FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: 04-2-LVII-IM-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
REVISION : 3 08/30/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	FUEL TANK ISOLATION VALVE	MC284-0572
■	MOOG	B41429

PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FUEL TANK ISOLATION AND REVERSE PRESSURE RELIEF VALVE ASSEMBLY. TWO NORMALLY CLOSED SOLENOID VALVES MANIFOLDED IN PARALLEL AND SINGLE REVERSE PRESSURE RELIEF VALVE.

■ QUANTITY OF LIKE ITEMS: 3
ONE MANIFOLD SET PER APU SUBSYSTEM.

■ FUNCTION:
(1) TO OPEN AND ALLOW FUEL TO FLOW FOR APU OPERATION. (2) TO PROVIDE FUEL SHUTOFF CAPABILITY IN THE EVENT OF DOWNSTREAM LEAKAGE (INTERNAL OR EXTERNAL). (3) TO PROVIDE REVERSE PRESSURE RELIEF. (4) TO PROVIDE VALVE/FUEL TEMPERATURE DATA TO ACTIVATE ORBITER OVERTEMPERATURE ALARM.

FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE
NUMBER: 04-2-LV11-IM- 12

REVISION#: 5 03/26/98

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
LRU: FUEL TANK ISOLATION VALVE **CRITICALITY OF THIS**
ITEM NAME: FUEL TANK ISOLATION VALVE **FAILURE MODE:** 1R2

FAILURE MODE:
FAILS OPEN (INCLUDING PREMATURE OPEN, INCOMPLETE TRANSFER TO THE CLOSED POSITION, FAILS TO CLOSE OR INTERNAL LEAKAGE).

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT

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

CAUSE:
ERRONEOUS APPLICATION OF ELECTRIC POWER, FAILURE OF THREE HYBRID DRIVERS OR SWITCH, INTERNAL MECHANICAL FAILURE, BINDING, CORROSION, CONTAMINATION, RELIEF VALVE INTERNAL LEAKAGE/FAILURE TO RESEAT COMPLETELY, RELIEF VALVE FAILURE TO ACTUATE RESULTING IN ISOLATION VALVE RELIEVING AND NOT RESEATING COMPLETELY

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:
A)

B)
FAILURE OF THIS STANDBY REDUNDANT FUNCTION IS DETECTABLE BY RELIEF VALVE CRACK/RESEAT PERFORMANCE IF NO OTHER FAILURE EXISTS. FOR THE FAILURE CASES DESCRIBED IN THIS FMEA/CIL, FAILURE IS NOT DETECTABLE UNTIL CALLED UPON FOR USE.

C)

MASTER MEAS. LIST NUMBERS: V46P0X10A

PRINT DATE: 03/30/98

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 04-2-LV11-IM- 12

V46P0X00A
V46T1X73A
V46T1X74A
V46T1X75A
V46T1X76A
V46X0X15A
V46X0X34A

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT FOR FAILURE OF ONE OR BOTH PARALLEL VALVES OR RELIEF VALVE. LOSS OF REDUNDANCY TO STOP FUEL FLOW TO THE APU GAS GENERATOR. LOSS OF CAPABILITY TO STOP FUEL FLOW IN THE EVENT A FUEL PUMP/LINE LEAK OCCURS.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT FOR FAILURE OF ONE OR BOTH PARALLEL VALVES OR RELIEF VALVE.

(C) MISSION:
NO EFFECT FOR FAILURE OF ONE OR BOTH PARALLEL VALVES OR RELIEF VALVE.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT FOR FAILURE OF ONE OR BOTH PARALLEL VALVES OR RELIEF VALVE. POSSIBLE LOSS OF CREW AND VEHICLE DUE TO FIRE/EXPLOSION IF EXTERNAL LEAKAGE OF HYDRAZINE OCCURS DOWNSTREAM OF THE FUEL ISOLATION VALVES.

(E) FUNCTIONAL CRITICALITY EFFECTS:
THIS FAILURE IN COMBINATION WITH A DOWNSTREAM EXTERNAL FUEL LEAK MAY RESULT IN A POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE APU PROPELLANT TANK ISOLATION VALVE ASSEMBLY CONSISTS OF TWO INDEPENDENTLY OPERATED SOLENOID VALVES MANIFOLDED IN PARALLEL WITH A SINGLE RELIEF VALVE COMMON TO EACH SOLENOID VALVE. ONE SWITCH IS USED TO OPERATE BOTH PARALLEL VALVES OF EACH APU SYSTEM. SERIES REDUNDANT POWER DRIVERS ARE USED TO PREVENT POWERING VALVES WITH A SINGLE DRIVER FAILURE.

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A CIRCUIT BREAKER FOR EACH VALVE IS INCORPORATED IN EACH CIRCUIT TO REMOVE POWER FROM EITHER VALVE IF REQUIRED. DISCRETE SIGNAL (V46X0X15E/V46X034E) MEASURED BETWEEN SECOND DRIVER AND EACH VALVE TO CONFIRM ELECTRICAL POWER TO EACH VALVE. A SINGLE GROUND DRIVER IS USED. EACH SOLENOID VALVE INCORPORATES REDUNDANT VALVE/FUEL TEMPERATURE SENSORS TO CONTINUOUSLY MEASURE VALVE TEMPERATURE WHICH IS MONITORED ON FDA. EACH SOLENOID VALVE IS DESIGNED TO REMAIN CLOSED THROUGH A SPRING PRELOAD UNTIL OPENED BY ELECTRICAL ENERGIZATION OF IT'S SOLENOID COIL. EACH VALVE COIL IS A THREE PIECE SEGMENTED DESIGN TO REDUCE POSSIBILITY AND SEVERITY OF SHORTING. THE DESIGN INCORPORATES INCREASED VALVE BODY MASS AND AN UNSTRESSED THICK BARRIER SEPARATING HYDRAZINE FROM THE COIL. EACH VALVE ASSEMBLY IS PROTECTED BY AN INLET FILTER TO PREVENT SYSTEM CONTAMINATES FROM ENTERING THE VALVE SEAT ASSEMBLY. THE COMMON RELIEF VALVE ASSEMBLY IS ALSO PROTECTED FROM SYSTEM CONTAMINATES BY INLET AND OUTLET FILTERS. BACKPRESSURE RELIEF IS BETWEEN 75 AND 250 PSID. THE POPPET/SEAT OF EACH SOLENOID VALVE AND RELIEF VALVE IS A NON SLIDING FIT DESIGN (S-SPRING) USED TO REDUCE MISALIGNMENT AND FRICTION.

EXTERNAL LEAK PATH OF THE VALVE ASSEMBLY HAS BEEN MINIMIZED BY LOW STRESS HERMETIC SEAL DESIGN. VALVE TO SYSTEM INTERFACE IS A MECHANICAL DYNA-TUBE SEAL DESIGN WITH A LOCK WIRE FEATURE TO ASSURE INTERFACE TORQUE.

(B) TEST:
VALVE IS PROOF PRESSURE TESTED AT 1,110 PSIG GN2 IN ATP. MAXIMUM EXTERNAL LEAKAGE IS 1 X 10-4 SCC/SEC AT 750 PSIG HELIUM. MAXIMUM INTERNAL LEAKAGE IS 36 SCCH AT 410 PSIG HELIUM.

OMRSD: TOXIC VAPOR CHECKS AND POST-FLIGHT SYSTEM INSPECTION PERFORMED DURING EACH GROUND TURNAROUND AS WELL AS VERIFICATION THAT EACH OF THE TWO PARALLEL VALVES OPENS AND CLOSES ON COMMAND. RELIEF VALVE CRACK AND VALVE RESEAT IS VERIFIED IN-FLIGHT EVERY FLIGHT.

(C) INSPECTION:
RECEIVING INSPECTION
MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED.

CONTAMINATION CONTROL
CLEANLINESS TO LEVEL 100 IS VERIFIED BY INSPECTION. CORROSION PROTECTION REQUIREMENTS ARE VERIFIED BY TEST.

ASSEMBLY/INSTALLATION
MANUFACTURING, ASSEMBLY, AND INSTALLATION REQUIREMENTS ARE VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. BURR AND WELD SPLATTER INSPECTION AT 20X MAGNIFICATION IS VERIFIED. SOLENIOD IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

PRINT DATE: 03/30/98

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WELDS INSPECTED AT 20X TO 30X MAGNIFICATION FOR SURFACE CRACKS, WELD BEAD GEOMETRY, VOIDS OR PORES. WELD VERIFICATION SAMPLE IS INSPECTED SIMILARLY AND RETAINED IN FILES FOR TRACEABILITY.

CRITICAL PROCESSES
WELDING PER SPECIFICATION REQUIREMENTS IS VERIFIED BY INSPECTION.

TESTING
TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ATP (INCLUDING INSULATION RESISTANCE AND DIELECTRIC STRENGTH) IS WITNESSED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING, PACKAGING, STORAGE AND SHIPPING PROCEDURES ARE VERIFIED.

(D) FAILURE HISTORY:
REFER TO PROBLEM REPORTING AND CORRECTIVE ACTION (PRACA) DATABASE

(E) OPERATIONAL USE:
CIRCUIT BREAKER CAN BE OPENED IF VALVES ARE ERRONEOUSLY POWERED OPEN.

- APPROVALS -

BOEING DESIGN	: STAN BARAUSKAS	3/30/98
BOEING S-SYSTEM MGR	: TIBOR FARKAS	3/30/98
BOEING SS&PAE MGR	: POLLY STENGER	3/30/98
BOEING SAFETY ENG	: GOPAL RAO	3/30/98
BOEING RELIABILITY ENG	: DAN HUNTER	3/30/98
NASA-JSC MOD	: MEL FRIANT	4/1/98
NASA-JSC DCE REP	: BRAD IRLBECK	4/1/98
JSC SSE MA	: DAVID BEAUGH	4/1/98
USA BRAITER ELEMENT	: MIKE BURGHARDT	4/1/98