FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0234 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 02/21/01

PART DATA

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

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINE ASSEMBLY, HELIUM FILL, 4500 PSIA. THE LINE ASSEMBLY CONSISTS OF BULKHEAD FITTINGS, TEES, ELBOWS, LINE SEGMENTS, AND A TEST PORT (TP8).

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
THE LINE ASSEMBLY PROVIDES THE FLOW PATH FROM THE HELIUM FILL DISCONNECT (PD8) TO THE HELIUM FILL CHECK VALVES (CV1,2,3,4) LOCATED UPSTREAM OF THE HELIUM TANKS.

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SUBSYSTEM NAME: MAIN PROPULSION
LRU: GHE FILL LINE ASSEMBLY
ITEM NAME: GHE FILL LINE ASSEMBLY

CRITICALITY OF THIS 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

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
FAILS B SCREEN BECAUSE THERE IS NO INSTRUMENTATION BETWEEN CHECK VALVES AND DISCONNECT.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT. BACKUP CHECK VALVES (CV1,2,3,4) WOULD PREVENT OVERBOARD LEAKAGE FROM ONBOARD HELIUM SUPPLY TANKS. GROUND HELIUM FILL IS LIMITED TO LESS THAN 0.5 LB/SEC AND IS INSUFFICIENT TO OVERPRESSURIZE THE AFT COMPARTMENT.

(B) INTERFACING SUBSYSTEM(S):

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SAME AS A.

(C) MISSION:
POSSIBLE LAUNCH SCRUB OR DELAY IF FAILURE OCCURS PRIOR TO T-13 SECONDS. HELIUM LEAKAGE IS DETECTABLE IN THE AFT COMPARTMENT BY USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). IF LEAKAGE RATE IS GREATER THAN 0.5 LB/SEC, LAUNCH PROCESSING SYSTEM (LPS) HELIUM FILL WILL NOT BE ABLE TO KEEP UP WITH THE LEAK. BOTTLE SUPPLY PRESSURES WILL DROP BELOW THE LCC REQUIREMENT (LESS THAN 4100 PSIA) WHICH IS VERIFIED DOWN TO T-13 SECONDS.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT.

(E) FUNCTIONAL CRITICALITY EFFECTS:
1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.
1) HELIUM FILL LINE ASSEMBLY RUPTURES.
2) ONE OF FOUR CHECK VALVES (CV1,2,3,4) FAILS TO CHECK.

RESULTS IN LOSS OF HELIUM FROM ONE MAIN ENGINE'S HELIUM SUPPLY (CV1,2,3) OR PNEUMATIC HELIUM SUPPLY (CV4). POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT (PRELAUNCH, ASCENT, AND ENTRY).

RUPTURE OF ENGINE SUPPLY CHECK VALVE (CV1, 2, OR 3) MAY RESULT IN UNCONTAINED ENGINE SHUTDOWN DUE TO LOSS OF ENGINE HELIUM SUPPLY.

RUPTURE OF PNEUMATIC SUPPLY CHECK VALVE (CV4) RESULTS IN LOSS OF PNEUMATIC HELIUM SUPPLY. HOWEVER, THERE IS SUFFICIENT HELIUM REMAINING IN THE PNEUMATIC ACCUMULATOR LEG TO CLOSE THE LO2 PREVALVES AT MECO.

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.

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 TUBE SEGMENT IS MANUFACTURED FROM 21-6-9 CRES 1/2 INCH DIAMETER BY 0.035 INCH WALL THICKNESS. THE TEST POINT COUPLING IS MACHINED FROM A 21-6-9 CRES BAR. THE DIMENSIONS ARE 1/2 INCH DIAMETER BY 0.051 INCH WALL THICKNESS. THE TEE FITTING IS MANUFACTURED FROM 304L CRES BAR 1/2 INCH DIAMETER BY 0.049 INCH WALL THICKNESS (ONE PORT) AND 3/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS (TWO PORTS). THE ELBOW IS MANUFACTURED FROM 304L CRES BAR 3/8 INCH DIAMETER BY 0.049 INCH WALL THICKNESS. THE BULKHEAD FITTING IS MANUFACTURED FROM INCONEL 718 BAR 1/2 INCH DIAMETER BY 0.035 INCH WALL THICKNESS. THE TUBE STEMS ARE NICKEL PLATED.

THE TUBE SEGMENTS, TEES, ELBOWS, BULKHEAD FITTING, AND TEST POINT COUPLING ARE JOINED BY INDUCTION BRAZING USING A 21-6-9 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 BULKHEAD FITTING AND TEST PORT COUPLING WERE PROOF PRESSURE TESTED TO 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 INTO 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.

THE CRES TUBING AND FITTINGS WERE 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)

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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. DETAIL HARDWARE IS INSPECTED VISUALLY DURING FABRICATION. AXIAL ALIGNMENT OF TUBING 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:
NO CREW ACTION CAN BE TAKEN.

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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