

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

NUMBER: 03-1-0116 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 04/02/90

**PART DATA**

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: LINE ASSEMBLY BOEING	V070-415771

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

LINE, HELIUM HIGH PRESSURE, FROM INTERCONNECT "OUT" VALVE (LV60,62,64) TO CHECK VALVE (CV28,39,44). THE LINE CONSISTS OF ONE TUBE SEGMENT BRAZED TO THE CHECK VALVE AND SOLENOID VALVE.

**REFERENCE DESIGNATORS:**

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

**FUNCTION:**

PROVIDES THE FLOW PATH FOR ENGINE HELIUM FROM THE INTERCONNECT "OUT" VALVE (LV60,62,64) TO THE "OUT" CHECK VALVE (CV28,39,44). THE ENGINE 1 AND ENGINE 3 LINES ARE PRESSURIZED WITH HIGH PRESSURE HELIUM FROM THE ENGINE SUPPLY TANKS WHEN THE INTERCONNECT "OUT" VALVE IS OPENED AT MECO+20 SECONDS AND AT MM303.

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

**NUMBER: 03-1-0116-01**

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

**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: GHE INTERCONNECT "OUT" LINE ASSEMBLY**

**CRITICALITY OF THIS**

**ITEM NAME: GHE INTERCONNECT "OUT" LINE ASSEMBLY**

**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, DEFECTIVE BRAZE JOINTS

**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:**

NO EFFECT DURING NOMINAL MAIN ENGINE OPERATION BECAUSE THE INTERCONNECT "OUT" VALVES ARE NOT OPENED UNTIL MECO+20 SECONDS. RESULTS IN LOSS OF THE ENGINE HELIUM SUPPLY WHEN THE E1 AND E3 INTERCONNECT "OUT" VALVES ARE OPENED AT MECO+20 SECONDS.

DURING ENTRY, INTERCONNECT "OUT" VALVE ON THE E1 AND E3 SYSTEMS WILL OPEN. FAILURE OF THIS LINE WILL RESULT IN LOSS OF ENGINE HELIUM. VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. RUPTURE DURING THE TIME

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0116-01**

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.

POSSIBLE LOSS OF AFT COMPARTMENT PURGE DURING ENTRY.

**(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 - PRELAUNCH, ASCENT

- 1) INTERCONNECT "OUT" LINE RUPTURE/LEAKAGE.
- 2) INTERCONNECT "OUT" CHECK VALVE (CV28,39,44) FAILS TO CHECK.

RESULTS IN LOSS OF PNEUMATIC HELIUM SUPPLY.

IF FAILURE OCCURS DURING ASCENT, RAPID LOSS OF HELIUM MAY OVERPRESSURIZE THE AFT COMPARTMENT. HELIUM TRAPPED IN THE ACCUMULATOR LEG OF THE PNEUMATIC SYSTEM SHOULD BE ADEQUATE FOR LO2 PREVALVE CLOSURE AT MECO, AND WILL BE SUPPLEMENTED WHEN THE LEFT ENGINE HELIUM CROSSOVER VALVE (LV10) OPENS AT MECO.

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

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:

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

- 1) INTERCONNECT "OUT" LINE RUPTURE/LEAKAGE.
- 2) INTERCONNECT "OUT" VALVE (LV60,62,64) FAILS TO REMAIN CLOSED.

POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND POSSIBLE UNCONTAINED ENGINE SHUTDOWN. AFTER LIFTOFF, EXCESSIVE HELIUM TANK AND/OR REGULATOR PRESSURE DECAY WILL BE INDICATED BY SM ALERT OR CAUTION AND WARNING.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0116-01**

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

POSSIBLE ABORT DUE TO EARLY SHUTDOWN OF ONE ENGINE.

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 TUBE SEGMENT IS MANUFACTURED FROM 21-6-9 CRES 3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS. THE CHECK VALVE, AND SOLENOID VALVE TUBE STEM ARE MACHINED FROM 21-6-9 CRES MATERIAL.

THE TUBE SEGMENT, CHECK VALVE, AND SOLENOID VALVE ARE JOINED BY INDUCTION BRAZING USING 21-6-9 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 TUBE ASSEMBLY IS PROOF PRESSURE TESTED TO 6750 PSIG AND LEAK CHECKED AT 4400 PSIG DURING PANEL ASSEMBLY ACCEPTANCE TEST.

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.

THE CRES TUBING AND FITTINGS WERE SUBJECTED TO THE FOLLOWING QUALIFICATION TESTS:

PROOF PRESSURE  
TWO TIMES OPERATING PRESSURE

EXTERNAL LEAKAGE  
AT 1.5 TIMES OPERATING PRESSURE

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

GROUND TURNAROUND TEST

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.

CONTAMINATION CONTROL

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

ASSEMBLY/INSTALLATION

PARTS PROTECTION FROM DAMAGE AND CONTAMINATION IS VERIFIED. DETAIL HARDWARE ARE INSPECTED VISUALLY DURING FABRICATION. AXIAL ALIGNMENT OF TUBING 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.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
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**(E) OPERATIONAL USE:**

DURING THE POST MECO/MPS DUMP TIME FRAME, THE CREW WILL BE DIRECTED (UPON GROUND CALL) TO CLOSE THE INTERCONNECT "OUT" VALVE ON THE AFFECTED ENGINE IN AN ATTEMPT TO SAVE HELIUM FOR LATER MISSION USAGE.

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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	: BILL PRINCE	:/S/ BILL PRINCE