

**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-E06-03

REVISION#: 1 07/24/98

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

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:

INABILITY TO MAINTAIN SYSTEM PRESSURE ON DEMAND

MISSION PHASE:

LO LIFT-OFF
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

JAMMED STROKING PISTON, BROKEN CAM SPRING, HANGER BEARING FAILURE, BROKEN COMPENSATOR SPRING, CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

RTLS RETURN TO LAUNCH SITE

REDUNDANCY SCREEN

A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

REDUCED SYSTEM PRESSURE. POSSIBLE LOSS OF ONE HYDRAULIC SYSTEM AT FUNCTIONS DUE TO AUTOMATIC OPERATION OF SWITCHING VALVES OR DUE TO

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REQUIRED SHUTDOWN TO PREVENT SWITCHING VALVE INSTABILITY. LOSS OF ONE OF THREE HYDRAULIC SYSTEMS.

(B) INTERFACING SUBSYSTEM(S):

LOSS OF HYDRAULIC POWER FOR ENGINE VALVE CONTROL FOR ONE ENGINE RESULTING IN LOSS OF ONE SSME THRUST CONTROL; HOWEVER, ENGINE VALVES WILL LOCK INTO POSITION AND ENGINE WILL CONTINUE TO OPERATE. LOSS OF REDUNDANT HYDRAULIC POWER SYSTEM FOR FOUR TVC ACTUATORS. LOSS OF NOSE WHEEL STEERING AND HYDRAULIC LANDING GEAR DEPLOYMENT CAPABILITY IF SYSTEM ONE IS LOST. LOSS OF ONE OF THREE HYDRAULIC POWER SYSTEMS TO FLIGHT CONTROL SURFACES AND BRAKES. LOSS OF ONE OF THREE ET UMBILICAL RETRACT ACTUATORS FOR EACH UMBILICAL PLATE.

(C) MISSION:

ABORT DECISION OR POSSIBLE EARLY MISSION TERMINATION.

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

NONE

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE LOSS OF CREW/VEHICLE WITH TWO FAILURES: THIS FAILURE, PLUS LOSS OF SECOND HYDRAULIC SYSTEM. CRITICALITY 1 FOR SSME INDUCED RTLS.

-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. 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 STEEL. SPRINGS ARE DESIGNED TO LOW STRESS. SOLENOID COIL IS HERMETICALLY SEALED

(B) TEST:

QUALIFICATION:

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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- 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 OPEN), AND 4500 PSIG TO OUTLET (OTHER PORTS OPEN AND SHAFT RESTRAINED). PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR PERMANENT SET.
- BURST TEST - TESTED AT 275 DEG F, 7,500 PSIG PRESSURE, 320 PSIG RETURN AND 500 PSIG CASE DRAIN. PASS/FAIL CRITERIA: PUMP SHALL NOT RUPTURE.
- ENDURANCE CYCLING TEST (SOLENOID) - 50,000 ENERGIZE/DE-ENERGIZE CYCLES. TESTED AT 100 DEG F, 32 VDC, 3918 RPM PUMP SPEED, 66.3 GPM, AND 2950 PSIG OUTLET PRESSURE. PASS FAIL/CRITERIA: SUBSEQUENT PASSAGE OF ELECTRICAL POWER TEST.

ACCEPTANCE:

- EXAMINATION OF PRODUCT - WEIGHT, WORKMANSHIP, FINISH, DIMENSIONS AND CONSTRUCTION.
- COIL PERFORMANCE TEST - COIL ENERGIZED AT 32 VDC FOR 1 HR. PASS/FAIL CRITERIA: OPERATING CURRENT SHALL NOT EXCEED 1.5 AMPS
- ELECTRICAL POWER TEST - TESTED AT 100 DEG F, 3000 PSIG FOR ENERGIZING 750 PSIG FOR DE-ENERGIZING, FOR 6 CYCLES AT VARYING VOLTAGES UP TO 32 VDC. PASS/FAIL CRITERIA: STEADY-STATE CURRENT SHALL NOT EXCEED 1.5 AMPS
- BREAK-IN RUN TEST - TESTED AT 100 DEG F, 2950 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.
- OPERATING PROOF AND OVERSPEED TEST - TESTED AT 240 DEG F, 300 PSIG TO CASE DRAIN, 220 PSIG RETURN, 4898 RPM, AND 3875 PSIG PRESSURE AT NO FLOW. LOAD CYCLE IS IMPOSED FROM 3875-3550 PSIG AT 85.4 GPM FOR 500 CYCLES. REPEATED FROM 3875-2000 PSIG FOR 500 CYCLES. PASS/FAIL CRITERIA: NO EXTERNAL LEAKAGE OR MALFUNCTION. SHAFT SEAL LEAKAGE SHALL NOT EXCEED 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.
- 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.
- CLEANLINESS TEST - LEVEL 190 PER MA0110-301.

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

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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 PROCESS 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.

(E) OPERATIONAL USE:

ATTEMPT TO REDUCE PRESSURE IN SYSTEM BELOW SWITCHING VALVE PRESSURE BY GOING TO LOW PRESSURE ON MAIN PUMP. IF LOW PRESSURE CANNOT BE ACHIEVED, ASSOCIATED APU MAY BE SHUT DOWN DEPENDING ON FLIGHT PHASE AND NUMBER OF REMAINING HYDRAULIC SYSTEMS.

- APPROVALS -

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