

## FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 04-2-MPU-IM2 -X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION: BASIC 07/17/98

## PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: AUXILIARY POWER UNIT (APU)	MC201-0001-05XX
	SUNDSTRAND	729867XX/754949
SRU	:MAGNETIC PICK UP UNIT	
	SMITH INDUSTRIES	5911014

## EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

MAGNETIC PICK-UP UNIT (APU TURBINE SPEED SENSOR) MPU1, MPU2, MPU 3. THE MAGNETIC PICK-UP (MPU) CONTAINS A MAGNETIC POLEPIECE AND WIRE COIL ASSEMBLY. THE POLEPIECE IS PLACED NEAR THE BEARING SPACER OF THE APU TURBINE WHEEL. AS THE TURBINE WHEEL ROTATES, TWO AXIAL GROOVES ON THE BEARING SPACER ALTER THE MAGNETIC FLUX THROUGH THE POLEPIECE AND WIRE COIL. THE CHANGING MAGNETIC FLUX INDUCES A VOLTAGE PULSE IN THE COIL, AND THIS PULSE (TWO PER REVOLUTION) IS DETECTED BY THE MPU FILTER AND COMBINE BOARD OF THE IAPU CONTROLLER.

QUANTITY OF LIKE ITEMS: 9

THREE PER APU

## FUNCTION:

MONITOR TURBINE SPEED TO PROVIDE FEEDBACK TO THE SPEED CONTROLLER CIRCUIT OF THE APU-1005 (IMPROVED) CONTROLLER (REFERENCE 04-2-CONTL1-IM/ CONTL2-IM/CONTL5-IM).

THE MPUS SUPPORT THE IMPROVED CONTROLLER "VOTING CIRCUIT." THE "VOTING CIRCUIT" GENERATES A FOURTH MPU SIGNAL OUTPUT FROM ANY TWO (OF THE THREE) MATCHING MPU SIGNALS.

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**SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)**

**LRU: AUXILIARY POWER UNIT (APU)**

**ITEM NAME: MAGNETIC PICKUP UNIT**

**CRITICALITY OF THIS  
FAILURE MODE: 1R3**

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**FAILURE MODE:**

LOSS OF OUTPUT, ERRONEOUS OUTPUT, INTERMITTENT OUTPUT

**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 FAILURE, BROKEN WIRE, SHORT TO GROUND.

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

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**REDUNDANCY SCREEN**

A) PASS  
B) FAIL  
C) PASS

**PASS/FAIL RATIONALE:**

A)

CONTROLLER CHECKOUT UNIT (CCU) VERIFIES CONTINUITY DURING EACH VEHICLE TURNAROUND.

B)

FAILS SCREEN "B" BECAUSE ONLY ONE OF THE THREE MPUS (MPU#3) IS MONITORED BY INSTRUMENTATION (V46R0X35A).

C)

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- FAILURE EFFECTS -

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**(A) SUBSYSTEM:**

NO EFFECT, EXCEPT IF MPU 3 IS LOST (TURBINE SPEED MONITORING IS LOST). LOSS OF SPEED CONTROL REDUNDANCY. FAILURE OF TWO MPUS RESULTS IN LOSS OF ONE APU FOR REMAINDER OF MISSION.

**(B) INTERFACING SUBSYSTEM(S):**

LOSS OF TWO MPUS WILL RESULT IN LOSS OF ONE APU AND SHAFT POWER TO HYDRAULIC PUMP.

**(C) MISSION:**

ABORT DECISION IS POSSIBLE IF MPU FAILURE COMBINED WITH A SECOND FAILURE (CONTROLLER, OR MPU) RESULTS IN LOSS OF SPEED CONTROL DURING POWERED FLIGHT (TIMING AND FLIGHT TRAJECTORY DEPENDENT).

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

NO EFFECT UNTIL SECOND APU LOSS. POSSIBLE LOSS OF VEHICLE IF TWO OUT OF THREE APU'S ARE LOST. LOSS OF ONE APU DURING POWERED FLIGHT WILL RESULT IN THE ASSOCIATED SSME GOING INTO HYDRAULIC LOCK-UP AND COULD RESULT IN LOSS OF ORBIT CAPABILITY OR BE CATASTROPHIC (WITH ADDITIONAL SSME VALVE FAILURE). (REF. FLIGHT RULE A10.1.2-5).

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

POSSIBLE LOSS OF VEHICLE IF TWO OF THREE APU'S ARE LOST

- 1) LOSS OF 1 OF 3 MPU'S: LOSS OF 1 OF 2 SPEED CONTROL PATHS.
- 2) LOSS OF 2 OF 3 MPU'S: LOSS OF APU
- 3) LOSS OF SECOND APU: POSSIBLE LOSS OF CREW/VEHICLE

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-DISPOSITION RATIONALE-

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**(A) DESIGN:**

COIL AND LEAD WIRE SOLDERED TO COPPER STRIP. POTTED ASSEMBLY, NO DYNAMIC PARTS. FEATURES FEWER COIL TURNS (750 VS. 6,000), INCREASE COIL WIRE GAUGE (#40), AND SOLDER CONNECTIONS ARE WRAPPED IN TAPE TO PREVENT DIRECT CONTACT WITH THE POTTING MATERIAL.

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**(B) TEST:**

ATP PERFORMED AT SUPPLIER INCLUDED INSULATION RESISTANCE (IR) AND DIELECTRIC TEST, DC RESISTANCE, OUTPUT VOLTAGE, POLARITY, AND BURN-IN (THERMAL CYCLE AND VIBRATION). MPU QUALIFIED WITH APU.

CERTIFICATION TESTS CONDUCTED WERE 75 HRS. APU OPERATION, 250 THERMAL CYCLES, AND 250 HRS. OPERATING TIME (VIBRATION)

CONTINUITY IS VERIFIED BY CCU TEST AND BIT EVERY FLOW. VERIFICATION OF OUTPUT VOLTAGE AND POLARITY PERFORMED AFTER FIELD REPLACEMENT DURING GROUND HOTFIRE.

OMRSD: ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION  
MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED.

CONTAMINATION CONTROL  
CLEANLINESS PER REQUIREMENTS IS VERIFIED BY INSPECTION. CORROSION PROTECTION REQUIREMENTS ARE VERIFIED BY INSPECTION, INCLUDING PASSIVATION OF HOUSINGS, HERMETIC SEAL OF UNIT BY TIG WELD, AND ENCAPSULATION OF THE UNIT.

ASSEMBLY/INSTALLATION  
MANUFACTURING, ASSEMBLY, AND INSTALLATION REQUIREMENTS ARE VERIFIED BY INSPECTION. DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES  
INSPECTION VERIFIES TIG WELDING, BRAZING, SOLDERING, CRIMPING, HEAT TREATING, AND BRASS FERRULE TIN PLATING.

TESTING  
TEST EQUIPMENT AND TOOL CALIBRATION 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.

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(E) OPERATIONAL USE:

LOSS OF ONE APU MAY RESULT IN SWITCHING TO HIGH SPEED AND INHIBIT ON OTHER TWO APUS; DEPENDING ON MISSION PHASE.

-IF APU SHUTS DOWN DURING ASCENT, REMAINING APUS ARE COMMANDED TO HIGH SPEED AND AUTOMATIC SHUTDOWN IS INHIBITED TO PRECLUDE INADVERTENT SHUTDOWNS.

-IF AN APU SHUTS DOWN DURING DESCENT, REMAINING APUS ARE COMMANDED TO HIGH SPEED AT TAEM AND AUTO SHUTDOWN REMAINS ENABLED.

- APPROVALS -

BOEING DESIGN	: B. BARRERA
BOEING S-SYSTEM MGR	: TIBOR FARKAS
BOEING SS&FAE MGR	: POLLY STENGER
BOEING SAFETY ENGINEER	: GLORIA CAMACHO
BOEING RELIABILITY ENG	: DAN HUNTER
NASA/JSC MOD	: MEL FRAINT
USA ORBITER	
USA SAM	

*B. Barrera 8-7-98*  
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