PRINT DATE: 09/21/94

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL HARDWARE
NUMBER: 04-2-CTK01-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION: 3 09/21/94

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:	TANK, WATER	ME282-0100-0001
LRU	:	COUPLING	ME276-0032-0009

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
WATER TANK AND TEST POINT COUPLING, GN_2 (MDO2)

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
STORES/PROVIDES COOLING WATER FOR APU INJECTOR COOLING SYSTEM. TANK USES PRESSURIZED DIAPHRAM TO PROVIDE WATER TO CONTROL VALVES. INJECTOR COOLING SYSTEM PREVENTS HYDRAZINE DETONATION DURING APU HOT RESTART. GG INJECTOR COOLING MUST BE PERFORMED PRIOR TO APU START IF GG INJECTOR OR BED TEMPERATURE IS ABOVE 415 DEG F (DUE TO SOAKBACK) PER V46T0X74A OR V46T0X22A. CREW OPENS VALVE FOR 209 SECONDS (MINIMUM) WITH CONTROLLER POWER ON AND APU OPERATE SWITCH IN "INJECTOR COOL" POSITION. CREW MONITORS REAL-TIME DISPLAY TO CONFIRM INJECTOR TEMPERATURES ARE DECREASING. AT END OF 209 SECONDS, CREW MUST CYCLE APU OPERATE SWITCH TO "START/RUN" POSITION IMMEDIATELY TO PREVENT REHEATING OF INJECTOR BRANCH PASSAGES. COOLDOWN PERIOD

INJECTOR COOLING CAN BE USED FOR BOTH PAD AND MISSION APU HOT RESTARTS (REFER TO THE FOLLOWING REFERENCE DOCUMENTS).

REFERENCE DOCUMENTS: NSTS-16007, LCC SECTIONS: APU-19, APU-20, APU-21 ~~22~~
NSTS-08934, (VOL I) SODB SECTION 3.4.4.3.5
NSTS 12820, FLIGHT RULE SECTION 10-3

PRIN: DATE: 09/21/94

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 04-2-CTK01-02

REVISION# 3 09/21/94

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
LRU: TANK, WATER GN2
ITEM NAME: TANK, WATER AND/OR COUPLING

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
EXTERNAL LEAK, WATER OR NITROGEN

MISSION PHASE: PRELAUNCH
LO LIFT-OFF
OO ON-ORBIT
ENTRY

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

CAUSE:
CONTAMINATION, CORROSION, MATERIAL DEFECT, EXTERNAL PENETRATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES
AOA ABORT ONCE AROUND

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

PASS/FAIL RATIONALE:
A)
B) "Injector cooling is addressed as an emergency system. Therefore, its functional criticality is 1R. Redundancy screens for this hardware is N/A as there is no redundant hardware
C) to perform this function."

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT FOR NOMINAL MISSION GROSS WATER LEAKAGE RESULTS IN LOSS OF COOLING CAPABILITY TO ALL THREE APU'S. POSSIBLE HYDRAZINE DETONATION AT RESTART DUE TO EXCESSIVE GG BRANCH PASSAGE TEMPERATURE IF COOLING IS NOT AVAILABLE. APU'S CANNOT BE SAFELY RESTARTED WITHOUT WATER COOLING UNTIL GG INJECTOR OR BED TEMPERATURE (V46T0X74A OR V46T0X22A) FALLS BELOW 415 DEG F (APPROXIMATELY 4 HOURS AFTER SHUTDOWN).

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT FOR NOMINAL MISSION LOSS OF SHAFT POWER TO ASSOCIATED HYDRAULIC SYSTEM(S). F WHT RESTART CANNOT BE PERFORMED.

(C) MISSION:

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 04-2-CTK01-02

(1ST FAILURE)

NO EFFECT FOR NOMINAL MISSION. PRECLUDES SAFE APU RESTART IN THE EVENT OF CONTINGENCY ABORT, OR SYSTEM-INDUCED AOA WITHIN FOUR HOURS OF APU SHUTDOWN. IF INJECTOR COOLING NOT AVAILABLE, ABORTS POSSIBLY DELAYED UNTIL GG INJECTOR TEMPERATURES FALL WITHIN SAFE RANGE.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT FOR NOMINAL MISSION. LOSS OF CREW/VEHICLE IF REENTRY IS ATTEMPTED WITHOUT HYDRAULIC POWER. POSSIBLE LOSS OF CREW/VEHICLE IN THE EVENT OF EMERGENCY SITUATION IF DEORBIT IS DELAYED. HAZARDOUS CONDITION EXISTS IF APU HOT RESTART IS ATTEMPTED WITHOUT INJECTOR COOLING.

(E) FUNCTIONAL CRITICALITY EFFECTS:
NO EFFECT FOR NOMINAL MISSION. LOSS OF AEROSURFACE CONTROL, NOSE WHEEL STEERING (APU'S 1 & 2), BRAKING, AND LOSS OF LANDING GEAR DEPLOY (APU 1) REDUNDANCY UNTIL APU'S CAN BE STARTED. CRITICALITY 1 FOR SYSTEM-INDUCED ABORT-ONCE-AROUND IF APU'S ARE SHUT DOWN PRIOR TO INITIATION OF ABORT.

-DISPOSITION RATIONALE-

(A) DESIGN:
CONTINUALLY DECREASING SYSTEM PRESSURE - BLOWDOWN SYSTEM. TITANIUM 6A14V TANK IS USED ON SCATHA PROGRAM AT 400 PSIG WORKING PRESSURE, COMPARED TO ~~400~~ 1130 PSIG FOR ORBITER. FRACTURE CONTROL MECHANICS ANALYSIS ALSO IMPOSED ON THIS TANK WITH BURST REQUIREMENT OF 800 PSIG.

TEST POINT COUPLING (MDO2) IS CERTIFIED FOR BOTH APU AND OMS/RCS USE WITH GN_2 FOR OPERATING PRESSURE TO 450 PSIG.

(B) TEST:
TANK ACCEPTANCE TEST PROOF PRESSURE AT 600 PSIG. TEST POINT ATP PROOF PRESSURE AT 900 PSIG. FUNCTIONAL VERIFICATION AT ACCEPTANCE PER ATP.

TANK QUALIFICATION TEST SPECIMEN HAD 100 EXPULSION CYCLES. MATERIALS, PIECE PARTS, AND ASSEMBLIES ARE VERIFIED INCREMENTALLY.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.
ELASTOMER COMPONENTS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
MOLD CLEANLINESS IS VERIFIED BY INSPECTION. CLEANLINESS TO LEVEL 100 IS VERIFIED BY INSPECTION. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE NUMBER: 04-2-CTK01-02

CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. MANUFACTURING, ASSEMBLY, AND INSTALLATION PROVISIONS ARE VERIFIED BY INSPECTION. DIAPHRAGM FABRICATION IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
BACKLIGHTING AND X-RAY OF DIAPHRAGM IS VERIFIED BY INSPECTION. PENETRANT AND RADIOGRAPHIC INSPECTIONS OF WELDS ARE VERIFIED BY INSPECTION. PENETRANT INSPECTION IS PERFORMED AFTER FORMING VESSEL IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
WELDING PER SPECIFICATION REQUIREMENTS 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:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:
NONE

- APPROVALS -

PAE MANAGER	: K. L. PRESTON	: K.L. Preston 9/22/94
PRODUCT ASSURANCE ENGR	: T. AI	:
DESIGN ENGINEERING	: J. C. ROBINSON	: J. C. Robinson
NASA SSMA	:	: Jeff Mellican 10/17/94
NASA SUBSYSTEM MANAGER	:	: D.B. Young 10-7-94