FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 04-2-LV12-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) SUNDSTRAND	MC201-0001-06XX AND SUBS 763758
SRU	:GAS GENERATOR VALVE MODULE, SOLENOID SUNDSTRAND	5910215 SAME

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE, PULSE CONTROL (PCV), DIRECT ACTING, 3 PORT, 2 POSITION, POPPET TYPE VALVE, NORMALLY OPEN, PRIMARY AND SECONDARY SPEED CONTROL

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3
ONE PER APU

FUNCTION:
TO CONTROL APU TURBINE SPEED (AT 103% SPEED - "NORMAL" SPEED - OR 115% SECONDARY) BY PORTING FUEL TO EITHER THE GAS GENERATOR OR TO THE BYPASS TO THE FUEL PUMP INLET. NOTE: CANNOT FUNCTION AS SHUTOFF VALVE.

PRINT DATE: 03/30/98

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 04-2-LV12-IM- 02

REVISION#: BASIC 03/26/98

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
LRU: AUXILIARY POWER UNIT (APU)
ITEM NAME: PULSE CONTROL VALVE, SOLENOID

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
FAILS IN THE DE-ENERGIZED POSITION (CLOSED TO BYPASS, OPEN 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 OR WELD FAILURE, CORROSION, CONTAMINATION, CONTROLLER LOGIC FAILURES, LOSS OF ELECTRICAL POWER OR WIRE SOLENOID FAILURE, OUTLET SEAT CRACKED/BROKEN, O-RING FAILURE, INTERNAL LEAKAGE, OUTLET SEAT/SEAL LEAKAGE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

REDUNDANCY SCREEN

A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

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(A) SUBSYSTEM:
LOSS OF PRIMARY SPEED CONTROL CAUSES APU TO OPERATE IN HIGH SPEED. POSSIBLE TURBINE OVERSPEED TO BURST IF (LV13) SHUTOFF VALVE ALSO FAILS OPEN. (REF. CIL 04-2-LV13-01)

(B) INTERFACING SUBSYSTEM(S):
NONE WITHOUT ADDITIONAL FAILURE. POSSIBLE DAMAGE TO ADJACENT EQUIPMENT FOR TURBINE OVERSPEED CASE.

(C) MISSION:
NONE WITHOUT ADDITIONAL FAILURE

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT IF FAILURE OCCURS PRIOR TO LIFT OFF OR UNTIL SECOND SYSTEM IS LOST. 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 ARE LOST.

-DISPOSITION RATIONALE-

(A) DESIGN:
VALVE IS PROTECTED BY 25-MICRON 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 IMPROVEMENTS; 1. THE INSPECTABILITY OF CRITICAL WELDS, 2. INCREASED BARRIER THICKNESS BETWEEN THE COIL AND POPPET CHAMBER TO REDUCE STRESS, 3. ADOPTED A BOLTED DESIGN TO FACILITATE OVERHAUL AND REPAIR, 4. INCORPORATED A SEGMENTED COIL TO PRECLUDE FAILURE INDUCED OVERHEAT, 5. FRACTURE/CORROSION RESISTANT INTERNAL VALVE SEAT/POPPET MATERIAL, 6. ADDITIONAL EXPOSURE TESTS ON SELECTED MATERIALS HAVING LIMITED DATA.

SOV MODE IS SERIES REDUNDANT TO THE PCV. THE SOV CYCLES ONLY IF THE PCV DOES NOT CONTROL. SOV DIVERTS FLOW FROM THE PCV TO THE BYPASS PORT (FUEL PUMP INLET) AND BLOCKS FLOW TO THE GAS GENERATOR IN IT'S NORMAL POSITION (NORMALLY CLOSED). SOV PERMITS FUEL FLOW FROM THE PCV TO THE GAS GENERATOR AND BLOCKS FLOW TO THE BYPASS PORT IN IT'S ENERGIZED POSITION.

(B) TEST:

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NGGVM PERFORMANCE IS VERIFIED DURING ACCEPTANCE TESTING AT THE VENDOR. ACCEPTANCE LEAKAGE TEST AND VALVE RESPONSE 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 IN 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 THE 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 WELDS. NDE 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 CORRECTION ACTION (PRACA) FAILURE HISTORY DATABASE

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(E) OPERATIONAL USE:
FOR AN APU THAT SHIFTS TO HIGH SPEED:
1. PRE-LAUNCH OCCURRENCE WILL CAUSE LAUNCH TO BE SCRUBBED
2. OCCURRENCE DURING ASCENT WILL CAUSE CREW TO SELECT HIGH SPEED TO MATCH ACTUAL OPERATION AND SHUTDOWN APU AS SOON AS POSSIBLE POST-MECO.
3. FOR OCCURRENCE DURING DESCENT (ENTRY), RUN TIME WILL BE MINIMIZED AND/OR APU WILL BE SHUTDOWN.

- APPROVALS -

BOEING DESIGN	: STAN BARAUSKAS	: Stan Barauskas
BOEING S-SYSTEM MGR	: TIBOR FARKAS	: 3/30/98
BOEING SS&PAE MGR	: POLLY STENGER	: for 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	: Brad Irlbeck 4/1/98
JSC SS&MA	: DAVID BEAUGH	: David Beaugh 4/1/98
USA ORBITER ELEMENT	: MIKE BURGHARDT	: M J. Burghardt 4/1/98