

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0235 -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:

LINE ASSEMBLY, HELIUM, 750 PSIA. THE LINE ASSEMBLY CONSISTS OF ENGINE FLANGE FITTINGS, TRANSDUCER BOSSES, TEES, ELBOWS, DYNATUBE FITTING, BULKHEAD FITTINGS, AND TUBE SEGMENTS.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3
ONE PER ENGINE HE SUPPLY

FUNCTION:

EACH LINE ASSEMBLY PROVIDES THE FLOW PATH FROM THE A AND B LEG CHECK VALVES (CV5,29; CV6,40; AND CV7,45) TO THE ENGINE INTERFACE. SUPPLIES HELIUM TO AN ENGINE FOR PURGE OF THE HIGH PRESSURE OXIDIZER TURBOPUMP (HPOT) INTERMEDIATE SEAL, EMERGENCY SHUTDOWN, BLEED VALVE ACTUATION AND OTHER ENGINE HELIUM REQUIREMENTS. THE LINE ASSEMBLY FROM CV6 AND CV40 ALSO CONTAINS A 0.5 INCH LINE PROVIDING THE FLOW PATH TO THE PNEUMATIC CROSSOVER VALVE (LV10).

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: SSME REG OUT SUPPLY LINE ASSEMBLY

CRITICALITY OF THIS

ITEM NAME: SSME REG OUT SUPPLY LINE ASSEMBLY

FAILURE MODE: 1/1

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, DAMAGED BRAZE JOINTS, DEFECTIVE/DAMAGED JOINT SEALS

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 MAY BE LOST. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT. POSSIBLE UNCONTAINED ENGINE SHUTDOWN. EXCESSIVE HELIUM TANK PRESSURE DECAY (SM ALERT: 20 PSI/3 SECONDS; CAUTION AND WARNING: 1150 PSIA LOWER LIMIT) AND/OR REGULATOR PRESSURE OUT OF LIMITS WILL BE INDICATED BY SM ALERT (BOTH LEGS: 679 LOWER AND 810 UPPER) OR CAUTION AND WARNING (LEG A ONLY: 680 LOWER LIMIT AND 810 UPPER LIMIT).

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

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. ENGINE ISOLATION VALVES ARE OPENED WHEN VEHICLE TRANSITIONS TO ORBITER SOFTWARE MAJOR MODE 303. RUPTURE ON THIS LINE DURING THE TIME 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.

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

(C) MISSION:
ON GROUND, 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:
DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE TUBE SEGMENT IS MANUFACTURED FROM 304L CRES 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS AND 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS. THE TEE BOSS FITTINGS ARE MACHINED FROM A 304L CRES BAR. THE TRANSDUCER BOSS FITTING IS MANUFACTURED FROM 21-6-9 CRES PLATE 1/4 INCH DIAMETER BY 0.035 INCH WALL THICKNESS. THE DIMENSIONS ARE 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS. THE LINE ASSEMBLY INCLUDES THREE DIFFERENT TYPES OF TEES ALL MANUFACTURED FROM INCONEL 718 BAR. ONE TYPE OF TEE FITTING IS 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS (THREE PORTS). A SECOND TYPE OF TEE FITTING IS 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS (TWO PORTS) AND 1/2 INCH DIAMETER BY 0.028 INCH WALL THICKNESS (ONE PORT). THE THIRD TYPE OF TEE IS 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS (TWO PORTS) AND 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS (ONE PORT). THE ELBOW IS MANUFACTURED FROM INCONEL 718 BAR 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS. THE BULKHEAD FITTING IS MANUFACTURED FROM 21-6-9 CRES PLATE 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS AND INCLUDES A PURGE PORT. ALL INCONEL 718 TUBE STEMS ARE NICKEL PLATED. THE ENGINE INTERFACE

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FLANGE IS MANUFACTURED FROM 21-6-9 CRES PLATE 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS.

THE DYNATUBE FITTING IS CONNECTED TO HELIUM CROSSOVER VALVE (LV10) USING A UNION MADE OF INCONEL 718 AND METALLIC BOSS SEAL FABRICATED FROM A286 CORROSION RESISTANT STEEL COATED WITH K-6 NICKEL LEAD. THE TUBE SEGMENTS AND FITTINGS ARE JOINED BY INDUCTION BRAZING USING 21-6-9 CRES UNIONS AND BRAZE ALLOY PREFORMS (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 BULKHEAD FITTING AND ENGINE FLANGE ARE PROOF PRESSURE TESTED TO 1600 PSIG AND LEAK CHECKED AT 800 PSIG PRIOR TO INSTALLATION INTO THE VEHICLE. 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 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 CRES TUBING WITH DYNATUBE FITTINGS AND SEALS WAS SUBJECTED TO THE FOLLOWING QUALIFICATION TESTS:

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

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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. 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.

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:

ENGINE HELIUM BOTTLE PRESSURE IS ON A DEDICATED DISPLAY IN COCKPIT. CREW ACTION IS TO FOLLOW NORMAL LEAK ISOLATION PROCEDURE.

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- 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