

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**

NUMBER: 03-1-0638 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/22/01

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**PART DATA**

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	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: LINE ASSEMBLY BOEING	V070-415142

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

LINE ASSEMBLY, HELIUM, LH2 MANIFOLD REPRESSURIZATION. THE LINE ASSEMBLY CONSISTS OF DYNATUBE FITTINGS AND A TUBE SEGMENT.

**REFERENCE DESIGNATORS:**

QUANTITY OF LIKE ITEMS: 1

**FUNCTION:**

THE LINE PROVIDES THE FLOW PATH BETWEEN THE LH2 REPRESSURIZATION CONTROL SOLENOID VALVES (LV42,43) FOR LH2 SYSTEM REPRESSURIZATION DURING MPS PROPELLANT DUMP AND FOR MANIFOLD REPRESSURIZATION DURING ENTRY.

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**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: LH2 MANF REPRESS LINE ASSY (BTW LV42/43)**

**CRITICALITY OF THIS**

**ITEM NAME: LH2 MANF REPRESS LINE ASSY (BTW LV42/43)**

**FAILURE MODE: 1/1**

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**FAILURE MODE:**

RUPTURE/LEAKAGE

**MISSION PHASE:**

PL PRE-LAUNCH  
LO LIFT-OFF  
DO DE-ORBIT

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

102 COLUMBIA  
103 DISCOVERY  
104 ATLANTIS  
105 ENDEAVOUR

**CAUSE:**

MATERIAL DEFECTS, FATIGUE, DAMAGED BRAZE JOINTS, DAMAGED/DEFECTIVE JOINT SEALS

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

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**REDUNDANCY SCREEN**

A) N/A  
B) N/A  
C) N/A

**PASS/FAIL RATIONALE:**

A)

B)

C)

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. RUPTURE DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED AND MANIFOLD REPRESSURIZATION VALVES (LV42,43) HAVE BEEN COMMANDED OPEN MAY

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RESULT IN OVERPRESSURIZATION OF AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

**(B) INTERFACING SUBSYSTEM(S):**

SAME AS A.

**(C) MISSION:**

POSSIBLE LOSS OF CREW/VEHICLE.

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

SAME AS C.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

CASE 1:

1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) LINE RUPTURES
- 2) LV42 FAILS TO REMAIN CLOSED

POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT. RESULTS IN LOSS OF HELIUM FROM THE PNEUMATIC HELIUM SUPPLY.

EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). AFTER LIFTOFF, EXCESSIVE HELIUM TANK AND/OR REGULATOR PRESSURE DECAY WILL NOT BE INDICATED BY SM ALERT OR CAUTION AND WARNING.

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

1R/3 3 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT.

- 1) LINE RUPTURES
- 2) LV43 FAILS TO REMAIN CLOSED
- 3) REGULATOR (PR6) LEAKS INTERNALLY (SENSE PORT LINE)

LH2 FROM THE FEEDLINE MANIFOLD WILL ENTER THE AFT COMPARTMENT. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS. POSSIBLE FIRE/EXPLOSION HAZARD.

LEAKAGE DETECTABLE ON GROUND PRIOR TO T-31 SECONDS USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE MECHANICAL FITTINGS (DYNATUBE) ARE MANUFACTURED FROM INCONEL 718 BAR 1/2 INCH DIAMETER BY 0.065 INCH WALL THICKNESS. THE INCONEL TUBE STEMS ARE NICKEL PLATED. THE TUBE SEGMENT IS MANUFACTURED FROM 304L CRES 1/2 INCH DIAMETER BY 0.025 INCH WALL THICKNESS.

THE SOLENOID VALVES ARE CONNECTED TO THE DYNATUBE FITTINGS USING UNIONS MADE OF INCONEL 718 AND METALLIC BOSS SEALS (TYPE III) FABRICATED FROM A286 CORROSION RESISTANT STEEL THAT IS COATED WITH K-6 NICKEL-LEAD.

THE TUBE SEGMENTS AND DYNATUBE FITTINGS ARE CONNECTED TOGETHER BY INDUCTION BRAZING USING A CRES UNION AND A BRAZE ALLOY PREFORM (81.5 AU, 16.5 CU, 2 NI). THE ROCKWELL INTERNATIONAL BRAZE ALLOY WAS SELECTED BECAUSE OF ITS LOWER BRAZING TEMPERATURE REQUIREMENT THAN THE INDUSTRY STANDARD, AIDING IN THE PREVENTION OF EXCESSIVE GRAIN GROWTH AND REDUCING EROSION OF TUBE ENDS.

**(B) TEST:**

ATP

THE LINE ASSEMBLY IS PROOF PRESSURE TESTED TO 1500 PSIG AND LEAK CHECKED AT 750 PSIG AFTER INSTALLATION IN THE VEHICLE.

CERTIFICATION

CERTIFICATION OF THE TUBING INSTALLATION WAS ACCOMPLISHED BY ROCKWELL INTERNATIONAL PER THE "ORBITER TUBING VERIFICATION PLAN SD75-SH-205".

THE 304L CRES TUBING WAS CERTIFIED FOR THE APOLLO PROPULSION SYSTEM, THE F5E, A-9, C130A, 707, 727, AND 737 AIRCRAFT. THE TUBING WAS QUALIFIED BY SIMILARITY AND BY ANALYSIS FOR ORBITER USAGE EXCEPT FOR FLEXURE FATIGUE AND RANDOM VIBRATION FOR THE LONG-LIFE ORBITER REQUIREMENTS. DATA FROM THE MISSION DUTY CYCLES CONDUCTED ON MPTA WERE ALSO USED TO CERTIFY TUBING INSTALLATIONS.

304L TUBING WITH DYNATUBE FITTINGS AND SEALS WAS SUBJECTED TO THE FOLLOWING QUALIFICATION TESTS:

PROOF PRESSURE  
TWO TIMES OPERATING PRESSURE

EXTERNAL LEAKAGE  
1.5 TIMES OPERATING PRESSURE  
1X10-6 SCCS MAX

IMPULSE FATIGUE (200,000 CYCLES)

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FLEXURE FATIGUE (10 MILLION FLEXURE CYCLES)

VIBRATION (7 UNITS)

45 MINUTES AT 0.4 G2/HZ

30 MINUTES AT 0.7 G2/HZ

10 MINUTES AT 0.2 G2/HZ

BURST TEST

FOUR TIMES OPERATING PRESSURE

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

ALL DETAIL HARDWARE IS VERIFIED INDIVIDUALLY, BY INSPECTION, AT DETAIL LEVEL ON MANUFACTURING ORDERS, WITH ALL PROCESSES INCORPORATED. RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL IS VERIFIED TO 100A. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

PARTS PROTECTION FROM DAMAGE AND CONTAMINATION IS VERIFIED. AXIAL ALIGNMENT OF DYNATUBE FITTINGS AND TUBING IS VERIFIED. TORQUES AND SEALING SURFACES ARE VERIFIED BY INSPECTION. LUBRICATION OF ALL THREADED FLUID FITTING COUPLINGS IS VERIFIED. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURES.

CRITICAL PROCESSES

ELECTRICAL BONDING IS VERIFIED BY INSPECTION. INDUCTION BRAZING IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

RADIOGRAPHIC INSPECTION OF INDUCTION BRAZED JOINTS IS VERIFIED.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

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PNEUMATIC TANK, REGULATOR, AND ACCUMULATOR PRESSURE ARE ON S/M ALERT FDA SYSTEM AND THE BFS SYSTEM SUMMARY DISPLAY. THIS ALLOWS THE FLIGHT CREW TO RESPOND TO A PNEUMATIC HELIUM SYSTEM LEAK INDEPENDENT OF GROUND CONTROL.

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**- APPROVALS -**

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S&R ENGINEERING	: W.P. MUSTY	:/S/ W.P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P.A. STENGER-NGUYEN
DESIGN ENGINEERING	: LEE DURHAM	:/S/ LEE DURHAM
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: JEFF MUSLER	:/S/ JEFF MUSLER
USA SAM	: MIKE SNYDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	:/S/ ERICH BASS