

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

NUMBER: 03-1-0636 -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	V070-415143

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

LINE ASSEMBLY, HELIUM, LO2 MANIFOLD REPRESSURIZATION. THE LINE ASSEMBLY CONSISTS OF DYNATUBE AND A TUBE SEGMENT.

**REFERENCE DESIGNATORS:**

QUANTITY OF LIKE ITEMS: 1

**FUNCTION:**

THE LINE PROVIDES A FLOW PATH FOR HELIUM BETWEEN THE REPRESSURIZATION CONTROL SOLENOIDS (LV40,41) DURING BOTH MPS PROPELLANT DUMP AND FOR MANIFOLD REPRESSURIZATION DURING ENTRY.

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**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: LO2 MANIF REPRESS LINE ASSY (BTW LV40/41)**

**CRITICALITY OF THIS**

**ITEM NAME: LO2 MANIF REPRESS LINE ASSY (BTW LV40/41)**

**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 DEFECT, 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 (LV40,41) ARE OPEN MAY RESULT IN

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

DURING THE PRESSURIZED DUMP, HELIUM WILL LEAK FROM THE REPRESS SYSTEM INTO THE AFT COMPARTMENT. FAILURE HAS NO EFFECT ON THE LO2 DUMP.

DURING ENTRY, FAILURE RESULTS IN DEPLETION OF HELIUM SUPPLY CAUSING LOSS OF AFT COMPARTMENT PURGE.

**(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/3 3 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT

- 1) LINE RUPTURES/LEAKAGE
- 2) REGULATOR (PR5) INTERNAL LEAKAGE (SENSE LINE)
- 3) MANIFOLD REPRESS VALVE (LV41) FAILS TO REMAIN CLOSED

RESULTS IN LO2 FROM THE MANIFOLD LEAKING INTO THE AFT FUSELAGE. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS. POSSIBLE AFT FUSELAGE OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD.

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

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

1R/3 4 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT

- 1) LINE RUPTURES/LEAKAGE
- 2) CHECK VALVE (CV10 OR CV12) FAILS TO CHECK
- 3) REGULATOR (PR5) INTERNAL LEAKAGE
- 4) MANIFOLD REPRESS VALVE (LV41) FAILS TO REMAIN CLOSED

GO2/GHE FROM THE ET PRESSURIZATION SYSTEM WILL ENTER THE AFT COMPARTMENT. POSSIBLE AFT FUSELAGE FIRE/EXPLOSION HAZARD. LEAKAGE OF GO2/GHE IS DETECTABLE ON THE GROUND PRIOR TO T-31 SECONDS USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

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(THIS FAILURE CASE IS NOT AN AFT COMPARTMENT OVERPRESSURIZATION CONCERN DURING PREPRESSURIZATION SINCE THE 0.015 INCH ORIFICE (RP1) WILL PRECLUDE SUFFICIENT FLOW RATE.)

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 TUBE SEGMENT AND FITTINGS ARE CONNECTED TOGETHER BY INDUCTION BRAZING USING A CRES UNION AND A BRAZE PREFORM (81.5 AU, 16.5 CU, 2 NI). THE ROCKWELL INTERNATIONAL BRAZE ALLOY WAS SELECTED DUE TO 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

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

IMPULSE FATIGUE (200,000 CYCLES)

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. COMPONENTS ARE INSPECTED VISUALLY, DIMENSIONALLY, AND INCREMENTALLY DURING FABRICATION. 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 AND PARTS PASSIVATION ARE 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.

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**(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.

**(E) OPERATIONAL USE:**

NO CREW ACTION CAN BE TAKEN.

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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