

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0634 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/22/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LINE ASSEMBLY BOEING	V070-415519

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LINE, HELIUM (0.25 INCH DIA.). THE LINE ASSEMBLY CONSISTS OF DYNATUBE FITTINGS, TEST PORT FITTING, AND TUBE SEGMENT.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

THE LINE PROVIDES THE FLOW PATH FOR HELIUM FROM CV13 TO CV24 DURING MPS PROPELLANT DUMP AND MANIFOLD REPRESSURIZATION. THE LINE INCORPORATES A TEST PORT (TP36).

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: LH2 MANF REPRESS LINE ASSY (BTW CV13/24)

CRITICALITY OF THIS

ITEM NAME: LH2 MANF REPRESS LINE ASSY (BTW CV13/24)

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:

FATIGUE, MATERIAL DEFECT

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:

A)

B)

FAILURE IS STANDBY REDUNDANT TO CHECK VALVES FAIL TO CHECK. FAILURE IS NOT DETECTABLE.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

DURING POST VACUUM INERT MANIFOLD PRESSURIZATION, HELIUM WILL LEAK FROM THE REPRESS SYSTEM INTO THE AFT COMPARTMENT. FAILURE HAS NO EFFECT.

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

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(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

NO EFFECT.

(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) LINE ASSY RUPTURES.
- 2) CHECK VALVE (CV14) FAILS TO CHECK. OR CHECK VALVE (CV15) FAILS TO CHECK.

LH2 FROM THE FEEDLINE MANIFOLD (THROUGH CV15) OR FROM THE RECIRCULATION LINE (THROUGH CV14) WILL ENTER THE AFT COMPARTMENT. POSSIBLE LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS. POSSIBLE FIRE/EXPLOSION HAZARD.

LEAKAGE DETECTABLE ON GROUND PRIOR 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/2 2 SUCCESS PATHS. TIME FRAME - PRE-LAUNCH AND ASCENT.

- 1) LINE ASSY RUPTURES.
- 2) CHECK VALVES (CV24) FAILS TO CHECK.

POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD DUE TO LEAKAGE OF GH2 (GHE LEAKAGE HAS NO EFFECT). GHE LEAKAGE FROM ANTI-ICING PURGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

GH2 FLOW CONTROL VALVES WILL OPEN IN AN ATTEMPT TO MAINTAIN ULLAGE PRESSURE. LOSS OF ET LH2 ULLAGE PRESSURE WILL RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE UNCONTAINED SSME SHUTDOWN DUE TO LOW LH2 NPSP.

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

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-DISPOSITION RATIONALE-

(A) DESIGN:

DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF PRESSURE AND 4.0 BURST PRESSURE. THE MECHANICAL FITTINGS (DYNATUBE) ARE MANUFACTURED FROM INCONEL 718 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS. THE TUBE SEGMENT IS MANUFACTURED FROM 304L CRES 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS. THE TEST PORT FITTING IS MANUFACTURED FROM 304L CRES BAR 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS (THREE PORTS). ALL INCONEL TUBE ENDS ARE NICKEL PLATED.

THE CHECK VALVES ARE CONNECTED TO THE DYNATUBE FITTINGS 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 SEGMENTS AND DYNATUBE FITTINGS ARE CONNECTED TOGETHER 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 520 PSIG AND LEAK CHECKED AT 200 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

EXTERNAL LEAKAGE
1.5 TIMES OPERATING PRESSURE

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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

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

ALL DETAIL HARDWARE IS VERIFIED BY INSPECTION, INDIVIDUALLY AT THE DETAIL LEVEL ON MANUFACTURING ORDERS, WITH ALL PROCESSES INCORPORATED.

CONTAMINATION CONTROL

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

ASSEMBLY/INSTALLATION

PARTS PROTECTION FROM DAMAGE AND CONTAMINATION ARE VERIFIED. TUBE AND AXIAL ALIGNMENT OF DYNATUBE FITTINGS ARE VERIFIED. TORQUES ARE VERIFIED. SEALING SURFACE VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURES.

CRITICAL PROCESSES

LUBRICANT TO ALL THREADED FLUID FITTING COUPLINGS ARE VERIFIED. ELECTRICAL BONDING IS VERIFIED.

NONDESTRUCTIVE EVALUATION

RADIOGRAPHIC INSPECTION OF INDUCTION BRAZES IS VERIFIED BY INSPECTION.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT 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.

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(E) OPERATIONAL USE:

LH2 ULLAGE PRESSURE IS ON SYSTEMS MANAGEMENT (SM) ALERT. CREW WILL OPEN THE LH2 FLOW CONTROL VALVES (VIA COCKPIT SWITCH S53 ON PANEL R2) FOR A LOW LH2 ULLAGE PRESSURE CONDITION.

IF THE LH2 NPSP DROPS BELOW THE PRE-FLIGHT ACCEPTED LEVELS (PER FLIGHT RULES), THE CREW WILL MANUALLY THROTTLE THE ENGINES TO KEEP THE NPSP HIGH ENOUGH TO PREVENT LH2 TURBOPUMP CAVITATION.

- 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	: ERICH BASS	: /S/ ERICH BASS