 PRINT DATE: 09/21/94

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL HARDWARE
NUMBER: 04-2-CLV13-IM-X

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
REVISION: 0 09/21/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	VALVE SOLENOID VALCOR ENGINEERING	ME289-0588-0001 V27200-709

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE SOLENOID, WATER, NORMALLY CLOSED

QUANTITY OF LIKE ITEMS: 3
THREE, ONE PER APU

FUNCTION:
CONTROLS FLOW OF COOLING WATER TO APU GAS GENERATOR (GG) TO LOWER INJECTOR TUBE BRANCH PASSAGE TEMPERATURES TO PREVENT 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 COOLING PERIOD, CREW MUST CYCLE APU OPERATE SWITCH TO "START/RUN" POSITION IMMEDIATELYTO PREVENT REHEATING OF INJECTOR BRANCH PASSAGES.

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) SOOB SECTION 3.4.4.3.5
NSTS 12820, FLIGHT RULE SECTION 10-3

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 04-2-CLV13-1M-02

REVISION# 0 09/21/94

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)
LRU: VALVE SOLENOID
ITEM NAME: VALVE SOLENOID

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
EXTERNAL LEAK, STUCK OPEN, INTERNAL LEAK

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, JAMMED

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

REDUNDANCY SCREEN
A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)

B)

C)

- 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).

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 04-2-CLV13-IM-02

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT FOR NOMINAL MISSION. LOSS OF SHAFT POWER TO ASSOCIATED HYDRAULIC SYSTEM(S).

(C) MISSION: (1 or 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:
THE VALVE IS NORMALLY CLOSED, DIRECT ACTING (2 POSITION) SOLENOID VALVE, AND WOULD NOT BE OPENED UNLESS APU HAS TO START IN THE "INJECTOR COOL" POSITION TO ALLOW HOT RESTART; THEREFORE THE FAIL OPEN MODE IS REMOTE. THE UNPOWERED VALVE IS CLOSED, WITH A RETURN SPRING FORCING THE PLUNGER ASSEMBLY INTO THE VALVE OUTLET.

THE ENGAGED SOLENOID COIL ASSEMBLY IS DESIGNED TO ELECTROMAGNETICALLY ATTRACT THE PLUNGER ASSEMBLY (ARMATURE) WITH FORCES TO OVERCOME THE RETURN SPRING. WATER FLOW THROUGH THE VALVE IS FILTERED THEN PASSES THROUGH A SINGLE FLOW PATH INTO THE PLUNGER. WITHIN THE PLUNGER, THE FLOW SYMMETRICALLY TRIRADIATES AROUND THE INTERNAL SEAL. INTERNAL SEALING IS ACCOMPLISHED USING A CAPTURED EPR O-RING INSTALLED ON THE PLUNGER ASSEMBLY SEATING IN A CONCIAL SHARED VALVE OUTLET.

ALL METALS USED INSIDE THE VALVE, WITH EXCEPTION OF THE COIL WINDINGS AND POWER LEADS ARE CONSTRUCTED OF 17-4, 17-7, 300 SERIES CRES. MAXIMUM WORKING PRESSURE IS 145 PSIA, PROOF PRESSURE OF 220 PSIG AND BURST PRESSURE OF 290 PSIG.

VALVE IS PROTECTED BY A 40 MICRON INLET FILTER.

THE "INJECTOR COOL" POSITION OF THE COCKPIT SWITCH IS USED TO OPEN EACH VALVE IN THE ORBITER.

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 04-2-CLV13-IM-02

(B) TEST:
ATP INCLUDES CLEANLINESS VERIFICATION, PROOF PRESSURE TO 220 PSIG, LEAK CHECKS AT 145 PSIG, FUNCTIONAL OPERATION, DIELECTRIC WITHSTANDING VOLTAGE (DWV), INSULATION RESISTANCE (IR), COIL RESISTANCE AND EXAMINATION OF PRODUCT.

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

QUALIFICATION TESTING HAS BEEN COMPLETED SUCCESSFULLY WITHOUT ANY FAILURES. THE VALVE CERTIFICATION CONSISTS OF BOTH TEST DATA AND MATERIAL/CONSTRUCTION ANALYSIS TO SATISFY DESIGN AND ENVIRONMENTAL REQUIREMENTS.

(C) INSPECTION:
RECEIVING INSPECTION
MATERIAL AND PROCESSES CERTIFICATIONS ARE VERIFIED.

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

ASSEMBLY/INSTALLATION
POTTING AND TORQUING ARE VERIFIED BY INSPECTION. DIMENSIONAL INSPECTIONS ARE PERFORMED AND VERIFIED BY INSPECTION. SURFACE FINISHES ARE VERIFIED BY INSPECTION. MANUFACTURING, ASSEMBLY, AND MANUFACTURING PROCEDURES ARE VERIFIED BY INSPECTION. TIG WELDMENTS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
VISUAL INSPECTION UNDER 10X MAGNIFICATION OF SEALING O-RINGS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
HEAT TREATMENT IS VERIFIED BY INSPECTION. SOLDERING REQUIREMENTS ARE 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:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

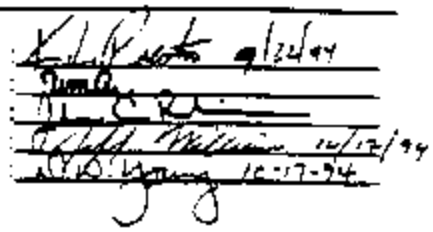
(E) OPERATIONAL USE:
NONE

PRINT DATE: 09/21/94

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 04-2-CLV13-IM-02

- APPROVALS -

PAE MANAGER	: K. L. PRESTON
PRODUCT ASSURANCE ENGR	: T. AI
DESIGN ENGINEERING	: J. C. ROBINSON
NASA SSMA	:
NASA SUBSYSTEM MANAGER	:



1