

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0122 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 02/21/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LINE ASSEMBLY BOEING	V070-415145

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LINE, HELIUM, LOW PRESSURE. THE LINE ASSEMBLY CONSISTS OF DYNATUBE FITTINGS, UNIONS, SEALS, AND A TUBE SEGMENT.

REFERENCE DESIGNATORS: .

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

THE LINE PROVIDES A HELIUM FLOW PATH BETWEEN THE LH2 FEED MANIFOLD RTLS PRESSURIZATION SOLENOID VALVES (LV74, LV75) FOR LH2 MANIFOLD PRESSURIZATION DURING AN RTLS AND TAL ABORT.

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LRU: LH2 RTLS REPRESS LINE ASSY (BTW LV74 & 75)

CRITICALITY OF THIS

ITEM NAME: LH2 RTLS REPRESS LINE ASSY (BTW LV74 & 75)

FAILURE MODE: 1R2

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, DEFECTIVE BRAZE JOINTS, DAMAGED/DEFECTIVE JOINT SEALS

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES

RTLS RETURN TO LAUNCH SITE
TAL TRANS-ATLANTIC LANDING

REDUNDANCY SCREEN

A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:

A)

B)

LEAKAGE FROM LINE IS STAND-BY REDUNDANT TO LV74 FAILS OPEN/INTERNAL LEAKAGE. FAILURE IS NOT DETECTABLE.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

NO EFFECT. REDUNDANT COMPONENTS WILL PREVENT FLOW OF HELIUM.

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DURING RTLS AND TAL ABORTS, THE PNEUMATIC HELIUM SUPPLY WILL BE LOST. ESCAPING HELIUM MAY OVERPRESSURIZE THE AFT COMPARTMENT.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

NO EFFECT FOR NOMINAL MISSION. POSSIBLE LOSS OF CREW/VEHICLE DURING RTLS AND TAL ABORT.

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

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1:

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

- 1) HELIUM LINE RUPTURES.
- 2) HELIUM SOLENOID VALVE (LV74) FAILS TO REMAIN CLOSED.

DURING ASCENT, THE PNEUMATIC HELIUM SUPPLY WILL BE LOST. ESCAPING HELIUM MAY OVERPRESSURIZE THE AFT COMPARTMENT.

WHEN THE CROSSOVER VALVE (LV10) OPENS AT MECO, THE PNEUMATIC HELIUM DISTRIBUTION SYSTEM WILL THEN BE FED FROM THE E2 HELIUM SUPPLY. THE ENGINE 2 SUPPLY WILL THEN ALSO LEAK THROUGH THE FAILED LINE.

WHEN THE E1 AND E3 INTERCONNECT "OUT" VALVES OPEN AT MECO+20 SECONDS, THE E1 AND E3 HELIUM SUPPLIES WILL ALSO LEAK THROUGH THE FAILED LINE.

STORED HELIUM PRESSURE IN THE ACCUMULATOR LEG SHOULD BE ADEQUATE TO OPERATE THE LO2 PREVALVES AT MECO. LOSS OF HELIUM MAY PREVENT OPERATION OF VALVES FOR MPS DUMP.

PURGE OF AFT COMPARTMENT AND LH2/LO2 SYSTEMS WOULD DEPEND SOLELY ON THE LEFT ENGINE HELIUM SYSTEM RESIDUALS.

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 RESULT IN OVERPRESSURIZATION OF 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).

CASE 2:

1R/3 3 SUCCESS PATHS. TIME FRAME - ASCENT (POST MECO).

- 1) HELIUM LINE RUPTURES.

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- 2) LV75 FAILS TO REMAIN CLOSED/INTERNAL LEAKAGE.
- 3) CHECK VALVE (CV30) FAILS TO CHECK.

AT MECO, THE LH2 FEEDLINE RELIEF ISOLATION VALVE (PV8) OPENS. HYDROGEN FROM THE LH2 MANIFOLD WILL LEAK THROUGH THE RUPTURE. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYOGENIC EXPOSURE, AFT FUSELAGE FIRE/EXPLOSION, AND OVERPRESSURIZATION HAZARD.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(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 WITH TUBE ENDS THAT ARE NICKEL PLATED. THE TUBE SEGMENT IS MANUFACTURED FROM 304L CRES 3/8 INCH DIAMETER BY 0.025 INCH WALL THICKNESS.

THE SOLENOID VALVES ARE CONNECTED TO THE DYNATUBE FITTING USING A UNION (ME273-0115-0006) MADE OF INCONEL 718 AND A METALLIC BOSS SEAL (ME261-0033-0206) FABRICATED FROM A286 CRES THAT IS COATED WITH K-6 NICKEL-LEAD. THE TUBE SEGMENT AND DYNATUBE FITTINGS ARE JOINED 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 INTO 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 FLEXURAL 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 DYNATUBE FITTINGS AND SEALS WITH 304L TUBING WERE SUBJECTED TO THE FOLLOWING QUALIFICATION TESTS:

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PROOF PRESSURE
TWO TIMES OPERATING PRESSURE

EXTERNAL LEAKAGE
AT 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. 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.

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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:

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.

- 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 DURHAN
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: JEFF MUSLER	:/S/ JEFF MUSLER
USA SAM	:MIKE SYNDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&Q	: BILL PRINCE	:/S/ BILL PRINCE