

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-6-E06 -X**

SUBSYSTEM NAME: HYDRAULICS

REVISION: 1 07/24/98

PART DATA

| | PART NAME | PART NUMBER |
|-----|------------------------------------|----------------------|
| | VENDOR NAME | VENDOR NUMBER |
| LRU | .PUMP, APU DRIVEN MAIN HYD ABEX | MC281-0029 |

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
PUMP, APU DRIVEN MAIN HYDRAULIC**

REFERENCE DESIGNATORS: 50V58PP4
50V58PP5
50V58PP6

QUANTITY OF LIKE ITEMS: 3
ONE IN EACH HYDRAULIC POWER SYSTEM

FUNCTION:
PROVIDE HYDRAULIC POWER FOR HYDRAULIC SUBSYSTEM WITH PROVISION FOR
ELECTRICAL DEPRESSURIZATION.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 02-6-E06-02

REVISION#: 2 07/24/98

SUBSYSTEM NAME: HYDRAULICS
LRU: PUMP, APU DRIVEN MAIN HYD
ITEM NAME: PUMP, APU DRIVEN MAIN HYD

CRITICALITY OF THIS FAILURE MODE: CR2

FAILURE MODE:
WILL NOT DEPRESSURIZE ON ELECTRICAL COMMAND

MISSION PHASE: DO DE-ORBIT

| | | |
|---|-----|-----------|
| VEHICLE/PAYLOAD/KIT EFFECTIVITY: | 102 | COLUMBIA |
| | 103 | DISCOVERY |
| | 104 | ATLANTIS |
| | 105 | ENDEAVOR |

CAUSE:
DEFECTIVE SOLENOID, PREMATURE SOLENOID CLOSING, SEIZED DEPRESSURIZATION PISTON

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF ONE HYDRAULIC SYSTEM DUE TO INABILITY TO RESTART APU.

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(B) INTERFACING SUBSYSTEM(S):

HYDRAULIC LANDING GEAR DEPLOYMENT CAPABILITY WOULD BE LOST IF SYSTEM ONE IS LOST LOSS OF ONE HYDRAULIC POWER SYSTEM TO FLIGHT CONTROL SURFACES, BRAKES AND NOSEWHEEL STEERING. POSSIBLE APU FUEL DEPLETION DURING AOA ABORT DUE TO INABILITY TO GO TO DEPRESSURIZATION.

(C) MISSION:

NONE. COMMITTED

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

NONE. COMMITTED

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE LOSS OF CREW/VEHICLE WITH TWO FAILURES: THIS FAILURE, PLUS LOSS OF SECOND HYDRAULIC SYSTEM.

-DISPOSITION RATIONALE-

(A) DESIGN:

ROTATING GROUP INCLUDING BEARINGS, DRIVE SHAFT, HANGER, COMPENSATOR SPOOL AND SLEEVE SIMILAR TO F-14 PUMP. DESIGN LIFE IS 750 HOURS. BEARINGS APPLIED LOADS ARE SMALL PERCENTAGE OF RATINGS. SHEAR SECTION OF DRIVE SHAFT FAILS WITHIN 3.5 PERCENT OF DESIGN TORQUE. THE COMPENSATOR VALVE SLEEVE AND SPOOL ARE STEEL HARDENED AND LAPPED FOR MATCHED SET. THE DEPRESSURIZATION AND STROKING PISTONS ARE HARDENED STEEL. THE DEPRESSURIZATION PISTON IS NOT LIKELY TO SEIZE DUE TO HARDENED MATING SURFACES OF CAP (440 STEEL RC 58-61) AND DEPRESS PISTON (TOOL STEEL RC 58-62). SPRINGS ARE DESIGNED TO LOW STRESS. SOLENOID COIL HERMETICALLY SEALED.

(B) TEST:

QUALIFICATION:

ENDURANCE CYCLING TEST - 750 HOURS OF OPERATION AT VARYING FLOW RATES. 33% OF TEST AT 240 DEG F. 67% OF TEST AT 192 DEG F.

OPERATING PROOF PRESSURE TEST - TESTED AT 240 DEG F, AT 125% RATED SPEED, 125% RATED DISCHARGE PRESSURE (AT NO FLOW). 10 CYCLES PER MINUTE FOR 5 MINUTES. PASS/FAIL CRITERIA: SHAFT SEAL LEAKAGE SHALL NOT EXCEED 5 CC/HR.

NON-OPERATING PROOF PRESSURE TEST - TESTED AT 275 DEG F, 160 PSIG TO INLET (CASE DRAIN AND OUTLET PORTS PLUGGED). 300 PSIG TO CASE DRAIN (OTHER PORTS

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OPEN; 4500 PSIG TO OUTLET (OTHER PORTS OPEN AND SHAFT RESTRAINED), AND 1500 PSIG TO ELECTRO DEPRESSURIZATION VALVE (EDV) DEPRESS CIRCUIT WITH EDV SOLENOID ENERGIZED. PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR PERMANENT SET.

BURST TEST - TESTED AT 275 DEG F, 7,500 PSIG PRESSURE OUTLET PORT, 320 PSIG RETURN, 500 PSIG CASE DRAIN, AND 2,500 PSIG EDV DEPRESS CIRCUIT. PASS/FAIL CRITERIA: PUMP SHALL NOT RUPTURE.

COIL PERFORMANCE TEST- COIL ENERGIZED AT 32 VDC FOR 1 HR. PASS/FAIL CRITERIA: OPERATING CURRENT SHALL NOT EXCEED 1.5 AMPS.

ENDURANCE CYCLING TEST (SOLENOID) - 50,000 ENERGIZE/DE-ENERGIZE CYCLES, TESTED AT 32 VDC. PASS/ FAIL CRITERIA: SUBSEQUENT PASSAGE OF ELECTRICAL POWER TEST.

ENDURANCE CYCLING TEST (EDV DEPRESS CIRCUIT) - 2,000 CYCLE OPERATIONAL TEST WHILE OPERATING THE PUMP AT RATED SPEED. THE PUMP IS CYCLED BETWEEN RATED PRESSURE AND DEPRESSURIZED PRESSURE. FLOW CONDITION IS AT APPROXIMATELY 5 GPM IN DEPRESSURIZED MODE AND 12 GPM MAX. IN THE PRESSURIZED MODE. PASS/FAIL CRITERIA: NO EVIDENCE OF STICKING OR BINDING OF PISTON IN CAP, OR CAP DAMAGE.

ACCEPTANCE.

EXAMINATION OF PRODUCT - WEIGHT, WORKMANSHIP, FINISH, DIMENSIONS, AND CONSTRUCTION. PRESSURE, DEPRESSURIZED START, PRESSURIZATION

ELECTRICAL POWER TEST - TESTED AT 100-125 DEG F, 3,000 PSIG FOR ENERGIZING, 750 PSIG FOR DE-ENERGIZING, FOR 5 CYCLES AT VARYING VOLTAGES UP TO 32 VDC. PASS/FAIL CRITERIA: STEADY-STATE CURRENT SHALL NOT EXCEED 1.5 AMPS.

ENDURANCE TEST - TESTED AT 100-125 DEG F, 2,950 PSIG PRESSURE, 55-75 PSIG RETURN FOR 18 HRS (3 HRS AT 30-75% OF RATED SPEED, 15 HRS AT 80-100% RATED SPEED, 3918 RPM, AND 66.3 GPM). PASS/FAIL CRITERIA: NO EVIDENCE OF MALFUNCTION.

NON-OPERATING PROOF TEST- TESTED AT 300 PSIG TO INLET PORT AND CASE DRAIN, 4,500 PSIG TO OUTLET PORT, 1,500 PSIG TO EDV DEPRESS CIRCUIT (EDV SOLENOID ENERGIZED). PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR PERMANENT SET.

OVERSPEED TEST- TESTED AT 4,898 RPM, 2,900-3,000 PSIG AND CYCLING BETWEEN ZERO TO FULL FLOW FOR 50 CYCLES. PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR MALFUNCTION. SHAFT SEAL LEAKAGE SHALL NOT EXCEED 1.5 CC/HR.

CALIBRATION TEST - TESTED AT 240 DEG F AT VARYING SPEEDS, FLOW RATES, AND DISCHARGE PRESSURES. PASS/FAIL CRITERIA: OVERALL EFFICIENCY SHALL BE GREATER THAN 85%.

DEPRESSURIZED START TEST - DEPRESSURIZED START-UP TO VERIFY 500-1000 PSIG DISCHARGE PRESSURE AT RATED SPEED AND 0, 2, AND 5 GPM.

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PRESSURIZATION TEST - WITH PUMP RUNNING AT RATED SPEED AND NO FLOW IN DEPRESS MODE. PRESSURIZE PUMP TO OPERATING PRESSURE, THEN DEPRESSURIZE PUMP. PASS/FAIL CRITERIA PRESSURIZATION/DEPRESSURIZATION RESPONSE TIME SHALL NOT EXCEED 1 SECOND.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

MATERIAL CERTIFICATION AND PROCESS CERTIFICATION ARE IMPOSED AND VERIFIED BY INSPECTION. BEARING-ROLLER DATA PACKAGE REVIEWED. STROKING PISTON DATA PAK IS REVIEWED AND VISUAL EXAMINATION IS PERFORMED BY RECEIVING INSPECTION. SLEEVE-COMPENSATOR AND SPOOL COMPENSATOR DATA PAKS ARE REVIEWED AND A VISUAL INSPECTION IS PERFORMED BY RECEIVING INSPECTION. THE RATE SPRING AND COMPENSATOR SPRING DATA PAKS ARE REVIEWED AND A VISUAL INSPECTION IS PERFORMED BY RECEIVING INSPECTION.

CONTAMINATION CONTROL

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

CRITICAL PROCESSES

HEAT TREATMENT PROCESS IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

MAGNETIC PARTICLE INSPECTION AND DYE PENETRANT ARE PERFORMED AND VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

HARDNESS CHECK OF EXTERNAL DRIVE SHAFT IS PERFORMED. PROCESSING SEQUENCE OF EXTERNAL DRIVE SHAFT IS VERIFIED BY INSPECTION. INSPECTION OF ALL FOUR PLACE DIMENSIONS. MACHINE FINISHES ARE VERIFIED BY INSPECTION. ALL TRUE DIMENSIONS ARE VERIFIED BY INSPECTION. SOLENOID DATA PACKAGE IS REVIEWED AND SOME DIMENSIONAL INSPECTIONS ARE PERFORMED.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING REQUIREMENTS 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.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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ONE FAILURE TO DEPRESSURIZED ON COMMAND IS DOCUMENTED ON CAR NO. 36RF19-010 (MC281-0029-0006) THE -0007 CONFIGURATION ADDED A 440 CRES SLEEVE TO THE DEPRESS PISTON CAP TO PREVENT GALLING AND TO PROVIDE ADDED QUAL TESTING.

(E) OPERATIONAL USE:

NONE; HOWEVER, APU RESTART MAY BE ATTEMPTED IN AUTOMATIC SHUTDOWN INHIBIT.

- APPROVALS -

EDITORIALLY APPROVED
TECHNICAL APPROVAL

. BNA
. VIA APPROVAL FORM

J. Kemura 7-30-98
. 95-CIL-009_02-6 .