PARTS.

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:

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- * VISUAL EXAMINATION TO VERIFY CONFORMANCE TO DRAWINGS, IDENTIFICATION MARKINGS, AND CLEANLINESS.
- * 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. ALL PURCHASED PARTS ARE 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 THE ACTUATOR IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

N/A FOR BRAKE COMPONENTS

CRITICAL PROCESSES

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

TESTING

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

HANDLING/PACKAGING
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:

EVA WORK AROUND CAN BE USED TO ACCOMPLISH SWING ARM MOTION.

- APPROVALS -

S&R ENGINEER	:A. NGUYEN	:/s/ Anh Nguyen_____
CARGO/INTEG ITM.	:J. CAPALENI	:/s/ Bob Dueease for_____
DESIGN ENGINEER	:P. HOE	:/s/ Pham Hoe_____
SSM	:L. J. SALVADOR	:/s/ Pham Hoe for_____
NASA/DCE	:B. BROWN	:/s/ B. Brown_____
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_____