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PRINT DATE: 12/18/91

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 04-2-MPU2-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION : 3 12/18/91

| | PART NAME | PART NUMBER |
|--------------|--|-------------------------------------|
| | VENDOR NAME | VENDOR NUMBER |
| ■ LRU : ■ | AUXILIARY POWER UNIT (APU) SUNDSTRAND | MC201-0001-02XX 729867XX/754949 |
| ■ LRU : ■ | AUXILIARY POWER UNIT (APU) SUNDSTRAND | MC201-0001-03XX 729867XX/754949A |
| ■ LRU : ■ | AUXILIARY POWER UNIT (APU) SUNDSTRAND | MC201-0001-04XX X742211X |
| ■ SRU : ■ | MAGNETIC PICKUP UNIT IMO | 58284 |
| ■ SRU : ■ | MAGNETIC PICKUP UNIT IMO | 5908321 |

 PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
MAGNETIC PICK-UP (SPEED SENSOR), (MPU #2 - HIGH SPEED (113%) CONTROL SENSOR).
- QUANTITY OF LIKE ITEMS: 3
ONE PER APU
- FUNCTION:
MONITOR TURBINE SPEED TO PROVIDE FEEDBACK TO THE HIGH SPEED CONTROL CIRCUIT OF THE APU CONTROLLER (CONTL2-11).

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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
 NUMBER: 04-2-MPU2-01

SUBSYSTEM: AUXILIARY POWER UNIT (APU)
 LRU :AUXILIARY POWER UNIT (APU)
 ITEM NAME: MAGNETIC PICKUP UNIT

REVISION# 3 12/18/91 R

CRITICALITY OF THIS
 FAILURE MODE:1R3

- FAILURE MODE:
 LOSS OF OUTPUT, INTERMITTENT OUTPUT, EXTRANEIOUS SIGNALS.

MISSION PHASE:

| | |
|----|----------------|
| PL | PRELAUNCH |
| LO | LIFT-OFF |
| OO | ON-ORBIT |
| DO | DE-ORBIT |
| LS | LANDING SAFING |

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

- CAUSE:
 INTERNAL FAILURE, BROKEN WIRE, EMI, SHORT TO GROUND CAUSED BY
 HUMIDITY, SALT, FOG.

- CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

- REDUNDANCY SCREEN A) PASS
- B) FAIL
- C) PASS

PASS/FAIL RATIONALE:

- A)
- B)
 MPU #2 NOT VERIFIED IN FLIGHT UNLESS APU IS SWITCHED INTO "HIGH" SPEED
 OR GOES TO SECONDARY SPEED AUTOMATICALLY.
- C)

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 - FAILURE EFFECTS -

- (A) SUBSYSTEM:
 NO EFFECT ON APU OPERATION UNLESS HIGH SPEED CONTROL IS REQUIRED BY PRIMARY CONTROL FAILURE.
- (B) INTERFACING SUBSYSTEM(S):
 NO EFFECT
- (C) MISSION:
 NO EFFECT
- (D) CREW, VEHICLE, AND ELEMENT(S):
 NO EFFECT
- (E) FUNCTIONAL CRITICALITY EFFECTS:
 1ST FAILURE, MPU #2 LOSS OR ERRATIC, NO EFFECT

 2ND FAILURE, NORMAL SPEED CONTROL LOST DUE TO GGVM PC VALVE, MPU #3, ETC. THIS WILL RESULT IN APU SHUTTING DOWN AT 129% BY SAFETY CIRCUIT (MPU #1)

 3RD FAILURE, LOSS OF SECOND APU MAY RESULT IN LOSS OF CREW/VEHICLE

 NOTE: 1) IF OPERATING IN INHIBIT MODE, APU WILL EXPERIENCE UNCONTROLLED OVERSPEED AFTER 1ST AND 2ND FAILURE.

 2) IF OPERATING IN HIGH SPEED AND MPU #2 IS LOST OR ERRATIC, APU CONTROL WILL SHIFT TO PRIMARY SPEED CONTROL (PC VALVE CONTROL).

 - DISPOSITION RATIONALE -

- (A) DESIGN:
 BOBBIN TO LEAD WIRE BRAZED. POTTED ASSEMBLY, NO DYNAMIC PARTS. MANUAL OVERRIDE OF FAILURE POSSIBLE (INHIBIT MODE). P/N 5908321 IS FOR UNITS MANUFACTURED IN 1989 AND POST. THEY FEATURE A BOBBIN MADE FROM VESPEL (POLYIMIDE) MATERIAL, IMPROVED TERMINAL POST BRAZING, AND POTTING FILL UNDER VACUUM TO REDUCE VOIDS.
- (B) TEST:
 ATP PERFORMED AT SUPPLIER INCLUDES INSULATION RESISTANCE (IR), HIGH POT AND CONTINUITY. APU ATP FUNCTIONAL TEST. MAG PICKUP QUALIFIED WITH APU. CERTIFICATION TESTS CONDUCTED WERE 27 MISSION DUTY CYCLES,

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THERMAL VACUUM, BENCH SHOCK, FOR A TOTAL OF 41.7 HR OPERATION, INCLUDING VIBRATION. OMRSD: APU 1/2/3 AUTO BITE TEST PERFORMED EVERY FLOW.

- (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:
CARS AB3724, AD3459 - MOISTURE CONTAMINATION CAUSED FAILURE. 1983 IMPROVEMENTS TO ADD SHRINK SLEEVING AND POTTING AS CORRECTIVE ACTION FOR THIS FAILURE HAVE BEEN EFFECTIVE IN PREVENTING RECURRENCE OF THIS FAILURE MODE.

CARS AD5037, AD5902 - BROKEN INTERNAL WIRE OF PRE-1983 MANUFACTURED UNITS. IMPROVED POTTING WAS INSTITUTED IN 1983 TO SUPPORT THE WIRE TO HELP PREVENT THIS FAILURE MODE. ADDITIONALLY, IN 1989, A VACUUM PROCESS WAS INSTITUTED TO IMPROVE THE POTTING FILL.

CAR AD7972 - PROTOTYPE UNIT OF THE P/N 5908321 FAILED DUE TO A BROKEN COIL WIRE RESULTING IN A DEVELOPMENT TEST APU EXPERIENCING ERRATIC SPEED VARIATIONS. FAILURE ANALYSIS INDICATED DAMAGED COIL WIRES MOST PROBABLY OCCURRED DURING MANUFACTURING. CORRECTIVE ACTION FOR UNITS BUILT SUBSEQUENT TO S/N V91C013 IS A 20X MAGNIFIED VISUAL INSPECTION PRIOR TO COVERING THE COIL ASSEMBLY.

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- (E) OPERATIONAL USE:
RESTART USING INHIBIT MAY BE ATTEMPTED BASED ON FLIGHT PHASE.

- APPROVALS -

| | | | | |
|--------------------------|----------------|---|------------|-------------------|
| RELIABILITY ENGINEERING: | D. R. ATAPATTU | : | <u>20A</u> | <u>J.E. D. Ko</u> |
| DESIGN ENGINEERING | : J. R. MUNROE | : | | |
| QUALITY ENGINEERING | : W. J. SMITH | : | | |
| NASA RELIABILITY | : | : | | |
| NASA SUBSYSTEM MANAGER | : | : | | |
| NASA QUALITY ASSURANCE | : | : | | |

7/29/92 *MR. [Signature]* *1/1/92*
W.D. Young *3-20-92*
[Signature] *2/17/92*