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

NUMBER: 04-2-CONTLS-IM-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	MC201-0001-1005
■	SUNDSTRAND	753831

## PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
SAFETY MONITORING (ELECTRONIC CONTROL CIRCUIT)

■ QUANTITY OF LIKE ITEMS: 4  
FOUR CONTROL CIRCUITS PER APU CONTROLLER, 1 CONTROLLER PER APU.

## ■ FUNCTION:

(1) CLOSES GGVM SHUTOFF VALVE AND PROVIDES <sup>AN OUTPUT</sup> SIGNAL TO THE VEHICLE WHICH CAUSES CREW (C&W) TO BE ALERTED AND FUEL TANK ISOLATION VALVES TO CLOSE IF TURBINE SPEED IS BELOW 80%.

(2) CLOSES GGVM SHUTOFF VALVE AND PROVIDES A SIGNAL TO THE VEHICLE WHICH CAUSES CREW (C&W) TO BE ALERTED AND FUEL TANK ISOLATION VALVES TO CLOSE IF TURBINE SPEED IS ABOVE 129%.

(1) PROVIDES AN OUTPUT SIGNAL TO CREW (C&W), CLOSES GGVM SHUTOFF VALVE AND CLOSES FUEL TANK ISOLATION VALVES IF TURBINE SPEED IS BELOW 80%. THIS FUNCTION IS ACTIVATED 10.5 SEC AFTER START INITIATED. TWO MATCHING UNDERSPEED MPU SIGNALS REQUIRED.

(2) PROVIDES AN OUTPUT SIGNAL TO CREW (C&W), CLOSES GGVM SHUTOFF VALVE AND CLOSES FUEL TANK ISOLATION VALVES IF TURBINE SPEED IS GREATER THAN 129% SPEED. ONE MPU OVERSPEED SIGNAL REQUIRED FOR FIRST 10.5 SEC, TWO MATCHING OVERSPEED MPU SIGNALS REQUIRED AFTER 10.5 SEC.

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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 SHUTDOWN SIGNAL OR INDICATION TO CREW)

MISSION PHASE:

PL	PRELAUNCH
LD	LIFT-OFF
DO	DE-ORBIT
LS	LANDING SAFING

- VEHICLE/PAYLOAD/KIT EFFECTIVITY:
 

102	COLUMBIA
: 103	DISCOVERY
: 104	ATLANTIS
: 105	ENGEAVOUR

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

- CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:

- A)
- B)  
FAILURE OF THIS CIRCUIT WOULD NOT BE DETECTABLE DURING FLIGHT BECAUSE AN OVER/UNDERSPEED CONDITION IS REQUIRED BEFORE THIS CIRCUIT IS USED.
- C)

- FAILURE EFFECTS -

- (A) SUBSYSTEM:  
FIRST FAILURE (OPEN CIRCUIT OR GROUND SHORT) NO EFFECT. *P* SECOND FAILURE

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(GGVM FAILING OPEN, REF. CIL 04-2-LV13-01) MAY RESULT IN APU OVERSPEED AND UNCONTAINED TURBINE WHEEL FRACTURE WHICH WILL RESULT IN FIRE/EXPLOSION. IF SECOND FAILURE RESULTS IN APU DROPPING BELOW 80%, AUTOMATIC CLOSURE OF GGVM AND FUEL ISOLATION VALVES WILL NOT OCCUR. APU MAY RUN AT A REDUCED SPEED. IF APU SHUTS DOWN, POWER MUST BE REMOVED FROM FUEL VALVES TO PREVENT FUEL OVERHEAT AND DETONATION.

- (B) INTERFACING SUBSYSTEM(S):  
 LOSS OF ONE HYDRAULIC SYSTEM AFTER A MINIMUM OF TWO FAILURES OR POSSIBLE LOSS OF ADJACENT EQUIPMENT/HARDWARE FOR UNCONTAINED OVERSPEED.
- (C) MISSION:  
 LOSS OF MISSION, CREW, AND VEHICLE FOR UNCONTAINED OVERSPEED OR LOSS OF TWO APU'S. CBW FOR OVERSPEED OR UNDERSPEED WILL NOT BE DISPLAYED.
- (D) CREW, VEHICLE, AND ELEMENT(S):  
 SAME AS (C)
- (E) FUNCTIONAL CRITICALITY EFFECTS:  
 SAME AS (A) ABOVE.

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 - DISPOSITION RATIONALE -  
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- (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 ~~MFC004-400~~ (OPPL) B PLUS.  
  
 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.  
  
 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.

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

OMRSD: ALL FOUR SAFETY CIRCUITS IN EACH CONTROLLER ARE VERIFIED EACH FLOW DURING GROUND TURNAROUND USING THE CONTROLLER CHECKOUT UNIT. IN ADDITION, IT VERIFIES THAT THERE ARE 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:

NONE.

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- APPROVALS -  
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RELIABILITY ENGINEERING: D. R. ATAPATTU  
DESIGN ENGINEERING : D. J. ZWICK  
QUALITY ENGINEERING : W. R. HIGGINS  
NASA RELIABILITY :  
NASA SUBSYSTEM MANAGER :  
NASA QUALITY ASSURANCE :

*R. Atapattu*  
*D. J. Zwick*  
*W. R. Higgins*  
*10/4/91*  
*1/27/92*  
*1-24-92*  
*1/12/91*