

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE
NUMBER: 04-2-HR17A-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION: 8 01/10/94

	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	: FUEL LINE HEATER SUNDSTRAND	58886 SAME
SRU	: FUEL PUMP HEATER SUNDSTRAND	58902 SAME
SRU	: APU FUEL HEATERS SUNDSTRAND	59653 SAME

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HEATER, APU FUEL PUMP/VALVE (GGVM)/FUEL LINES/H2O LINE

QUANTITY OF LIKE ITEMS: 3

1 DESCRIBED ABOVE PER APU SYSTEM, EACH WITH REDUNDANT ELEMENTS (A AND B)

FUNCTION:

TO MAINTAIN FUEL TEMPERATURE ABOVE 45 DEG F TO PREVENT FUEL FROM FREEZING. COCKPIT SWITCHES ON PANEL A12 ARE USED TO POWER HEATERS AND TO SELECT A OR B SYSTEMS. THERMOSTATS IN EACH SYSTEM AUTOMATICALLY REGULATE TEMPERATURE.

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SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
LRU: AUXILIARY POWER UNIT (APU), FUEL TANK, FUEL LINES CRITICALITY OF THIS
ITEM NAME: APU FUEL HEATERS FAILURE MODE: 1R2

FAILURE MODE:

OPEN (DISCONTINUITY IN HEATER ELEMENTS, LEAD WIRES, TERMINAL BLOCKS OR CONNECTORS)

MISSION PHASE:

DO DE-ORBIT
LO LIFT-OFF
OO ON-ORBIT
PL PRELAUNCH

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

CAUSE:

MATERIAL DEFECT, IMPROPER INSTALLATION, DAMAGE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:

A)
REDUNDANT HEATER SYSTEMS A & B CAN BE VERIFIED DURING GROUND TURNAROUND BUT ARE NORMALLY VERIFIED EACH FLIGHT VIA IN FLIGHT CHECKOUT (IFC). ADDITIONALLY BOTH A & B GAS GENERATOR/FUEL PUMP HEATER SYSTEMS ARE VERIFIED PRELAUNCH AND POST AFT CLOSEOUT.

B)
HEATER TEMP SENSORS ARE ON FAULT DETECTION ANNUNCIATION (FDA). LOW LIMIT IS 60 DEG F FOR BYPASS LINE TEMPERATURE (V46TOX28A).

C)
HEATER SYSTEMS ARE REDUNDANT.

MASTER MEAS. LIST NUMBERS: V46TOX28A
V46TOX12A
V46TOX71A
V46TOX72A
V46TOX92A

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- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT ON APU OPERATION SINCE HEATERS ARE OFF. LOSS OF HEATER REDUNDANCY AFTER FIRST FAILURE.

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT.

(C) MISSION:

LAUNCH SCRUB IF DETECTED. NO EFFECT UNLESS BOTH HEATER SYSTEMS A & B FAIL, WHICH MAY RESULT IN ORBITER ATTITUDE CHANGE OR MISSION ABORT.

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

NO EFFECT UNTIL SECOND SYSTEM LOSS. POSSIBLE LOSS OF CREW/VEHICLE DUE TO FIRE/EXPLOSION IF FUEL FREEZES AND LINE RUPTURE OCCURS UPON THAWING.

(E) FUNCTIONAL CRITICALITY EFFECTS:

FIRST FAILURE NO EFFECT - FAILURE OF HEATER SYSTEM WILL BE DETECTABLE BY INSTRUMENTATION/FDA AND RESULT IN CREW SWITCHING TO REDUNDANT HEATER SYSTEM WITHIN THE NORMAL RESPONSE TIME OF 15 MINUTES. FAILURE OF REDUNDANT HEATER SYSTEM OR COCKPIT SWITCH WILL RESULT IN ORBITER ATTITUDE MANAGEMENT TO MAINTAIN SYSTEM THERMAL CONSTRAINTS WITHIN LIMITS (REF. FLIGHT RULE 10-167). FMEA/CIL GROUND RULES DO NOT ALLOW OFF NOMINAL CREW INTERACTION TO BE CONSIDERED AS A REDUNDANT ITEM. THEREFORE, CRITICALITY IS 1R2.

-DISPOSITION RATIONALE-

(A) DESIGN:**LINE HEATERS:**

UNITS ARE MANUFACTURED BY COX AND COMPANY. HEATING ELEMENT INSULATION IS MIL-W-81381. ELEMENTS FOR HEATER A & B ARE TWISTED TOGETHER AND COVERED BY SILICON INSULATION. TERMINAL BLOCK IS SILICON RUBBER. LEAD WIRES INSULATED WITH TEFLON. ALL EXTERNAL INSULATING MATERIALS ARE RESISTANT TO CORROSION AND/OR DETERIORATION WHEN IN CONTACT WITH HYDRAZINE OR OIL. ENVIRONMENTAL TEMPERATURE REQUIREMENT IS -65 DEG F TO 350 DEG F.

FUEL PUMP HEATER:

HEATER UNIT HERMETICALLY SEALED. LEAD WIRES TEFLON INSULATED.

GGVM HEATER:

FLAT ELEMENT RESISTANCE HEATER SANDWICHED BETWEEN LAMINATES. LEAD WIRES TEFLON INSULATED.

TANK HEATER:

PAD HEATER WITH TEFLON INSULATED LEAD WIRES.

(B) TEST:

DIELECTRIC STRENGTH BETWEEN EXTERNAL SURFACE TO HEATER ELEMENT AND BETWEEN HEATER TO HEATER ELEMENT. INSULATION RESISTANCE BETWEEN

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EXTERNAL SURFACE TO EACH HEATER ELEMENT AND BETWEEN TWO HEATER ELEMENTS PER DRAWING REQUIREMENT.

OMRSD: APU 1/2/3 HEATER TEST BY COCKPIT COMMAND PERFORMED FIRST FLOW AND ON A CONTINGENCY BASIS THEREAFTER, ANY TIME HEATER OR LINES ARE DISTURBED. FLIGHT DATA IS USED TO VERIFY HEATER OPERATION EVERY FLOW AFTER THE FIRST FLIGHT. ADDITIONALLY, BOTH A & B GAS GENERATOR/FUEL PUMP SYSTEMS VERIFIED TO BE FUNCTIONING NOMINALLY PRIOR TO LAUNCH AFTER AFT COMPARTMENT CLOSEOUT.

(C) INSPECTION:

RECEIVING INSPECTION

MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS AND CORROSION PROTECTION REQUIREMENTS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

INSPECTION VERIFIES CONFIGURATION OF THE HEATER TO DRAWING REQUIREMENTS. THE LOCATION AND SPACING OF THE HEATER ELEMENTS AND LEAD WIRE CONNECTIONS AND JOINTS WITHIN THE HEATER ARE VERIFIED TO DRAWING REQUIREMENTS.

NONDESTRUCTIVE EVALUATION

INSPECTION VERIFIES HEATER ELEMENT RESISTANCE INSPECTION AND X-RAY INSPECTION PER DRAWING REQUIREMENTS.

CRITICAL PROCESSES

CRIMPING OF LEAD WIRES WITH HEATER WIRING PER COX PROPRIETARY PROCESS IS VERIFIED BY INSPECTION.

TESTING

PERFORMANCE OF THE HEATER IS EVALUATED VIA ACCEPTANCE TEST PROCEDURE WHICH IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING OF THE HEATER PER DRAWING REQUIREMENTS IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CAR 30RF15

FAILED OFF HEATER SYSTEM A ON THREE CONSECUTIVE FLIGHTS OF OV104. CAUSE ISOLATED TO WIRING BETWEEN THE AFT LOAD CONTROLLER ASSEMBLY #2 AND COCKPIT PANEL A12. PROBLEM COULD NOT BE DUPLICATED ON THE GROUND. REPLACEMENT OF WIRING RESULTED IN SYSTEM OPERATING NORMALLY ON THE NEXT FLIGHT.

(E) OPERATIONAL USE:

FIRST FAILURE - SELECT ALTERNATE HEATER.

SECOND FAILURE - PERFORM ON-ORBIT THERMAL CONDITIONING AND/OR OPERATE APU PERIODICALLY TO MAINTAIN FUEL SYSTEM TEMPERATURES.

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- APPROVALS -

EDITORIALLY APPROVED : RI
EDITORIALLY APPROVED : JSC
TECHNICAL APPROVAL : VIA CR

John
John Abbey 1/19/94
~~ORR~~ 5502704