

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 04-2-V12-13-IM -X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION: BASIC 03/26/98

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: AUXILIARY POWER UNIT (APU) SUNDSTRAND	MC201-0001-06XX AND SUBS 763758
SRU	: GAS GENERATOR VALVE MODULE, SOLENOID SUNDSTRAND	5910215 SAME

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

GAS GENERATOR VALVE MODULE, TWO SOLENOID VALVES (EACH VALVE IS 3 PORT, 2 DIRECTION) IN SERIES, ONE NORMALLY OPEN AND THE OTHER NORMALLY CLOSED.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3
ONE PER APU

FUNCTION:

WHEN VALVE CYCLES, IT PROVIDES APU TURBINE PRIMARY AND SECONDARY SPEED CONTROL. NORMALLY CLOSED VALVE SHUTS DOWN THE APU.

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LRU: AUXILIARY POWER UNIT (APU)

ITEM NAME: VALVE, SOLENOID

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

EXTERNAL LEAKAGE OF FUEL

MISSION PHASE:

PL	PRE-LAUNCH
LO	LIFT-OFF
DO	DE-ORBIT
LS	LANDING/SAFING

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:

EXTERNAL LEAKAGE RESULTS FROM: STRUCTURAL/MATERIAL FAILURE OF VALVE MANIFOLD AND/OR O-RINGS, LOSS OF TORQUE ON MULTIPLE COVER FASTENERS, FAILED FLUID CONNECTOR SEALING, OR FAILED BODY BORE PLUG.

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:**

APU UNDERSPEED SHUTDOWN AND LOSS OF THE APU IF LEAKAGE IS GROSS.

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(B) INTERFACING SUBSYSTEM(S):

LOSS OF SHAFT POWER TO ONE HYDRAULIC PUMP. ADJACENT REDUNDANT EQUIPMENT AND COMPONENTS EXPOSED TO HYDRAZINE FUEL. POSSIBLE DAMAGE TO REDUNDANT EQUIPMENT FROM FIRE AND/OR EXPLOSION.

(C) MISSION:

ABORT DECISION IS POSSIBLE IF FAILURE OCCURS DURING ASCENT (TIMING AND FLIGHT TRAJECTORY DEPENDENT).

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

POSSIBLE LOSS OF VEHICLE IF FUEL ENTERS AFT FUSELAGE AND IS IGNITED OR IF DAMAGE EXTENDS TO REDUNDANT EQUIPMENT CAUSING LOSS OF ANOTHER HYDRAULIC/APU SYSTEM. THIS POSSIBILITY IS DIMINISHED BY THE CLOSURE OF FUEL ISOLATION VALVES, WHICH LIMITS THE AMOUNT OF HYDRAZINE THAT CAN ENTER THE AFT COMPARTMENT.

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE LOSS OF VEHICLE IF TWO OF THREE APUS ARE LOST

-DISPOSITION RATIONALE-

(A) DESIGN:

VALVE IS PROTECTED BY 25 MICRON SYSTEM FILTER IN-LINE UPSTREAM AND FUEL PUMP 25-MICRON FILTER IN-LINE UPSTREAM. CORROSION-RESISTANT MATERIALS (17-7PH, 304L, MP35N, TITANIUM) ARE USED. NGGVM INCORPORATES THE FOLLOWING: 1. THE INSPECTABILITY OF CRITICAL WELDS, 2. INCREASED BARRIER THICKNESS, 3. ADOPTED A BOLTED DESIGN TO FACILITATE OVERHAUL AND REPAIR, 4. INCORPORATED A SEGMENTED COIL TO PRECLUDE FAILURE INDUCED OVERHEAT, 5. FRACTURE/CORROSION RESISTENT INTERNAL VALVE SEAT/POPPET MATERIAL, 6. ADDITIONAL EXPOSURE TESTS ON SELECTED MATERIALS HAVING LIMITED DATE.

(B) TEST:

NGGVM PERFORMANCE IS VERIFIED DURING ACCEPTANCE TESTING AT THE VENDOR. ACCEPTANCE LEAKAGE TESTS ARE CONDUCTED AT BOTH VALVE AND APU LEVEL. CERTIFICATION TESTS CONDUCTED AT THE WHITE SANDS TEST FACILITY COMPLETED 33.8 HOURS IN 1996. APPROXIMATELY 30 HOURS ADDITIONAL TESTING TO BE PERFORMED 1997-99.

OMRSD: ELECTRICAL AND EXTERNAL LEAK CHECKS ARE PERFORMED ON THE ORBITER AFTER APU INSTALLATION. OPERATION IS THEN VERIFIED THROUGH A CONFIDENCE RUN PRIOR TO FLIGHT OF EACH NEWLY INSTALLED APU. FLIGHT DATA IS USED TO

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VERIFY NGGVM OPERATION EVERY FLOW AFTER FIRST FLIGHT. BETWEEN FLIGHTS, ELECTRICAL CONTINUITY AND CONTROLLER TESTS ARE PERFORMED TO VERIFY FLIGHT READINESS.

(C) INSPECTION:**RECEIVING INSPECTION**

MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED.

CONTAMINATION CONTROL

CLEANLINESS OF TO LEVEL 100 IS VERIFIED BY INSPECTION. FLUID SAMPLES ARE ANALYZED FOR CONTAMINATION AND VERIFIED BY INSPECTION. CORROSION PROTECTION REQUIREMENTS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

MANUFACTURING, ASSEMBLY, AND INSTALLATION REQUIREMENTS ARE VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. SOLENOID IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

PENETRANT INSPECTION OF WELDS AND ASSEMBLIES IS VERIFIED. RADIOGRAPHIC INSPECTION OR CROSS SECTION INSPECTION OF LOT SAMPLES PERFORMED ON WELDS. NDE IS PERFORMED ON ALL CRITICAL WELDS.

CRITICAL PROCESSES

WELDING PER SPECIFICATION REQUIREMENTS IS VERIFIED BY INSPECTION. WELDING PROCEDURES, EQUIPMENT AND SCHEDULES ARE REVIEWED/APPROVED BY APU CORE TEAM. DESTRUCTIVE INSPECTION OF LOT SAMPLES OF PRODUCTION HARDWARE IS VERIFIED BY INSPECTION.

TESTING

CALIBRATION OF TOOLS AND TEST EQUIPMENT AND ARE VERIFIED BY INSPECTION. ATP 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) FAILURE HISTORY DATABASE.

(E) OPERATIONAL USE:

WHEN FAILURE IS DETECTED; 1. DURING ASCENT, APU IS SHUTDOWN AND FUEL ISOLATION VALVE IS CLOSED AS SOON AS POSSIBLE POST MECO. 2. DURING DESCENT, APU MAY BE SHUTDOWN AND FUEL ISOLATION VALVES CLOSED. IF SO, REMAINING APUS ARE COMMANDED TO HIGH SPEED AT TAEM AND AUTO SHUTDOWN REMAINS ENABLED.

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- APPROVALS -

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

Stan Barauskas 3/30/98
~~*Tibor Farkas 3/30/98*~~
~~*Polly Stenger 3/30/98*~~
~~*Gopal Rao 3/30/98*~~
~~*Dan Hunter 3/30/98*~~
~~*Mel Friant 4/1/98*~~
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