

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0255 -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 INTERCONNECT LINE ASSEMBLY, 4500 PSIA. THE LINE ASSEMBLY CONSISTS OF TEES, ELBOW, TRANSDUCER FITTING, CROSS FITTING, TEST PORT FITTING, TANK FLANGE, BULKHEAD FITTINGS, AND TUBE SEGMENTS.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

THE LINE ASSEMBLY PROVIDES THE HELIUM FLOW PATH FROM THE PNEUMATIC SUPPLY TANK (TK4) TO EACH OF THE ENGINE HELIUM SUPPLY INTERCONNECT "IN" VALVES (LV59,61,63) AND INTERCONNECT "OUT" CHECK VALVES (CV28,39,44) ALLOWING THE TRANSFER OF HIGH PRESSURE HELIUM IN EITHER DIRECTION BETWEEN THE PNEUMATIC SUPPLY SYSTEM AND ANY OR ALL ENGINE SUPPLY SYSTEMS. THE LINE INTERFACES WITH THE PNEUMATIC ISOLATION VALVES (LV7,8), THE PNEUMATIC HELIUM FILL CHECK VALVE (CV4), THE INTERCONNECT "IN" SOLENOID VALVES (LV59,61,63) AND THE INTERCONNECT "OUT" CHECK VALVES (CV28,39,44). THE LINE ASSEMBLY ALSO CONTAINS A FILTER (FL5) (REFERENCE FMEA/CIL 03-1-0145).

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0255-01

REVISION#: 2 02/21/01

SUBSYSTEM NAME: MAIN PROPULSION

LRU: GHE INTERCONNECT LINE ASSEMBLY

ITEM NAME: GHE INTERCONNECT LINE ASSEMBLY

CRITICALITY OF THIS

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:

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 BE FED FROM THE LEFT ENGINE HELIUM SUPPLY. WHEN THE

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0255-01**

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

STORED HELIUM PRESSURE IN THE ACCUMULATOR LEG AND SUPPLEMENTAL HELIUM FROM LV10 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).

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

(C) MISSION:
ON GROUND, POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

(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 TUBING. THE DIMENSIONS OF THE TUBE SEGMENTS ARE AS FOLLOWS:

1 INCH DIAMETER BY 0.065 INCH WALL THICKNESS
5/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS
1/2 INCH DIAMETER BY 0.035 INCH WALL THICKNESS
3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0255-01**

THE TEES ARE MANUFACTURED FROM 21-6-9 CRES BAR. THE DIMENSIONS OF THE TEES ARE AS FOLLOWS:

1/2 INCH DIAMETER BY 0.035 INCH WALL THICKNESS (TWO PORTS) AND 3/8 INCH DIAMETER BY 0.49 INCH WALL THICKNESS (ONE PORT)

1 INCH DIAMETER BY 0.109 INCH WALL THICKNESS (TWO PORTS) AND 1/2 INCH DIAMETER BY 0.056 INCH WALL THICKNESS (ONE PORT)

1 INCH DIAMETER BY 0.109 INCH WALL THICKNESS (ONE PORT) AND 1/2 INCH DIAMETER BY 0.056 INCH WALL THICKNESS (TWO PORTS)

3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS (THREE PORTS)

THE ELBOW IS MANUFACTURED FROM 21-6-9 CRES BAR 3/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS (TWO PORTS). THE TEST PORT FITTING (TP29) IS MANUFACTURED FROM INCONEL 718 BAR 3/8 INCH DIAMETER BY 0.028 INCH WALL THICKNESS (TWO PORTS). THE TRANSDUCER FITTING IS MANUFACTURED FROM 304L CRES BAR 3/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS. THE CROSS FITTING IS MANUFACTURED FROM 21-6-9 CRES BAR 1 INCH DIAMETER BY 0.109 INCH WALL THICKNESS (ONE PORT), 5/8 INCH DIAMETER BY 0.069 INCH WALL THICKNESS (ONE PORT), AND 3/8 INCH DIAMETER BY 0.043 INCH WALL THICKNESS (TWO PORTS). THE BULKHEAD FITTINGS CONTAIN A PURGE PORT AND ARE MANUFACTURED FROM 21-6-9 CRES PLATE 3/8 INCH DIAMETER BY 0.035 INCH WALL THICKNESS. THE TANK FLANGE IS MANUFACTURED FROM INCONEL 718 BAR WITH A TUBE STEM THAT IS 5/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS. THE TANK FLANGE INCLUDES A LEAK TEST PORT. ALL INCONEL 718 TUBE STEMS ARE NICKEL PLATED.

THE TUBE SEGMENTS 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 BULKHEAD FITTING, TRANSDUCER FITTING, TANK FLANGE, AND TEST PORT 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

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0255-01**

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

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, AT DETAIL LEVEL ON MANUFACTURING ORDERS, WITH ALL PROCESSES INCORPORATED. 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 TUBING IS VERIFIED. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURES.

CRITICAL PROCESSES
ELECTRICAL BONDING, HEAT TREATMENT, AND PARTS PASSIVATION ARE VERIFIED BY INSPECTION. INDUCTION BRAZING IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0255-01**

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:

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 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