

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE****NUMBER: 03-1-0254 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 2 02/21/01**PART DATA**

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: LINE ASSEMBLY BOEING	V070-415771
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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

HELIUM LINE ASSEMBLY, 4500 PSIA. THE LINE ASSEMBLY CONSISTS OF DYNATUBE FITTING AND TUBE SEGMENT.

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS:** 6  
ONE EACH PER ENGINE HE SUPPLY

**FUNCTION:**

THE LINE PROVIDES THE FLOW PATH FOR HELIUM FROM THE ENGINE SUPPLY ISOLATION VALVES (LV1,2,3,4,5,6) TO THE RESPECTIVE PRESSURE REGULATORS (PR1,7,2,8,3,9) IN EACH LEG OF THE ENGINE SUPPLY SYSTEM.

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**NUMBER: 03-1-0254-01**

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**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: SSME GHE SUPPLY LINE ASSEMBLY**

**ITEM NAME: SSME GHE SUPPLY LINE ASSEMBLY**

**CRITICALITY OF THIS**

**FAILURE MODE: 1/1**

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**FAILURE MODE:**

RUPTURE/LEAKAGE

**MISSION PHASE:**

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 ASCENT, HELIUM SUPPLY TO ONE ENGINE MAY BE LOST. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT. POSSIBLE UNCONTAINED ENGINE SHUTDOWN IF REDUNDANT LEG CANNOT PROVIDE ENGINE HELIUM REQUIREMENTS. EXCESSIVE HELIUM TANK PRESSURE DECAY (SM ALERT: 20 PSI/3 SECONDS; CAUTION AND WARNING: 1150 PSIA LOWER LIMIT) AND/OR REGULATOR PRESSURE OUT OF LIMITS WILL

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BE INDICATED BY SM ALERT (BOTH LEGS: 679 LOWER AND 810 UPPER) OR CAUTION AND WARNING (LEG A ONLY: 680 LOWER LIMIT AND 810 UPPER LIMIT).

EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. ENGINE ISOLATION VALVES ARE OPENED WHEN VEHICLE TRANSITIONS TO ORBITER SOFTWARE MAJOR MODE 303. RUPTURE ON THIS LINE DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED MAY RESULT IN OVERPRESSURIZATION OF THE AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

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

SAME AS A.

**(C) MISSION:**

ON GROUND, POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION. POSSIBLE ABORT DUE TO EARLY SHUTDOWN OF ONE ENGINE.

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

POSSIBLE LOSS OF CREW/VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

NONE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

THE LINE ASSEMBLY IS DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE MECHANICAL DYNATUBE FITTING IS MANUFACTURED FROM INCONEL 718 BAR 1/2 INCH DIAMETER BY 0.065 INCH WALL THICKNESS. THE TUBE SEGMENT IS MANUFACTURED FROM 21-6-9 CRES BAR 1/2 INCH DIAMETER BY 0.035 INCH WALL THICKNESS.

THE DYNATUBE FITTING IS CONNECTED TO THE COMPONENTS 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 SEGMENT AND FITTING ARE JOINED 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.

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**(B) TEST:**

ATP

THE LINE ASSEMBLY IS PROOF PRESSURE TESTED TO 6750 PSIG AND LEAK CHECKED AT 4400 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 21-6-9 CRES TUBING WAS CERTIFIED FOR THE DC10, L1011, AND 747 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.

21-6-9 CRES 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)

FLEXURE FATIGUE (10 MILLION FLEXURE CYCLES)

VIBRATION (7 UNITS)  
45 MINUTES AT 0.4 G<sup>2</sup>/HZ  
30 MINUTES AT 0.7 G<sup>2</sup>/HZ  
10 MINUTES AT 0.2 G<sup>2</sup>/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. RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

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**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.

**(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:**

ENGINE HELIUM BOTTLE PRESSURE IS ON A DEDICATED DISPLAY IN COCKPIT. CREW ACTION IS TO FOLLOW NORMAL LEAK ISOLATION PROCEDURE.

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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