

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- HARDWARE**NUMBER: M0-AG1-M13 -X****SUBSYSTEM NAME:** REMOTELY OPERATED ROFU UMBILICAL (ROFU)**REVISION:** 01/23/03**PART DATA**

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
:ROFU	V847-544100-001
:ARM ACTUATOR TELAIR (FORMERLY HOOVER ELECTRIC)	MC287-0057-0002 17820-2

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

MOTOR DRIVEN GEARBOX

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 MOVE THE SWING ARM TO THE STOW, MATE, AND RELAX POSITIONS.

FAILURE MODES EFFECTS ANALYSIS FMEA -- FAILURE MODE

NUMBER: M0-AG1-M13- 01

REVISION#: 01/23/03

SUBSYSTEM NAME: REMOTELY OPERATED FLUID UMBILICAL (ROFU)

LRU:

CRITICALITY OF THIS

ITEM NAME: ARM ACTUATOR

FAILURE MODE: 2R3

FAILURE MODE:

PHYSICAL BINDING/JAMMING, FAILS FREE

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, LOSS OF LUBRICANT, FAILURE/DEFLECTION OF INTERNAL PART, TEMPERATURE, FATIGUE, VIBRATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN **A) PASS**
 B) FAIL
 C) FAIL

PASS/FAIL RATIONALE:

- A)**
PRELAUNCH INSTALLATION AND CHECKOUT
- B)**
THERE IS NO SPECIFIC IN-FLIGHT INSTRUMENTATION TO SIGNAL GEARBOX CONDITION
- C)**
LOSS OF FUNCTION DUE TO SINGLE FAILURE OF THE SECONDARY GEARBOX (GEAR CAM)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF ARM'S DEPLOY/STOW/RELAX FUNCTIONS.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- FAILURE MODE
NUMBER: M0-AG1-M13- 01****(B) INTERFACING SUBSYSTEM(S):**

PAYLOAD CANNOT BE DEPLOYED DUE TO INABILITY TO STOW THE ROFU ARM IN ORDER TO PROVIDE REQUIRED CLEARANCE PRIOR TO PAYLOAD DEPLOYMENT.
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:

THESE FAILURE EFFECTS RESULT IN LOSS OF ARM DEPLOY/STOW/RELAX CAPABILITY. REQUIRING EVA WORK-AROUND TO PERFORM ARM DEPLOY/STOW/RELAX FUNCTIONS.

SUCCESS PATHS REMAINING AFTER FIRST FAILURE: 1

- TIME TO EFFECT -

REACTION TIME: SECONDS

-DISPOSITION RATIONALE-

(A) DESIGN:

GEARBOX IS SEALED TO EXCLUDE CONTAMINATION. DESIGN FACTOR OF SAFETY IS 1.4 X LIMIT LOAD. ALL COMPONENTS SHOW POSITIVE MARGINS BY ANALYSIS. DESIGN PRECLUDES DAMAGE UNDER STALLED CONDITION. EMERGENCY EVA DISCONNECT IS PROVIDED TO MANUALLY OVERRIDE INOPERATIVE GEARBOX.

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.
- * ENVIRONMENTAL TESTS - VIBRATION FOR 600 SEC/AXIS (STOWED). VIBRATION FOR 1400 SEC/AXIS (MATED) BY THE ROFU QUALIFICATION TEST. FIVE THERMAL / VACUUM CYCLES.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- FAILURE MODE
NUMBER: M0-AG1-M13- 01**

- * 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 ARM 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 ARE 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

PENETRANT INSPECTION OR MAGNETIC PARTICLE INSPECTION 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 ACTUATOR ASSEMBLY PRIOR TO DELIVERY IS VERIFIED BY INSPECTION PER APPLICABLE PROCEDURE.

HANDLING/PACKAGING

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- FAILURE MODE
NUMBER: M0-AG1-M13- 01**

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:

CONDUCT EVA WORKAROUND TO PERFORM ARM DEPLOY/STOW/RELAX FUNCTIONS.

- 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_____