

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0252 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 02/21/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LINE ASSEMBLY BOEING	V070-415770

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

HELIUM TANK LINE ASSEMBLY, 4500 PSIA. THE LINE ASSEMBLY CONTAINS TEES, BULKHEAD FITTING, CROSS FITTING, TEST PORT, TRANSDUCER BOSS, TANK FLANGE FITTINGS, TANK THREADED INTERFACE FITTING, AND TUBE SEGMENTS.

REFERENCE DESIGNATORS:

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

FUNCTION:

THE LINE ASSEMBLIES CONNECT THE TWO 4.7 CUBIC FOOT AND THE ONE 17.3 CUBIC FOOT HELIUM TANKS THAT PROVIDE HELIUM TO THE TWO PARALLEL LEGS THAT SUPPLY EACH SSME. THE LINE PROVIDES A FLOW PATH FROM THE CHECK VALVES (CV1,2,3) AT THE HELIUM FILL LINE TO THE HELIUM TANKS AND TO THE ENGINE HELIUM SUPPLY ISOLATION CHECK VALVES (CV25,26; CV36,37; CV41,42).

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LRU: SSME GHE SUPPLY LINE ASSEMBLY (4500 PSI)

CRITICALITY OF THIS

ITEM NAME: SSME GHE SUPPLY LINE ASSEMBLY (4500 PSI)

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:

RESULTS IN LOSS OF HELIUM FROM ONE MAIN ENGINE'S HELIUM SUPPLY. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT OR MIDBODY (PRELAUNCH, ASCENT, AND ENTRY).

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RUPTURE OF HELIUM SUPPLY LINE MAY RESULT IN UNCONTAINED ENGINE SHUTDOWN DUE TO LOSS OF ENGINE HELIUM SUPPLY.

EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AFTER HELIUM FILL. AFTER LIFTOFF, EXCESSIVE ENGINE HELIUM SUPPLY TANK AND/OR REGULATOR PRESSURE DECAY WILL BE INDICATED BY SM ALERT OR CAUTION AND WARNING.

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. THIS FAILURE 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.

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

(C) MISSION:
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.

-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 5/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS AND 3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS. THERE ARE TWO DIFFERENT TYPES OF 21-6-9 CRES TEES. ONE TYPE IS 5/8 INCH DIAMETER BY 0.069 INCH WALL THICKNESS (THREE PORTS). THE SECOND TYPE IS 5/8 INCH DIAMETER BY 0.069 INCH WALL THICKNESS (TWO PORTS) AND 3/8 INCH DIAMETER BY 0.043 INCH WALL THICKNESS (ONE PORT). THE TEST PORT FITTINGS (TP26,27,28) ARE MANUFACTURED FROM INCONEL 718 BAR 3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS. THE TRANSDUCER BOSS IS MANUFACTURED FROM INCONEL 718 BAR 5/8 INCH DIAMETER BY 0.069 INCH WALL THICKNESS. ALL INCONEL TUBE ENDS ARE NICKEL PLATED. THE BULKHEAD FITTING IS MANUFACTURED FROM INCONEL 718 BAR 5/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS. THE CROSS FITTING IS MANUFACTURED FROM 21-6-9 CRES BAR AND CONTAINS TWO PORTS 5/8 INCH DIAMETER BY 0.069 INCH WALL THICKNESS AND TWO PORTS 3/8 INCH DIAMETER BY 0.043 INCH WALL THICKNESS. THE

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TANK FLANGES ARE MANUFACTURED FROM INCONEL 718 WITH TUBE STEMS OF 5/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS. THE TANK FLANGES INCLUDE LEAK TEST PORTS. THE TANK THREADED INTERFACE FITTING CONSISTS OF AN INCONEL 718 ADAPTER (5/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS) AND AN INCONEL 718 NUT.

THE TUBE SEGMENTS, FLANGES, 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.

(B) TEST:
ATP

THE TANK FLANGE, TANK THREADED INTERFACE FITTING, TEST PORT FITTING, CROSS FITTING, AND TRANSDUCER BOSS FITTING ARE PROOF PRESSURE TESTED AT 9000 PSIG AND LEAK CHECKED AT 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
1X10⁻⁶ 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

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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. DETAIL HARDWARE ARE INSPECTED VISUALLY DURING FABRICATION. AXIAL ALIGNMENT OF TUBING IS VERIFIED. TORQUES AND SEALING SURFACES ARE VERIFIED BY INSPECTION. 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:

NO CREW ACTION CAN BE TAKEN.

- APPROVALS -

S&R ENGINEERING

: W.P. MUSTY

:/S/ W. P. MUSTY

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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