

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 04-2-CONTL2-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION : 2 89/08/09

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	APU CONTROLLER SUNSTRAND	MC201-0001-0075 7294850

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HIGH SPEED CONTROL (ELECTRONIC CONTROL CIRCUIT).
- QUANTITY OF LIKE ITEMS: 3
1 CONTROL CIRCUIT PER APU CONTROLLER, 1 PER APU
- FUNCTION:
 - (1) PROVIDES AN OUTPUT SIGNAL TO OPEN THE NORMALLY CLOSED SHUTOFF VALVE (LV13) IN RESPONSE TO A "START" COMMAND WITH PRE-START CONDITIONS SATISFIED OR TO A "COOL" COMMAND FOR AN UNCONDITIONAL START.
 - (2) CANCELS OUTPUT SIGNAL (IN RESPONSE TO MPU #2) AND ALLOWS VALVE TO CLOSE WHEN TURBINE SPEED APPROACHES 113 PLUS OR MINUS 8 PER CENT.
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REVISION# 2 10/26/89

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

CRITICALITY OF THIS
FAILURE MODE:1/1

FAILURE MODE:

PREMATURE OUTPUT, CAUSING INADVERTENT APU RESTART (PRODUCES A SIGNAL TO OPEN VALVE AFTER AN APU SHUTDOWN OR DURING A PLANNED HOT RESTART PRIOR TO COMPLETION OF THE 209 SECOND MANUAL GG INJECTOR COOLING).

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

CAUSE:

INTERNAL PIECE-PART FAILURE, WIRE-TO-WIRE SHORT, COCKPIT SWITCH SHORT

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:

A)
B)
C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT UNLESS DETONATION RESULTS DUE TO UNCOOLED HOT INJECTOR FUEL PASSAGES. IF MINOR DETONATION OCCURS, THE INJECTOR MAY BE DAMAGED, CAUSING ROUGH COMBUSTION. IF MAJOR DETONATION OCCURS, APU IS LOST WITH

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POSSIBLE FUEL SYSTEM RUPTURE.

(B) INTERFACING SUBSYSTEM(S):

LOSS OF ONE HYDRAULIC SYSTEM. POSSIBLE LOSS OF ADJACENT HARDWARE DUE TO APU DETONATION.

(C) MISSION:

LOSS OF MISSION IF FAILURE OCCURS FOLLOWING ASCENT.

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

POSSIBLE LOSS OF CREW/VEHICLE DUE TO RAW FUEL IN AFT (FIRE) OR APU DETONATION.

(E) FUNCTIONAL CRITICALITY EFFECTS:

FUEL ISOLATION VALVE CLOSURE IS ACCOMPLISHED IN A FEW SECONDS FOLLOWING APU SHUTDOWN. POSSIBLE LOSS OF CREW/VEHICLE IF FAILURE OCCURS PRIOR TO CLOSURE OF ISOLATION VALVES. CLOSURE OF ISOLATION VALVES INHIBITS THIS FAILURE MODE.

 - DISPOSITION RATIONALE -

(A) DESIGN:

ELECTRICAL COMPONENTS ARE REQUIRED TO BE QUALIFIED, PROPERLY DERATED AND APPLIED PER MC201-0001, PARAGRAPH 3.3.2.2. MECHANICAL PARTS SELECTED FROM MF0004-100. ELECTRICAL PARTS SELECTED FROM MF0004-400. 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). ADDITIONAL HUMIDITY, FLIGHT VIBRATION, AND THERMAL VACUUM TESTS ARE CONDUCTED FOR THE OPERATIONAL CONFIGURATION.

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

OMRSD: APU 1/2/3 CONTROLLER CHECKOUT THRU GROUND CONNECTION PERFORMED

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EVERY FLOW.

(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 NHB 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 BY INSPECTION.

(D) FAILURE HISTORY:

NO QUALIFICATION/FLIGHT FAILURES TO DATE. SANGAMO CAPACITORS FAILED IN ATP RESULTING IN ALL CAPACITORS BEING CHANGED OUT (CAR AC9235).

ALTERNATE PART WAS SUBSTITUTED IN CONTROLLER, RESULTING IN ERRATIC OUTPUT DURING VEHICLE CHECKOUT (CAR AC2853). CIRCUIT WAS REDESIGNED TO BE IMMUNE TO COMPONENT MANUFACTURING VARIATIONS.

TWO INSTANCES OF APU HOT RESTART HAVE BEEN RECORDED IN THE PROBLEM RESOLUTION AND CORRECTIVE ACTION (PRACA) SYSTEM. BOTH RESULTED IN HYDRAZINE DETONATION WITH GAS GENERATOR INJECTOR TUBE AND GAS GENERATOR VALVE MODULE DAMAGE.

BOTH OCCURRED IN TEST STANDS, AND NEITHER WAS AN INADVERTENT RESTART, HOWEVER, THESE INSTANCES ARE MENTIONED HERE BECAUSE THEY SHOW THE EFFECTS OF A HOT RESTART.

THE FIRST (CAR ABD284) OCCURRENCE WAS AT JSC ON 3/24/78 AS A PART OF DEVELOPMENT TESTING. CORRECTIVE ACTION INCLUDED CHANGING MISSION RULES TO OPERATE APU'S CONTINUOUSLY THROUGHOUT AOA (ABORT ONCE AROUND), AND THUS MAKES A HOT RESTART UNNECESSARY.

AT THE TIME, THE APU INJECTOR TEMPERATURE LIMIT FOR HOT RESTART WAS ALSO

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REVISED TO A TEMPERATURE OF 450 DEG F. IN ADDITION, A FEASIBILITY STUDY OF ACTIVE WATER COOLING OF THE GAS GENERATOR TO GIVE THE APU AN UNRESTRICTED HOT RESTART CAPABILITY WAS AUTHORIZED.

THE SECOND INSTANCE (CAR AB42D5) OCCURRED AT JSC ON 6/6/79 AS A PART OF PREQUALIFICATION TESTING. CORRECTIVE ACTION AUTHORIZED THE ADDITION OF AN ACTIVE WATER COOLING SYSTEM TO COOL BOTH THE FUEL PUMP AND THE GAS GENERATOR VALVE MODULE AFTER APU SHUTDOWN.

(E) OPERATIONAL USE:

CLOSE TANK ISOLATION VALVE, THEN SHUT OFF CONTROLLER POWER.

- APPROVALS -

RELIABILITY ENGINEERING:	T. R. BOLTZ	DRR:	<u>W. J. P. [Signature]</u>	11/6/89
DESIGN ENGINEERING	: J. R. MUNROE	:	<u>[Signature]</u>	10/26/89
QUALITY ENGINEERING	: D. DESAI	:	<u>W. J. [Signature]</u>	11/1/89
NASA RELIABILITY	:	:	<u>[Signature]</u>	1/5/90
NASA SUBSYSTEM MANAGER	:	:	<u>W. J. [Signature]</u>	1/5/90
NASA QUALITY ASSURANCE	:	:	<u>[Signature]</u>	11/3/89