

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

NUMBER: 03-1-0253 -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	V070-415770

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

HELIUM LINE ASSEMBLY, 4500 PSIA. THE LINE ASSEMBLY CONSISTS OF CROSS FITTING, TEE FITTINGS, TEST PORT FITTING, BULKHEAD REDUCER FITTINGS, AND TUBE SEGMENTS.

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS:** 3  
ONE ASSY PER ENGINE HE SUPPLY

**FUNCTION:**

THE LINE ASSEMBLY PROVIDES THE FLOW PATH FROM THE ENGINE SUPPLY ISOLATION CHECK VALVES (CV25,26; CV36,37; CV41,42) TO THE ENGINE SUPPLY ISOLATION VALVES (LV1,2; LV3,4; LV5,6), AND FROM THE INTERCONNECT "OUT" SOLENOID VALVES AND THE INTERCONNECT "IN" CHECK VALVES (LV60, CV27; LV62, CV38; LV64, CV43). THE LINE ASSEMBLY ALSO PROVIDES AN INTERCONNECT FLOW PATH BETWEEN THE PARALLEL ENGINE SUPPLY LEGS. EACH PARALLEL LEG ALSO CONTAINS A FILTER (FL2,3,4,6,7,8) (REFERENCE FMEA/CIL 03-1-0242).

**FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE**

**NUMBER: 03-1-0253-01**

**REVISION#: 2 02/21/01**

**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: SSME GHE SUPPLY XOVER/INTC LINE ASSY**

**CRITICALITY OF THIS**

**ITEM NAME: SSME GHE SUPPLY XOVER/INTC LINE ASSY**

**FAILURE MODE: 1/1**

---

**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

**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:**

DURING ASCENT, HELIUM SUPPLY TO ONE ENGINE WILL BE LOST. ESCAPING HELIUM MAY OVERPRESSURIZE THE AFT COMPARTMENT.

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 MAY

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0253-01**

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

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

**(B) INTERFACING SUBSYSTEM(S):**  
SAME AS A.

**(C) MISSION:**  
ON GROUND, POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

**(D) CREW, VEHICLE, AND ELEMENT(S):**  
POSSIBLE LOSS OF CREW/VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**  
NONE.

---

**-DISPOSITION RATIONALE-**

---

**(A) DESIGN:**  
THE LINE ASSEMBLY IS DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE TUBE SEGMENTS ARE MANUFACTURED FROM 21-6-9 CRES TUBING 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS, 3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS, AND 1/2 INCH DIAMETER BY 0.035 INCH WALL THICKNESS. THERE ARE TWO DIFFERENT TYPES OF 304L CRES TEES. ONE TYPE IS 3/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS (TWO PORTS) AND 1/2 INCH DIAMETER BY 0.058 INCH WALL THICKNESS (ONE PORT). THE SECOND TYPE IS 1/2 INCH DIAMETER BY 0.058 INCH WALL THICKNESS (TWO PORTS) AND 3/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS (ONE PORT). THE TEST PORT FITTINGS ARE MANUFACTURED FROM 21-6-9 CRES PLATE. THE BULKHEAD REDUCER FITTINGS ARE MANUFACTURED FROM 21-6-9 CRES BAR 1/2 INCH DIAMETER BY 0.049 INCH WALL THICKNESS. THE CROSS FITTING IS MANUFACTURED FROM 21-6-9 BAR 3/8 INCH DIAMETER BY 0.043 INCH WALL THICKNESS (TWO PORTS), 1/4 INCH DIAMETER BY 0.029 INCH WALL THICKNESS (ONE PORT), AND 1/2 INCH DIAMETER BY 0.056 INCH WALL THICKNESS (ONE PORT).

THE TUBE SEGMENTS AND FITTINGS 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.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0253-01**

**(B) TEST:**  
ATP

THE CROSS FITTING AND THE BULKHEAD REDUCER FITTING ARE PROOF PRESSURE TESTED TO 9000 PSIG AND LEAK CHECKED TO 4500 PSIG PRIOR TO INSTALLATION INTO THE VEHICLE. 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<sup>-6</sup> 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, AT DETAIL LEVEL ON MANUFACTURING ORDERS, WITH ALL PROCESSES INCORPORATED. RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0253-01**

**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 TUBING IS VERIFIED. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURES.

**CRITICAL PROCESSES**

ELECTRICAL BONDING, HEAT TREATMENT, 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:**

NO CREW ACTION CAN BE TAKEN.

---

**- APPROVALS -**

---

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	: BILL PRINCE	:/S/ BILL PRINCE