

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 04-2-MPU-IM-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

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	PART NAME VENDOR NAME	PART NUMBER 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 742211
■ SRU : ■	MAGNETIC PICKUP UNIT IMO	58284
■ SRU : ■	MAGNETIC PICKUP UNIT IMO	5908321

PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
MAGNETIC PICK-UP UNIT (SPEED SENSOR)

■ QUANTITY OF LIKE ITEMS: 3
THREE PER APU

■ FUNCTION: *EITHER THE BASELINE CONTROLLER OR*
MONITOR TURBINE SPEED TO PROVIDE FEEDBACK TO THE SPEED CONTROLLER
CIRCUIT OF THE APU-1005 (IMPROVED) CONTROLLER (REFERENCE 04-2-GONTL1-IM/
CONTL2-IM/CONTLS-IM).

WHEN USED WITH THE BASELINE CONTROLLER
EACH OF THE THREE MPUS SERVE AS AN INPUT TO INDIVIDUAL SPEED CONTROL
CIRCUITS ~~AND TO A "VOTING CIRCUIT"~~. THE "VOTING CIRCUIT" ACTS, IN
EFFECT, AS A FOURTH MPU USING THE SIGNAL FROM ANY TWO MATCHING MPU
SIGNALS (OF THE THREE MPUS) TO GENERATE AN OUTPUT.

WHEN USED WITH THE IMPROVED CONTROLLER IS ALLOCATED

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

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CRITICALITY OF THIS
FAILURE MODE:1R3

■ FAILURE MODE:
LOSS OF OUTPUT

MISSION PHASE:

PL PRELAUNCH
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 CAUSED BY HUMIDITY OR
SALT FOG.

■ CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:

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

- FAILURE EFFECTS -

■ (A) SUBSYSTEM:
NO EFFECT. LOSS OF MPU REDUNDANCY. FAILURE OF TWO MPUS RESULTS IN LOSS

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OF ONE APU FOR REMAINDER OF MISSION.

- (B) INTERFACING SUBSYSTEM(S):
NO EFFECT. LOSS OF TWO MPUS WILL RESULT IN LOSS OF APU AND SHAFT POWER TO HYDRAULIC PUMP.
- (C) MISSION:
NO EFFECT.
- (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 10-13).
- (E) FUNCTIONAL CRITICALITY EFFECTS:
TWO MPU FAILURES PER APU REQUIRED TO SHUT DOWN THE APU. THE APU IS NON-REGAINABLE. DURING THE 10.5 SECOND START DELAY, OVERSPEED SIGNAL FROM ANY ONE MPU WILL SHUT DOWN THE APU. THE APU MAY BE RESTARTED WITH THE SAFTIES INHIBITED (USING INJECTOR COOLING IF NECESSARY) IF IT IS DETERMINED THAT THE OVERSPEED WAS 'FALSE'.

- DISPOSITION RATIONALE -

- (A) DESIGN:
BOBBIN TO LEAD WIRE BRAZED. POTTED ASSEMBLY, NO DYNAMIC PARTS. MANUAL OVERRIDE OF FAILURE POSSIBLE. (P/N 5908321 IS FOR UNITS MANUFACTURED IN 1989 AND POST).
- (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, THERMAL VACUUM, BENCH SHOCK, FOR A TOTAL OF 41.7 HOURS OPERATION INCLUDING VIBRATION.

OMRSD: MPU CONTINUITY IS VERIFIED WITH THE CONTROLLER CHECKOUT UNIT EVERY FLOW DURING GROUND TURNAROUND.
- (C) INSPECTION:
RECEIVING INSPECTION
MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED.

CONTAMINATION CONTROL
CLEANLINESS PER REQUIREMENTS IS VERIFIED BY INSPECTION. CORROSION

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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.

- **(B) 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 IN WORK.

- **(E) OPERATIONAL USE:**
LOSS OF ONE APU MAY RESULT IN SWITCHING TO HIGH SPEED AND INHIBIT ON OTHER TWO APUS; DEPENDING ON MISSION PHASE.

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- APPROVALS -

RELIABILITY ENGINEERING:	D. R. ATAPATTU	:	<i>[Signature]</i>
DESIGN ENGINEERING	: D. J. ZWICK	:	<i>[Signature]</i> 10/7/91
QUALITY ENGINEERING	: W. R. HIGGINS	:	<i>[Signature]</i> 8/1/91
NASA RELIABILITY	:	:	<i>[Signature]</i> 11/1/92
NASA SUBSYSTEM MANAGER	:	:	<i>[Signature]</i> 1-24-92
NASA QUALITY ASSURANCE	:	:	<i>[Signature]</i> 1/20/91