

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE**  
**NUMBER: 02-1F-G08-A -X**

**SUBSYSTEM NAME: LANDING DECELERATION**

**REVISION: 0            06/27/88**

---

**PART DATA**

---

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
<b>LRU</b>	<b>: ACTUATOR, UPLOCK, MLG PARKER BERTEA</b>	<b>MC287-0033</b>

---

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
**ACTUATOR, UPLOCK**

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS: 2**  
**ONE IN EACH MAIN GEAR WHEEL WELL**

**FUNCTION:**  
**PROVIDES CAPABILITY FOR ACTUATING THE MECHANICAL LOCK RETAINING THE  
GEAR AND DOOR IN THE FULL UP AND CLOSED POSITION.**

**FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE**

**NUMBER: 02-1F-G08-A- 01**

**REVISION#: 1 08/04/97**

**SUBSYSTEM NAME: LANDING DECEL: LANDING GEAR ACTUATORS**

**LRU: ACTUATOR, UPLOCK, MLG**

**ITEM NAME: ACTUATOR, UPLOCK, MLG**

**CRITICALITY OF THIS FAILURE MODE: 1R2**

**FAILURE MODE:  
EXTERNAL LEAKAGE**

**MISSION PHASE: DO DE-ORBIT**

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

**CAUSE:  
MATERIAL DEFECT (CYLINDER RUPTURE), DAMAGED PISTON ROD SEAL,  
CONTAMINATION, FLOW REGULATOR LEAK, EXTEND PORT LEAK, RETRACT PORT LEAK -**

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

<b>REDUNDANCY SCREEN</b>	A) PASS
	B) PASS
	C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

**AT DOWN GEAR COMMAND - LOSS OF HYDRAULIC SYSTEM NUMBER ONE;  
PYROTECHNIC ACTUATOR FOR UNLOCKING GEAR.**

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE  
NUMBER: 02-1F-G08-A- 01**

**(B) INTERFACING SUBSYSTEM(S):**

NO HYDRAULIC POWER TO UNLOCK GEAR. LOSS OF HYDRAULIC REDUNDANCY TO NOSE WHEEL STEERING AND REDUNDANCY TO BRAKES, HOWEVER, DIFFERENTIAL BRAKING IS AVAILABLE FOR STEERING.

**(C) MISSION:**

NONE, ADEQUATE FLIGHT CONTROL. FULL GEAR DEPLOYMENT.

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

SAME AS (C)

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

POTENTIAL LOSS OF CREW/VEHICLE WITH TWO FAILURES: AFTER LOSS OF UPLOCK ACTUATOR FUNCTION AND FAILURE OF PYROTECHNIC DEPLOYMENT THE MAIN LANDING GEAR CANNOT BE DEPLOYED.

---

**-DISPOSITION RATIONALE-**

---

**(A) DESIGN:**

CYLINDER-BURST FACTOR IS 2.5. 2024-T851 ALUMINUM ALLOY PROVIDES OPTIMUM MIX OF STRENGTH/WEIGHT FOR ACTUATOR. ALLOWABLE STRESS IS 56,760 PSI AT 275 DEGREES F. ACTUAL CALCULATED CYLINDER HOOP STRESS (BURST) IS 50,653 PSI. MARGIN OF SAFETY IS 0.12. CYLINDER DESIGN USES VERY GRADUAL MATERIAL THICKNESS TRANSITIONS AND GENEROUS RADII TO AVOID STRESS CONCENTRATION EFFECTS. GLAND-MINIMUM MARGIN OF SAFETY EQUALS 0.24 IN SEAL GROOVE. ASSUMES CONSERVATIVE NOTCH FACTOR OF 3 AND MINIMUM MATERIAL THICKNESS. FATIGUE ANALYSIS 200,000 CYCLES, REQUIREMENT IS 6,000 CYCLES.

**(B) TEST:**

QUALIFICATION-ENDURANCE CYCLING IS 6,000 CYCLES. 1,500 CYCLES AT EACH FLUID TEMPERATURE: -35 DEGREES F, 65 DEGREES F, 175 DEGREES F, AND 275 DEGREES F. CYCLE RATE IS 100 PER HOUR MAXIMUM. RETRACT TIME IS 0.5 SECONDS. WITH A DELTA PRESSURE OF 2,460 PSI AND AN OPPOSING LOAD OF 3,800 POUNDS FOR 30 PERCENT OF STROKE AND 2,700 POUNDS FOR REMAINDER OF STROKE. BURST PRESSURE IS 7,500 PSI. THIS IS ALSO TESTED AS PART OF THE LANDING GEAR TEST ARTICLE (SIMULATOR).

ACCEPTANCE-PROOF PRESSURE, 4,500 PSI. LEAKAGE CHECK ONE DROP MAXIMUM IN 25 CYCLES AT OPERATING CONDITIONS. STATIC TEST AT 3,000 AND 50 PSI.

**GROUND TURNAROUND TEST**

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 02-1F-G08-A-01**

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD. THE OMRSD DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE. IF THERE IS ANY DISCREPANCY BETWEEN THE GROUND TESTING DATA PROVIDED BELOW AND THE OMRSD, THE OMRSD IS THE MORE ACCURATE SOURCE OF THE DATA.

OMRSD-HYDRAULIC SYSTEM INSPECTION, PERFORMED PRIOR TO EACH MISSION; LEFT AND RIGHT HAND WHEEL WELL ZONAL INTERNAL DETAIL INSPECTION, PERFORMED PRIOR TO EACH MISSION; VISUAL INSPECTION FOR EVIDENCE OF LEAKAGE OR DAMAGE. POST LANDING HYDRAULIC RESERVOIR EFFLUENT SAMPLES, PERFORMED AFTER EVERY FLIGHT; VERIFY THAT RESULTS OF FLUID SAMPLE CONTAMINATION MEET SPECIFICATION. GENERAL REQUIREMENT 5.2. VERIFY ALL HYDRAULIC FLUID USED TO SERVICE VEHICLE IS PER MIL-H-83282.

**(C) INSPECTION:**

RECEIVING INSPECTION  
RECORDS AND TEST REPORTS CERTIFYING MATERIAL AND PHYSICAL PROPERTIES ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL  
CONTAMINATION CONTROL PLAN IS IMPLEMENTED AND VERIFIED BY INSPECTION. STRICT COMPLIANCES WITH MACHINING SPECIFICATION AND CORROSION CONTROL PLAN REQUIRED AND COPIES OF THESE SPECIFICATIONS ARE INCLUDED IN EACH PLANNING PACKAGE AND VERIFIED BY INSPECTION.

CRITICAL PROCESSES  
HEAT TREAT AND CADMIUM PLATING PROCESSES ARE VERIFIED BY INSPECTION. SHOT PEENING (TO KEEP CHROME PLATING MICROCRACKS FROM REDUCING PARENT MATERIAL FATIGUE PROPERTIES) AND CHROME PLATING OF OUTPUT PISTON ROD ARE VERIFIED BY INSPECTION.

NDE  
PENETRANT INSPECTION OF CYLINDER IS VERIFIED BY INSPECTION. PENETRANT OR MAGNETIC PARTICLE INSPECTION OF DETAIL PARTS, DEPENDING ON THE ALLOY, IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION  
COMPONENT/PIECE PARTS ARE VERIFIED UNDAMAGED PRIOR TO CLEANING AND PACKAGING. QUALITY CONTROL WITNESSES TORQUING OF RESTRICTOR INTO MANIFOLD. QUALITY ASSURANCE WITNESSES SEAL AND BACKUP RING INSTALLATION AND ALL TORQUES. MIPS ARE IMPOSED FOR IN-PROCESS ACCEPTANCE TEST WITNESSING, DATA PACK REVIEW, HARDWARE SHIPMENTS AND ALL FAILURES. ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION.

TESTING  
ATP IS WITNESSED BY RI SOURCE INSPECTION.

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

**(D) FAILURE HISTORY:**

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE  
NUMBER: 02-1F-G08-A- 01

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. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE.

(A6055-010) DURING QUALIFICATION TESTING, WHILE PERFORMING LOW TEMPERATURE ENDURANCE CYCLING AT -35 DEGREES F, THE UNIT EXHIBITED EXTERNAL LEAKAGE AT THE ROD END. THE CAUSE WAS A LOSS OF SEAL RESILIENCY AT LOW TEMPERATURE, DUE TO EXPOSURE TO A COMBINATION OF HIGH TEMPERATURES AND PRESSURES DURING PREVIOUS TESTS. THE PROCUREMENT SPECIFICATION WAS REVIEWED BY THE ENGINEERING COMMUNITY AND WAS FOUND TO BE TOO STRICT, THEREFORE THE SPECIFICATION WAS CHANGED TO INCREASE THE ALLOWABLE LEAKAGE AND THE METHOD OF PERFORMING LEAKAGE TESTING WAS ALSO REVISED.

(E) OPERATIONAL USE:

DIFFERENTIAL BRAKING FOR STEERING IF SYSTEM ONE IS LOST. PYROTECHNIC ACTUATOR WILL DEPLOY/UNLOCK GEAR. HYDRAULIC SYSTEM ONE ISOLATION VALVE CAN BE CLOSED AFTER DETECTION OF LEAK FOR SYSTEM ISOLATION.

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: <u>J. Kimura 8/4/97</u>
EDITORIALLY APPROVED	: JSC	: <u>A. Sorey</u>
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-011/02-1F