FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-6-G13-IM -X

SUBSYSTEM NAME: HYDRAULICS

REVISION: 2 03/31/92

PART DATA

	PART NAME **VENDOR NAME**	**PART NUMBER** **VENDOR NUMBER**
LRU	: VALVE, LANDING GEAR CONTROL	MC621-0029-0005

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
SERIES RETRACT VALVES, LANDING GEAR CONTROL (RETRACT 1 AND 2), SINGLE SOLENOID OPERATED 2 POSITION/3 WAY.

REFERENCE DESIGNATORS: 67V58LV25
67V58LV41

QUANTITY OF LIKE ITEMS: 2
TWO IN HYDRAULIC POWER SYSTEM #1 RETRACT SIDE (LV25 AND LV41) OF THE LANDING GEAR CIRCUIT

FUNCTION:
BOTH RETRACT (LV25 AND LV41) VALVES CONTROL THE RETRACT SIDE OF THE LANDING GEAR CIRCUIT OF POWER SYSTEM #1. GSE CONTROL POWER IS REQUIRED FOR STOWING/RETRACTING THE LANDING GEAR (NO INFLIGHT CAPABILITY) IN ADDITION, LV25 PROVIDES A RETURN PATH FOR THE LANDING GEAR CIRCUIT, AND LV41 PROVIDES A REDUNDANT RETURN PATH IF LV25 FAILS OPEN. WHEN THE VALVE IS CLOSED (DE-ENERGIZED), FLOW IS VENTED FROM THE RETRACT LINE TO RETURN DURING EXTENSION, AND SYSTEM 1 PRESSURE IS ISOLATED FROM THE RETRACT SIDE. HYDRAULIC PRESSURE AND SOLENOID POWER ARE REQUIRED TO OPEN VALVE. WHEN VALVE IS OPEN (ENERGIZED) BY GSE COMMANDS (GROUND OPERATION ONLY) HYDRAULIC SYSTEM 1 PRESSURE IS DIRECTED TO RETRACT SIDE FOR GEAR RETRACTION.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE
NUMBER: 02-6-G13-IM- 04

REVISION#: 4 07/24/98

SUBSYSTEM NAME: HYDRAULICS
LRU: VALVE, LANDING GEAR CONTROL
ITEM NAME: VALVE, LANDING GEAR CONTROL

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
JAMS IN INTERMEDIATE POSITION (RETURN PATH RESTRICTED)

MISSION PHASE: DO DE-ORBIT

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

CAUSE:
GALLING DUE TO CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) FAIL
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)
NO VERIFICATION METHOD OR INSTRUMENTATION AVAILABLE TO INDICATE EXACT VALVE POSITION. PRESSURE SWITCH (V51X0074W) INDICATES SOME RETURN PATH IS AVAILABLE THROUGH LV41. STRUT ACTUATOR SHUTTLE VALVE INDICATES SOME RETURN PATH IS AVAILABLE THROUGH LV25. NEITHER OF THESE INSTRUMENTS WILL DETECT RESTRICTED RETURN PATH.

B)
NO INSTRUMENTATION AVAILABLE DURING FLIGHT TO INDICATE VALVE POSITION. PRESSURE SWITCH (V51X0074W) INDICATION AVAILABLE DURING GROUND OPERATION ONLY.

C)

- FAILURE EFFECTS -

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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(A) SUBSYSTEM:
LV25 FAILURE - LOSS OF HYDRAULIC RETURN PATH. POTENTIAL LOSS OF HYDRAULIC LANDING GEAR DEPLOY AND POWERED NOSEWHEEL STEERING.
LV41 FAILURE - LOSS OF 1 OF 2 HYDRAULIC FLOW PATHS TO RETURN.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT FOR LV25 FAILURE. LOSS OF HYDRAULIC LANDING GEAR DEPLOY CAPABILITY. PYRO DEPLOY IS NECESSARY.
NO EFFECT FOR LV41 FAILURE PRIMARY FLOW PATH THROUGH LV25 IS AVAILABLE FOR HYDRAULIC LANDING GEAR DEPLOY.

(C) MISSION:
NO EFFECT

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT

(E) FUNCTIONAL CRITICALITY EFFECTS:
CRIT 1R2 - LV25 FAILURE - POSSIBLE LOSS OF CREW/VEHICLE DUE TO INABILITY TO UNLOCK AND EXTEND LANDING GEARS AFTER TWO FAILURES: THIS FAILURE AND LOSS OF PYRO DEPLOY CAPABILITY.
CRIT 1R3 - LV41 FAILURE - POSSIBLE LOSS OF CREW/VEHICLE WITH THREE FAILURES: THIS FAILURE. PLUS PREMATURE TRANSFER OF THE REDUNDANT LANDING GEAR RETRACT VALVE (LV25) TO THE OPEN POSITION, AND FAILURE OF PYROTECHNIC BACKUP TO RELEASE MAIN GEAR.

-DISPOSITION RATIONALE-

(A) DESIGN:
SPRING MATERIAL IS 302 CRES AND SPRING IS COMPLETELY CONTAINED. PLUNGER IS 440C CRES. ANALYSIS ALLOWING COMPLETE LOSS OF ONE EFFECTIVE SPRING COIL INDICATES AVAILABLE PRESSURE WILL NOT OPEN VALVE (UNSEAT BALL). SUPPLIER STANDARD BALL TYPE DESIGN USED ON VARIETY OF PROPRIETARY PILOT OPERATED FLUID CONTROLS FOR AIRCRAFT INDUSTRY OVER 50,000 PILOT VALVE UNITS BUILT. SOLENOID COIL IS HERMETICALLY SEALED, ISOLATING IT FROM THE HYDRAULIC FLUID.

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(B) TEST:
QUALIFICATION:
ENDURANCE CYCLING TEST - 20,000 CYCLES AT RATED FLOW AND PRESSURE. 8,000 AT 35 DEG F. 2,000 AT 0 DEG F AND 10,000 AT 275 DEG F WITH A RATE OF 6 CYCLES/MINUTE.

IMPULSE CYCLING TEST 50,000 IMPULSE CYCLES AT 3,000-4,500-3,000 PSI AT 2 HZ.

BURST PRESSURE TEST - TESTED AT 7,500 PSI.

ACCEPTANCE:
PROOF PRESSURE TEST - TESTED AT 4,500 PSIG PRESSURE PORT ONLY; 4,500 PSIG CYLINDER AND PRESSURE PORT; 2,250 PSIG RETURN PORT ONLY. PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR PERMANENT DEFORMATION.

GROUND TURNAROUND TEST
NONE (FAILURE UNDETECTABLE ON THE GROUND WITHOUT INVASIVE PROCEDURE).

(C) INSPECTION:
RECEIVING INSPECTION
RECEIVING INSPECTION VERIFIES MATERIAL AND PROCESS CERTIFICATIONS (RAW MATERIAL, PLATING AND COATING). PROCURED PARTS ARE VERIFIED AT RECEIVING INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS IS VERIFIED BY INSPECTION TO BE WITHIN SPECIFICATION REQUIREMENTS PER MA0110-301, LEVEL 190 CLEANLINESS OF SOLENOID IS VERIFIED BY INSPECTION TO BE WITHIN SPECIFICATION REQUIREMENTS. CLEANLINESS OF TEST FLUID USED DURING ACCEPTANCE TESTING IS VERIFIED BY INSPECTION TO BE WITHIN SPECIFICATION REQUIREMENTS

CRITICAL PROCESSES
SURFACE TREATMENT (PASSIVATION) IS VERIFIED BY INSPECTION HEAT TREATMENT AND SOLDERING ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
SOLENOID BUILD-UP, IN-PROCESS TESTING, AND COMPLETED SOLENOID ASSEMBLY ARE VERIFIED BY INSPECTION CRITICAL DIMENSIONS ARE VERIFIED BY INSPECTION.

TESTING
ACCEPTANCE TESTS (PROOF PRESSURE, LEAKAGE, DIELECTRIC WITHSTANDING VOLTAGE, INSULATION RESISTANCE FUNCTIONS) ARE VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING AND STORAGE OF COMPONENTS TO PREVENT EXTERNAL DAMAGE IS VERIFIED BY INSPECTION

(D) FAILURE HISTORY:

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CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE.

ONE RELEVANT FAILURE IS DOCUMENTED ON CAR KB2497. SERIES RETRACT VALVE IS LV25 FAILED IN INTERMEDIATE POSITION DUE TO GALLING.

(E) OPERATIONAL USE:
NONE

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: J. Komura 7-30-98
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 95-CIL-009_02-6