

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
 NUMBER: M4-1BG-A01FSH -X

SUBSYSTEM NAME: ELECTRICAL POWER GENERATION - CRYO, GENERIC
 REVISION: 3 03/27/96

PART DATA

| PART NAME | PART NUMBER |
|-------------------------------------|---------------|
| VENDOR NAME | VENDOR NUMBER |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454001 |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454002 |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454004 |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454006 |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454008 |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454011 |
| SRU : LINES, COMPONENTS & FITTINGS | M072-454012 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454011 |
| SRU : LINES, COMPONENTS, & FITTINGS | V070-454021 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454031 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454041 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454051 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454052 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454061 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454062 |
| SRU : LINES, COMPONENTS & FITTINGS | V458-454002 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454906 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454907 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454908 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454909 |
| SRU : LINES, COMPONENTS & FITTINGS | V070-454926 |

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| SRU | : LINES, COMPONENTS & FITTINGS | V070-454927 |
| SRU | : LINES, COMPONENTS & FITTINGS | V070-454928 |
| SRU | : LINES, COMPONENTS & FITTINGS | V070-454929 |
| SRU | : LINES, COMPONENTS & FITTINGS | V070-454946 |
| SRU | : LINES, COMPONENTS & FITTINGS | V070-454947 |
| SRU | : LINES, COMPONENTS & FITTINGS | V070-454948 |
| SRU | : LINES, COMPONENTS & FITTINGS | V070-454949 |
| SRU | : LINES, COMPONENTS & FITTINGS | M072-454013 |
| SRU | : LINES, COMPONENTS & FITTINGS | M072-454014 |
| SRU | : LINES, COMPONENTS & FITTINGS | M072-454015 |
| SRU | : LINES, COMPONENTS & FITTINGS | M072-454009 |
| SRU | : LINES, COMPONENTS & FITTINGS | M454100 |

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINES, COMPONENTS AND FITTINGS, H2

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
LINES, COMPONENTS AND FITTINGS DISTRIBUTE H2 FROM THE STORAGE TANK
SUBASSEMBLIES TO THE FUEL CELLS.

- APPROVALS -

PRODUCT ASSURANCE ENGR : J. NGUYEN
DESIGN ENGINEERING : T. D. NGUYEN
EDITED BY: B. ADDISON TCA

J. Nguyen 7/2/97
T. D. Nguyen 7/2/97
B. Addison 9-12-97

PAGE: 3

PRINT DATE: 12/09/92

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M4-1BG-A01F8E-01

SUBSYSTEM: ELECTRICAL POWER GENERATION - CRYO, GENERIC
ITEM NAME: LINES, COMPONENTS & FITTINGS
REVISION# 2 12/09/92
CRITICALITY OF THIS
FAILURE MODE: 1/1

FAILURE MODE:
EXTERNAL LEAKAGE

MISSION PHASE:
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT
LS LANDING SAFING

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

| | |
|-----|-----------|
| 102 | COLUMBIA |
| 103 | DISCOVERY |
| 104 | ATLANTIS |
| 105 | ENDEAVOUR |

CAUSE:
MECHANICAL SHOCK, VIBRATION, CORROSION, OVERPRESSURE, MISHANDLING

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:
SUBSYSTEM DEGRADATION - LOSS OF H2 SUPPLY. EXCESSIVE LOSS OF H2 WOULD REQUIRE RECONFIGURATION OF THE SYSTEM TO ISOLATE LEAK. POSSIBLE LOSS OF SEVEN H2 TANK SUPPLIES (TANKS 3 THROUGH 9).

(B) INTERFACING SUBSYSTEM(S):
DEGRADATION OF INTERFACE FUNCTION - LEAK ISOLATION MAY RESULT IN LOSS

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OF H2 REACTANT SUPPLY TO ONE FUEL CELL POWERPLANT. LOSS OF FCP1/BUS "A" OR FCP3/BUS "C" IS LOSS OF OMS ENGINE PURGE CAPABILITY, WHICH IS REQUIRED FOR TAL AND APT COMPARTMENT MPS HELIUM PURGE CAPABILITY, WHICH IS REQUIRED FOR RTLS AND TAL.

(C) MISSION:
ABORT DECISION.

(D) CREW, VEHICLE, AND ELEMENT(S):
GROSS LEAKAGE OF H2 MAY RESULT IN LOSS OF ALL THREE FUEL CELL POWERPLANTS, DUE TO LOSS OF SYSTEM PRESSURE BEFORE LEAK ISOLATION COULD BE PERFORMED (DEPRESSURIZATION OCCURS IN 7 SECONDS WORST CASE). ALSO, UNDETECTED OR UNISOLATABLE LEAKAGE OF H2 MAY RESULT IN EXPLOSIVE MIXTURE IN THE MIDBODY DURING ENTRY.

(E) FUNCTIONAL CRITICALITY EFFECTS:
NONE

- DISPOSITION RATIONALE -

(A) DESIGN:
RELIEF VALVE PROTECTION FOR OVERPRESSURE CONDITIONS PROVIDING AT LEAST ONE MANIFOLD VALVE IS OPEN. LINE DESIGN BURST PRESSURE IS A MINIMUM OF 4 TIMES WORKING PRESSURE. COMPONENT DESIGN BURST PRESSURE IS A MINIMUM OF 2 TIMES WORKING PRESSURE. OV-103, OV-104, AND OV-105 FITTINGS ARE SAFETY-WIRED. LINES, FITTINGS AND COMPONENTS ARE VIBRATION-ISOLATED FROM VEHICLE STRUCTURE. MATERIALS ARE CORROSION RESISTANT AND COMPATIBLE WITH WORKING FLUIDS. CREW PROVIDED WITH CAUTION AND WARNING FOR OVERPRESSURE. ANALYSIS HAS DETERMINED THAT TUBING INSTALLATION IS COMPATIBLE WITH G LOADS IN THE 40 TO 50 G RANGE WHICH IS IN EXCESS OF EXPECTED CRASH AND LANDING SHOCK REQUIREMENTS. PRELAUNCH GN2 MID-BODY PURGE PROVIDES INERT ENVIRONMENT THROUGHOUT LIFT-OFF PHASE.

(B) TEST:
PLUMBING ASSEMBLY QUALIFICATION TEST INCLUDED: VIBRATION-RANDOM (0.01 G SQ/HZ TO 300 HZ², SINUSOIDAL (+/- 0.25 G PEAK) AND ACOUSTIC (25 TO 800 HZ, 130-148 DB FOR 175 MISSION EQUIVALENT), 100 THERMAL CYCLES (AMBIENT/CRYO/+200 DEG F/AMBIENT/CRYO/AMBIENT).

PRELAUNCH MIDBODY INERT PURGE WILL DETECT HAZARDOUS LEAKAGE OF REACTANTS. LINES AND COMPONENTS PROOF PRESSURED AND THERMALLY CYCLED DURING QUALIFICATION TEST. FITTINGS AND JOINTS LEAK TESTED AND PROOF PRESSURED DURING PRSD SUBSYSTEM TEST AND CHECKOUT AFTER INSTALLATION. FITTINGS ARE LEAK CHECKED WHEN COMPONENTS ARE REMOVED AND REPLACED. GSE WORK-ACCESS PLATFORMS ARE PLACED IN THE LOWER MID-FUSELAGE FOR TRAINED PERSONNEL TO PERFORM WORK ON THE SYSTEM. VEHICLE ACCESS IS LIMITED TO ESSENTIAL PERSONNEL ONLY.

OMRSD: PRSD SYSTEM PRESSURE DECAY CHECK PERFORMED EVERY TURNAROUND.

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(C) INSPECTION:

RECEIVING INSPECTION

ALL METALLIC RAW MATERIAL INCLUDING TUBING IS VERIFIED FOR CHEMISTRY. PHYSICAL PROPERTIES ARE VERIFIED BY LAB ANALYSIS (LOT SAMPLED).

CONTAMINATION CONTROL

CLEANLINESS PER SPECIFICATION TO LEVEL 200A (TUBES) IS VERIFIED BY INSPECTION PERSONNEL.

ASSEMBLY/INSTALLATION

COMPLIANCE WITH REQUIREMENTS SPECIFIED ON ALL MANUFACTURING ORDERS IS VERIFIED BY INSPECTION PERSONNEL. AT ASSEMBLY, THE FOLLOWING ARE VERIFIED BY INSPECTION PERSONNEL: CORROSION PROTECTION FOR THREADED AND BLIND FASTENERS. DURING LINE INSTALLATION, TUBING BEND RADII, TUBING SUPPORT INTERVALS, AND PROXIMITY TO ELECTRICAL LINES ARE VERIFIED ACCEPTABLE. DYNATUBE FITTINGS ARE VERIFIED FOR ALIGNMENT AND GAP. SYSTEM IS VERIFIED FOR CLEANLINESS. TORQUE CODED FITTINGS ARE VERIFIED PER SPECIFIED TORQUE REQUIREMENTS. SUPPLIER HARDWARE IS INSPECTED PER MIP'S CONTAINED IN THE QUALITY PLANNING REQUIREMENTS DOCUMENT.

NONDESTRUCTIVE EVALUATION

RADIOGRAPHIC INSPECTION IS APPLIED AND VERIFIED BY INSPECTION PERSONNEL RELATIVE TO BRAZING.

CRITICAL PROCESSES

INDUCTION BRAZE IS VERIFIED BY INSPECTION PERSONNEL.

TESTING

CONNECTIONS AND COMPONENTS ARE LEAK TESTED AT MAXIMUM OPERATING PRESSURE AND PROOF PRESSURE TESTED TO 1.5 TIMES MAXIMUM OPERATING PRESSURE. SAMPLE TUBING BENDS ARE FABRICATED AND SECTIONED TO VERIFY MINIMUM WALL THICKNESS AND MATERIAL HARDNESS AT AREA OF MINIMUM THICKNESS.

HANDLING/PACKAGING

INSPECTION PERSONNEL VERIFY THAT PARTS ARE PACKAGED AND PROTECTED PER REQUIREMENTS.

(D) FAILURE HISTORY:

THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE:

CREW WOULD PERFORM ONE OR MORE OF THE FOLLOWING: (1) DEACTIVATE TANK HEATERS; (2) CLOSE MANIFOLD VALVES; (3) SHUT DOWN FUEL CELL.

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- APPROVALS -

| | | | | |
|------------------------|---|----------------|---|------------------------------------|
| P&E MANAGER | : | T. J. EAVENSON | : | <u>K.L. Paster for 12/14/92</u> |
| PRODUCT ASSURANCE ENGR | : | T. K. KIMURA | : | <u>T.K. Kimura 12/9/92</u> |
| DESIGN ENGINEERING | : | M. M. SCHEIERN | : | <u>M.M. Scheiern 12/14/92</u> |
| NASA RELIABILITY | : | | : | <u>William E. Campbell 1-25-93</u> |
| NASA SUBSYSTEM MANAGER | : | | : | <u>William E. Campbell 1-25-93</u> |
| NASA QUALITY ASSURANCE | : | | : | <u>William E. Campbell 1-25-93</u> |