

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: 04-2-LV13-IM -X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION: BASIC 03/26/98

PART DATA

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

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

SOLENOID SHUTOFF VALVE, DIRECT ACTING, 3 PORT, 2 POSITION POPPET TYPE VALVE, NORMALLY CLOSED. HIGH SPEED CONTROL AND APU SHUTOFF.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3
ONE PER APU

FUNCTION:

(1) TO CONTROL APU TURBINE WHEN "HIGH SPEED" (113%) HAS BEEN MANUALLY SELECTED OR WHEN PULSE CONTROL (PC) VALVE (LV12) FAILS OPEN.
(2) TO SHUT DOWN THE APU WHEN DE-ENERGIZED AND SHUTOFF FUEL FLOW TO MAINTAIN APU INLET PRESSURE FOR SUBSEQUENT APU START/OPERATION

FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE

NUMBER: 04-2-LV13-IM- 02

REVISION#: BASIC 03/26/98

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

LRU: AUXILIARY POWER UNIT (APU)

CRITICALITY OF THIS

ITEM NAME: SHUTOFF VALVE, SOLENOID

FAILURE MODE: 1R2

FAILURE MODE:

FAILS IN THE DE-ENERGIZED POSITION (OPEN TO BYPASS, CLOSED TO OUTLET)

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:

INTERNAL MECHANICAL , CONTAMINATION OR CORROSION IN THE VALVE OR
 ARMATURE MECHANISM, SEAT CONTAMINATION, CONTAMINATION IN
 ARMATURE/MAGNET GAP, BYPASS SEAT/SEAL LEAKAGE, DUAL CONTROLLER LOGIC
 FAILURES, LOSS OF ELECTRICAL POWER OR WIRE/SOLENOID FAILURE, O-RING FAILURE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

AOA ABORT ONCE AROUND
 ATO ABORT TO ORBIT
 RTLS RETURN TO LAUNCH SITE
 TAL TRANS-ATLANTIC LANDING

REDUNDANCY SCREEN A) PASS
 B) PASS
 C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

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- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF ONE APU SYSTEM IF SOV FAILS TO OPEN OR REMAIN OPEN, OR IF BYPASS SEAT LEAKS. APU FAILS TO START OR SHUTS DOWN (UNDERSPEED), ALSO POSSIBILITY OF FUEL OVERHEATING AND DECOMPOSING WITH MULTIPLE CONTROLLER FAILURES CAUSING SOLENOID TO REMAIN POWERED, RESULTING IN RUPTURE OF VALVE WHILE APU IS NOT OPERATING.

(B) INTERFACING SUBSYSTEM(S):

LOSS OF SHAFT POWER TO ONE HYDRAULIC PUMP FOR THE CASE OF APU FAILURE TO START OR SHUTDOWN (UNDERSPEED).

(C) MISSION:

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

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

NO EFFECT IF FAILURE OCCURS PRIOR TO LIFT OFF OR UNTIL SECOND SYSTEM LOSS. CRITICALITY 1 FOR ANY NON-APU INDUCED RTLS, ATO, AOA, OR TAL DUE TO THE POSSIBLE ADDITIONAL LOSS OF ASSOCIATED APU/HYD AND MAIN ENGINE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

POSSIBLE LOSS OF VEHICLE IF TWO OUT OF THREE APU'S LOST.

-DISPOSITION RATIONALE-

(A) DESIGN:

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

(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

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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 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 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 SAMPLE PERFORMED ON SELECTED WELDS. NDE IS PERFORMED FOR CRITICAL WELDS.

CRITICAL PROCESSES

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

TESTING

CALIBRATION OF TOOLS AND TEST EQUIPMENT 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:

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PRELAUNCH OCCURRENCE WILL CAUSE LAUNCH TO BE SCRUBBED. IF VALVE FAILS CLOSED, SHUTTING DOWN APU DURING ASCENT, REMAINING APUS ARE COMMANDED TO HIGH SPEED AND AUTOMATIC SHUTDOWN IS INHIBITED TO PRECLUDE INADVERTENT SHUTDOWNS. IF APU SHUTS DOWN DURING DESCENT, REMAINING APUS ARE COMMANDED TO HIGH SPEED AT TAEM AND AUTO SHUTDOWN REMAINS ENABLED.

- 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 SSEMA	: DAVID BEAUGH
USA ORBITER ELEMENT	: MIKE BURGHARDT

Stan Barauskas 3/30/98
~~*Tibor Farkas 3/22/98*~~
~~*Polly Stenger 3/30/98*~~
~~*D. Hunter 3/20/98*~~
~~*Mel Friant 3/20/98*~~
~~*Brad Irlbeck 4/1/98*~~
~~*Bud Fulkner 3/11/98*~~
David Beaugh 4/1/98
~~*M. Burghardt 4/1/98*~~