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PRINT DATE: 12/14/94

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE
NUMBER: 04-2-L1-X**

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU)

REVISION: 1 12/09/94

| | PART NAME VENDOR NAME | PART NUMBER VENDOR NUMBER |
|-----|----------------------------------|--------------------------------------|
| LRU | : LINES, FUEL | V070-465202 |
| LRU | : LINES, FUEL | V070-465243 |

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LINES, FUEL (FEED, FILL, DRAIN, TEST, AND SEAL CAVITY DRAIN LINES)

QUANTITY OF LIKE ITEMS: 3

ONE SET PER APU

FUNCTION:

(1) TO CARRY FUEL FROM THE FUEL TANK TO THE APU. (2) TO FILL AND DRAIN FUEL TANK AND PROVIDE PURGE AND CHECKOUT CAPABILITY. (3) TO PROVIDE AN OVERBOARD DRAIN FOR APU FUEL PUMP SHAFT SEAL.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE
NUMBER: 04-2-L1-11**

SUBSYSTEM NAME: AUXILIARY POWER UNIT (APU) **REVISION#** 1 **12/09/94**
LRU: LINES, FUEL
ITEM NAME: LINES, FUEL **CRITICALITY OF THIS FAILURE MODE:** 1/1

FAILURE MODE:
EXTERNAL LEAKAGE

MISSION PHASE:

PL PRE-LAUNCH
 LO LIFTOFF
 OO ON ORBIT
 DO DEORBIT
 LS LANDING SAFING

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

CAUSE:

LINE RUPTURE, CRACKS, CORROSION, SEAL OR FITTING FAILURE.

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:

POSSIBLE LOSS OF ONE APU SYSTEM BEFORE MISSION COMPLETION IF LEAKING FUEL IS NOT IGNITED. POSSIBLE LOSS OF ADJACENT AND/OR REDUNDANT APU HARDWARE DUE TO FIRE OR CHEMICAL ATTACK.

(B) INTERFACING SUBSYSTEM(S):

POSSIBLE LOSS OF SHAFT POWER TO ONE HYDRAULIC PUMP. POSSIBLE LOSS OF ADJACENT AND/OR REDUNDANT HARDWARE DUE TO FIRE OR CHEMICAL ATTACK.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE
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(C) MISSION:

ABORT DECISION REQUIRED IF FAILURE OCCURS DURING ASCENT. MINIMUM DURATION FLIGHT REQUIRED IF LEAK OCCURS ON ORBIT.

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

POSSIBLE LOSS OF CREW/VEHICLE IF LEAKING FUEL IS IGNITED OR IF ADJACENT AND/OR REDUNDANT HARDWARE IS LOST DUE TO FIRE OR CHEMICAL ATTACK.

-DISPOSITION RATIONALE-

(A) DESIGN:

PROVEN DESIGN. LINES UNDER 1 IN., 304L WELDED IN PLACE. DESIGN BURST PRESSURE 4 TIMES OPERATING PRESSURE MINIMUM.

DYNATUBE/DUAL SEAL FITTINGS (17-4) ATTACHED WITH WELDED SLEEVE & WITH DUAL-SEALING SURFACES. THE WELDED CONSTRUCTION ELIMINATES JOINTS AND POSSIBLE LEAK PATHS.

FASTENING CLAMPS ALLOW FREEDOM OF MOVEMENT. TUBING BENDS ARE CONTROLLED BETWEEN FIXED POINTS TO FACILITATE INSTALLATION AND ACCOMMODATE VEHICLE GROWTH AND MOVEMENT.

(B) TEST:

INITIAL TUBING PROOF PRESSURE AT 1.5 TIMES OPERATING PRESSURE. SUBSYSTEM FUNCTIONAL AND LEAK TESTS AFTER INSTALLATION.

DYNATUBE FITTING QUALIFIED BY RESISTOFLEX FOR 200,000 IMPULSE CYCLES UP TO 4,500 PSI AT 400 DEG F TO -85 DEG F, 12000 PSI BURST PLUS SINE VIBRATION AT +/- 0.41 G TO +/- 10 G FOR 3 HR IN 20 MIN. SWEEPS FROM 5 TO 2,000 CPS.

ROCKWELL PERFORMED TUBING CERTIFICATION TESTS PER ORBITER TUBING VERIFICATION PLAN (SD 75-84-205). THIS TESTING INCLUDED WORST CASE USAGE, PRESSURE CYCLING, FATIGUE, AND OFF-LIMIT TESTING FOR LINES, JOINTS, AND PANELS. SYSTEM EVALUATION TESTS ON OV-101 AND AT SUNDSTRAND ALLOWED EVALUATION OF THE INSTALLED SYSTEM CONDITION.

OMRSD: TOXIC VAPOR CHECKS AND POSTFLIGHT SYSTEM INSPECTION ARE PERFORMED EVERY FLOW.

(C) INSPECTION:

THE FOLLOWING HARDWARE AND PROCESSES ARE VERIFIED BY INSPECTION:

- 1) RECEIVING INSPECTION MATERIALS AND PROCESSES CERTIFICATIONS
- 2) CONTAMINATION CONTROL CLEANLINESS TO LEVEL 100
- 3) CORROSION PROTECTION PROVISIONS
- 4) ASSEMBLY/INSTALLATION MANUFACTURING, ASSEMBLY, AND INSTALLATION PROCEDURES
- 5) INSTALLATION OF LINE SUPPORT ISOLATORS
- 6) TUBE AND AXIAL ALIGNMENT OF DYNATUBE FITTINGS
- 7) TORQUE
- 8) NO TUBE PRELOADS PRESENT DURING INSTALLATION

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- 9) CRITICAL DIMENSIONS AND SURFACE FINISHES
- 10) ELECTRICAL BOND
- 11) NONDESTRUCTIVE EVALUATION RADIOGRAPHIC CHECKS OF WELDS
- 12) CRITICAL PROCESSES WELDING PER SPECIFICATION REQUIREMENTS
- 13) TEST EQUIPMENT AND TOOL CALIBRATION
- 14) ATP
- 15) PROOF AND LEAK TESTS
- 16) HANDLING, PACKAGING, STORAGE, AND SHIPPING PROCEDURES

(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:

CLOSE ISOLATION VALVES. IF UNSUCCESSFUL IN STOPPING THE LEAK, RUN APU TO FUEL DEPLETION.

- APPROVALS -

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

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