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PRINT DATE: 09/04/91

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: 04-2-CONTL2-14-X

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SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

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	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	APU CONTROLLER SUNDSTRAND	MC201-0001-1005 753831

PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HIGH SPEED CONTROL (ELECTRONIC CONTROL CIRCUIT) FOR THE GGVM SHUTOFF (N.C.) VALVE
- QUANTITY OF LIKE ITEMS: 4
FOUR CONTROL CIRCUITS PER APU CONTROLLER, 1 CONTROLLER PER APU
- FUNCTION:
 - (1) PROVIDES AN OUTPUT SIGNAL TO OPEN THE GGVM SHUTOFF (N.C.) VALVE ~~(LV13)~~ IN RESPONSE TO A "START/RUN" COMMAND.
 - (2) PROVIDES AN OUTPUT SIGNAL TO ^{CYCLE} OPEN THE NORMALLY CLOSED GGVM SHUTOFF VALVE TO MAINTAIN TURBINE - HIGH (113%) SPEED WITHIN PLUS OR MINUS 8% WHEN HIGH SPEED IS SELECTED BY CREW.

(50V#6LV17)

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SUBSYSTEM: AUXILIARY POWER UNIT (APU)
LRU :APU CONTROLLER
ITEM NAME: APU CONTROLLER

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CRITICALITY OF THIS
FAILURE MODE:1R2

■ FAILURE MODE:

LOSS OF OUTPUT, (FAILS TO PRODUCE AND MAINTAIN SIGNAL TO OPEN SHUTOFF VALVE).

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:

WIRE TO GROUND SHORT, TWO CONTROLLER INTERNAL PIECE PART FAILURES, OPEN CIRCUIT

■ CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

AOA ABORT ONCE AROUND
ATO ABORT TO ORBIT
RTL5 RETURN TO LAUNCH SITE
TAL TRANS ATLANTIC ABORT

- 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; APU SHUTS DOWN WITH SINGLE WIRE TO GROUND SHORT. TWO SPEED CONTROL CIRCUIT FAILURES REQUIRED TO CAUSE APU TO SHUT DOWN.
- (B) INTERFACING SUBSYSTEM(S):
 LOSS OF SHAFT POWER TO ONE HYDRAULIC PUMP IF APU SHUTS DOWN.
- (C) MISSION:
 ABORT DECISION IS REQUIRED IF FAILURE OCCURS PRIOR TO ENTRY COMMITMENT.
- (D) CREW, VEHICLE, AND ELEMENT(S):
 NO EFFECT UNTIL SECOND APU SYSTEM 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:
 POSSIBLE LOSS OF CREW/VEHICLE IF TWO APUS SHUTDOWN. THIS FAILURE WOULD RESULT IN ONE APU SHUTTING DOWN.

 - DISPOSITION RATIONALE -

- (A) DESIGN:
 FOUR SEPARATE SPEED CONTROL CIRCUITS FEED INTO A PARALLEL/SERIES COMBINATION OF VALVE DRIVER SWITCHES (FET). ELECTRICAL COMPONENTS ARE REQUIRED TO BE QUALIFIED, PROPERLY DERATED, AND APPLIED PER MC201-0001, PARAGRAPH 3.3.2.2. ELECTRICAL PARTS SELECTED FROM ~~MS004-400 (OPPL)~~ B PLUS.
OPPL
 CONFORMAL COATING PER SUNDSTRAND SPEC CP 17.32-01. CLEANLINESS PER MA0110-301. CONTROLLER VIBRATION DAMPED AT MOUNTING.
 THE OPPL CALLS FOR GLASSIVATION FOR INTEGRATED CIRCUIT DIE, SINGLE SEAL FOR TANTALUM WET SLUG CAPACITORS, ETC. DERATING OF EEE PARTS IS EXPANDED BEYOND THE SIMPLISTIC (75% X RATED) REQUIREMENTS OF THE CONTRACT.
- (B) TEST:
 CONTROLLER IS FUNCTIONALLY TESTED DURING ATP. CONTROLLER IS SUBJECTED TO AVT. CONTROLLER IS THERMAL TESTED DURING ATP - RANGE 70 DEG F, 130 DEG F, 30 DEG F.

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CONTROLLER IS QUALIFIED FOR QAVT, EMI, THERMAL VACUUM (-65 DEG F TO 165 DEG F, 80 K FT FOR 10 CYCLES), HUMIDITY AND FLIGHT VIBRATION.

ALL EEE PARTS ARE SUBJECTED TO SCREENING AND BOX LEVEL BURN-IN TESTS TO DETECT MARGINAL PARTS AND TO CAUSE INFANT MORTALITY FAILURES.

OMRSD: CONTROLLER/CCU TESTS ARE PERFORMED ON EACH CONTROLLER EVERY FLOW DURING GROUND TURNAROUND TO VERIFY ALL FOUR SPEED CONTROL CIRCUITS AND NO GROUND SHORTS.

- (C) INSPECTION:
RECEIVING INSPECTION
VISUAL AND DIMENSIONAL INSPECTIONS ARE PERFORMED ON ALL INCOMING PARTS. MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED.

CONTAMINATION CONTROL
CLEANLINESS IS VERIFIED BY INSPECTION.

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

CRITICAL PROCESSES
SOLDERING TO MHB 5300.4(3A) IS VERIFIED BY INSPECTION.

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:
NONE.

- (E) OPERATIONAL USE:
LOSS OF ONE APU MAY RESULT IN SWITCHING TO HIGH SPEED AND INHIBIT ON THE 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> 10/21/91
NASA RELIABILITY	:	:	<i>[Signature]</i> 1/27/92
NASA SUBSYSTEM MANAGER	:	:	<i>[Signature]</i> 1-24-92
NASA QUALITY ASSURANCE	:	:	<i>[Signature]</i> 11/2/91