

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE  
NUMBER: 02-6-C07-IM -X**

**SUBSYSTEM NAME: HYDRAULICS**

**REVISION: 3      07/24/98**

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**PART DATA**

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<b>PART NAME</b>	<b>PART NUMBER</b>
<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU : VALVE, LATCHING	MC284-0469

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

VALVE, SHUTOFF, SOLENOID OPERATED LATCHING, (BRAKE ISOLATION VALVE 1 AND LANDING GEAR EXTEND ISOLATION VALVE)

**REFERENCE DESIGNATORS:** 50V58LV26 (BRAKE ISO 1)  
50V58LV43 (EXTEND ISO)

**QUANTITY OF LIKE ITEMS: 2**

TWO IN HYDRAULIC POWER SYSTEM #1 LANDING GEAR DISTRIBUTION LINES (LV43 AND LV26)

**FUNCTION:**

ONE VALVE (LV43) ISOLATES THE LANDING GEAR HYDRAULIC CIRCUIT FROM THE HYDRAULIC POWER SYSTEM #1 WHEN POWER IS NOT REQUIRED. THE OTHER VALVE (LV26) ISOLATES THE MAIN LANDING GEAR HYDRAULIC BRAKE CIRCUIT FROM THE HYDRAULIC POWER SYSTEM #1 WHEN POWER OR THERMAL CONDITIONING FLUID FLOW IS NOT REQUIRED. A CHECK VALVE IS PROVIDED INTERNAL TO BOTH VALVES ON THE OUTLET SIDE. ON LV43 THIS CHECK VALVE IS NECESSARY FOR LANDING GEAR STOWAGE/DEPLOYMENT WITH GSE. ONE SOLENOID OPENS VALVE AND ONE SOLENOID CLOSES VALVE. HYDRAULIC PRESSURE IS REQUIRED IN CONJUNCTION WITH SOLENOID COMMAND TO CYCLE VALVE. A VALVE POSITION INDICATION SWITCH IS ALSO PROVIDED.

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

NUMBER: 02-6-C07-IM-02

REVISION#: 3 07/24/98

SUBSYSTEM NAME: HYDRAULICS

LRU: VALVE, LATCHING

ITEM NAME: VALVE, LATCHING

CRITICALITY OF THIS

FAILURE MODE: 1R2

**FAILURE MODE:**

FAILS TO OPEN OR PREMATURE CLOSING

MISSION PHASE: DO DE-ORBIT

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

**CAUSE:**

FAILURE OF LATCHING MECHANISM, CONTAMINATION, VIBRATION, STRUCTURAL FAILURE OF CLOSING SOLENOID VALVE PLUNGER, DEFECTIVE SOLENOID (FAILS TO OPEN ONLY), FAILED CLOSED CHECK VALVE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

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

**PASS/FAIL RATIONALE:**

A)

B)

VALVE HAS POSITION INDICATION

C)

**- FAILURE EFFECTS -****(A) SUBSYSTEM:**

LOSS OF REDUNDANT HYDRAULIC POWER TO ONE BRAKE SYSTEM (LV26 ONLY). LOSS OF HYDRAULIC POWER TO MAIN LANDING GEAR CIRCUIT (LV43 ONLY) AND LOSS OF

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REDUNDANT HYDRAULIC POWER TO NOSE LANDING GEAR CIRCUIT AND NOSE WHEEL STEERING.

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

LOSS OF SYSTEM 1 HYDRAULIC POWER TO THE BRAKES (LV26 ONLY). SYSTEM 1 IS PRIMARY SUPPLY FOR HALF BRAKES. LOSS OF HYDRAULIC MAIN LANDING GEAR DEPLOYMENT (LV43 ONLY). ALSO, LOSS OF CAPABILITY FOR ON ORBIT THERMAL CONDITIONING FOR SYSTEM 1 BRAKE LINES (LV26 ONLY). (CRIT. 3/3).

**(C) MISSION:**

NO EFFECT

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

NO EFFECT

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

POSSIBLE LOSS OF CREW/VEHICLE DUE TO INABILITY TO DEPLOY MAIN LANDING GEAR AFTER TWO FAILURES; THIS FAILURE (WITH LV43) AND FAILURE OF PYROTECHNIC DEPLOY BACKUP TO RELEASE GEAR. ALSO, POSSIBLE LOSS OF CREW/VEHICLE WITH THREE FAILURES. THIS FAILURE (LV43 ONLY), LOSS OF HYDRAULIC SYSTEM 2 SUPPLY TO NOSE, LOSS OF THE NOSE GEAR BACKUP UPLOCK PYRO CARTRIDGE RESULTING IN THE LOSS OF CAPABILITY TO DEPLOY THE NOSE LANDING GEAR. ALSO, POSSIBLE LOSS OF CREW/VEHICLE WITH THREE FAILURES; THIS FAILURE (LV26 ONLY), LOSS OF NOSEWHEEL STEERING (NUMEROUS SINGLE-POINT FAILURES EXIST, E.G., SWITCHING VALVE FAILURE), AND LOSS OF HYDRAULIC SYSTEM 3 TO BRAKES. THIS RESULTS IN 50 PERCENT BRAKES WITH NO NOSE WHEEL STEERING (CRIT 1).

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

LATCHING VALVE:

BI-STABLE DESIGN, LATCHED IN POSITION, REQUIRES ELECTRICAL ACTUATION OF A SOLENOID PLUS PRESSURE TO UNLATCH SPOOL AND CHANGE SPOOL POSITION. ONE OF TWO SOLENOIDS OPENS VALVE, OTHER SOLENOID CLOSES VALVE. SHOULD SOLENOID PLUNGER FAIL OR LATCH SPRING FAIL, THE "GLYD" RING SPOOL FRICTION WILL TEND TO PREVENT PREMATURE SPOOL TRANSLATION. LEE JET 100 MICRON FILTER INTERNAL TO VALVE ASSISTS IN PREVENTING CONTAMINATION FROM ENTERING THE LATCHING MECHANISM AREA.

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**CHECK VALVE:**

HYDRAULIC SYSTEM FILTER IS 5 MICRON NOMINAL, 15 MICRON ABSOLUTE, HIGH SYSTEM DELTA PRESSURE ACROSS THE VALVE WILL TEND TO OVERCOME ANY INCREASED CRACKING PRESSURE DUE TO CONTAMINATION AND MAINTAIN VALVE IN OPEN POSITION. LOW STRESSED 18-8 HIGH STRENGTH STAINLESS STEEL SPRING FOR HIGH ENDURANCE LIMIT. POPPET AND GUIDE ARE CONSTRUCTED OF 440C CRES AND 17-4 PH CRES RESPECTIVELY TO MINIMIZE CHANCE OF BINDING.

**(B) TEST:**

**QUALIFICATION:**

ENDURANCE CYCLING - 10,000 CYCLES AT 0 DEGREES F, 5,000 CYCLES AT 35 DEGREES F AND 5,000 CYCLES AT 95 DEGREES F AT SYSTEM OPERATING PRESSURE. PASS/FAIL CRITERIA: MUST PASS PERFORMANCE RECORD TEST.

IMPULSE TEST - 3,000-4,500-3,000 PSI, 120/MINUTE MAXIMUM APPLIED TO INLET. 45,000 CYCLES WITH VALVE IN CLOSED MODE WITH OUTLET OPEN. 5,000 CYCLES WITH VALVE IN OPEN MODE WITH OUTLET BLOCKED. 1,500 - 2,250 - 1,500 PSI, APPLIED AT THE SPOOL DRAIN PORT. 50,000 CYCLES. PASS/FAIL CRITERIA: MUST PASS PERFORMANCE RECORD TEST.

RANDOM VIBRATION - 5 MINUTES PER AXIS AT 20-50 HZ + 6 DB/OCT, 50-2000 HZ 0.01 G2/HZ PASS/FAIL CRITERIA: SUCCESSFUL PASSAGE OF PERFORMANCE RECORD TEST PLUS NO DAMAGE TO VALVE.

PERFORMANCE RECORD TEST - ELECTRICAL POWER TEST, LOW VOLTAGE TEST, POSITION INDICATOR TEST, RESPONSE TIME TEST, VALVE OPERATION TEST, AND A LEAKAGE TEST.

**ACCEPTANCE:**

EXAMINATION OF PRODUCT - WEIGHT, WORKMANSHIP, FINISH, DIMENSIONS, AND CONSTRUCTION.

INSULATION RESISTANCE TEST - CONNECT SPECIFIED PINS TOGETHER AND APPLY 500 VDC BETWEEN PINS. PASS/FAIL CRITERIA: RESISTANCE SHALL BE GREATER THAN 100 MEGOHMS (PER MIL-STD-202, METHOD 302).

PROOF TEST - 4,500 PSI.

PERFORMANCE RECORD TEST - ELECTRICAL POWER TEST, LOW VOLTAGE TEST, POSITION INDICATOR TEST, RESPONSE TIME TEST, VALVE OPERATION TEST, AND A LEAKAGE TEST.

VALVE CLEANLINESS TEST - LEVEL 190 PER MAO110-301.

**GROUND TURNAROUND TEST**

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

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**(C) INSPECTION:**

**RECEIVING INSPECTION**

RECEIVING INSPECTION VERIFIES MATERIAL AND PROCESS CERTIFICATION.

**CONTAMINATION CONTROL**

CLEANLINESS LEVEL OF 190 PER MAO110-301 IS VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**

SPOOL ASSEMBLY WELDS ARE PENETRANT AND RADIOGRAPHICALLY INSPECTED,  
VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

PASSIVATION IS VERIFIED BY INSPECTION. SOLDERING IS VERIFIED BY INSPECTION.  
WELDING OF SPOOL ASSEMBLIES IS VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION BY PRODUCTION  
PROCEDURES DURING MANUFACTURING THROUGH ASSEMBLY. INSPECTION VERIFIES  
THAT CONTRACTUAL AND TRACEABILITY REQUIREMENTS ARE IMPOSED ON ALL  
ELECTRICAL PARTS. MACHINING AND ASSEMBLY OPERATIONS ARE VERIFIED BY  
INSPECTION. SOLENOID FABRICATION IS VERIFIED BY INSPECTION. INSPECTION  
VERIFIES THAT ALL O-RINGS/SINGLE BACK UP RINGS ARE PROPERLY IN PLACE AND NO  
INSTALLATION DAMAGE OCCURS PRIOR TO ASSEMBLING INTO MATING PART.

**TESTING**

ATP IS VERIFIED BY RI INSPECTION.

**HANDLING/PACKAGING**

HANDLING/PACKAGING OF COMPONENTS IS 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. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO  
LONGER BEING KEPT UP-TO-DATE.

(AD2170-010) (1984, OV104) DURING SUBSYSTEM CHECKOUT, THE VALVE FAILED TO  
OPEN. A PARTICLE OF URETHANE FOAM WAS FOUND DURING DISASSEMBLY. IT WAS  
CONCLUDED THAT THE PARTICLE WAS INTRODUCED DURING THE VALVE ASSEMBLY  
PROCESS, AND WAS AN ISOLATED OCCURRENCE. THERE WAS NO CORRECTIVE  
ACTION; HOWEVER, THE SUPPLIER HAS A NEW ASSEMBLY AREA WHICH WAS SURVEYED  
FOR FOREIGN MATERIAL.

**(E) OPERATIONAL USE:**

CREW WILL ATTEMPT TO RE-OPEN VALVE.

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- APPROVALS -

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EDITORIALLY APPROVED

: BNA

: *J. Korman 7-30-98*

TECHNICAL APPROVAL

: VIA APPROVAL FORM

: 95-CIL-009\_02-6