FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0430 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/21/01

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: LINE ASSEMBLY BOEING	V070-415612

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINE ASSEMBLY, HIGH POINT BLEED, GH2, 0.75 INCH DIAMETER, FOAM INSULATED. CONSISTS OF TUBE SEGMENTS, FLANGES, AND TUBE FITTINGS.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
THE LINE EXTENDS FROM THE HI POINT BLEED VALVE (PV22) TO THE HIGH POINT BLEED DISCONNECT (PD17) ON THE T-0 UMBILICAL, PROVIDING A PATH FOR GH2 TO BLEED FROM THE HIGH POINT OF THE ENGINE FEED SYSTEM. BLEED OPERATION IS INITIATED AT THE START OF FAST FILL AND TERMINATES AT HI POINT BLEED VALVE CLOSURE (APPROXIMATELY T-26 SECONDS). THE LINE HAS NO FLIGHT FUNCTION; BLEED VALVE IS CLOSED DURING ASCENT.

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SUBSYSTEM NAME: MAIN PROPULSION
LRU: LH2 HIGH POINT BLEED LINE ASSEMBLY **CRITICALITY OF THIS**
ITEM NAME: LH2 HIGH POINT BLEED LINE ASSEMBLY **FAILURE MODE:** 1/1

FAILURE MODE:
RUPTURE/LEAKAGE DURING LOADING AND FLIGHT.

MISSION PHASE: PL PRE-LAUNCH

VEHICLE/PAYLOAD/KIT EFFECTIVITY:
102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:
FATIGUE FAILURE, MATERIAL DEFECT, IMPROPER BRAZE, DAMAGED/DEFECTIVE 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:
HAZARDS ASSOCIATED WITH LEAKAGE OF CRYOGENIC PROPELLANTS. LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE HAZARD. LEAKAGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

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NUMBER: 03-1-0430-01

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

(C) MISSION:
POSSIBLE LOSS OF CREW/VEHICLE.

(D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:
1R2 2 SUCCESS PATHS. TIME FRAME - ASCENT
1) LINE RUPTURE/LEAKAGE
2) LH2 HIGH POINT BLEED VALVE (PV22) INTERNAL LEAKAGE

LH2 WILL LEAK INTO THE AFT FUSELAGE CAUSING POSSIBLE AFT COMPARTMENT OVERPRESS, AND FIRE/EXPLOSION HAZARD. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF LINE OPERATIONS. THE TUBE MATERIAL IS 21-6-9 CRES, 0.75 INCH O.D. AND .016 INCH WALL THICKNESS. THE TWO FLANGES AND TEE ARE MACHINED FROM 21-6-9 CRES MATERIAL. THE ELBOW IS MACHINED FROM 304L CRES BAR. THE TUBE SEGMENTS, FLANGES, TEE, AND ELBOW ARE CONNECTED TOGETHER BY INDUCTION BRAZING USING A 21-6-9 CRES UNION AND BRAZE ALLOY PREFORM (81.5 AU, 16.5 CU, 2 NI). THE ROCKWELL INTERNATIONAL BRAZING 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 FLANGES AND TEE ARE PROOF PRESSURE TESTED TO 135 PSIG AND LEAK CHECKED AT 90 PSIG WITH GHE.

THE LINE ASSEMBLY IS PROOF PRESSURE TESTED TO 66 PSIG AND LEAK CHECKED AT 30 PSIG.

CERTIFICATION

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NUMBER: 03-1-0430-01

CERTIFICATION OF THE TUBING INSTALLATION WAS ACCOMPLISHED BY ROCKWELL INTERNATIONAL PER THE "ORBITER TUBING VERIFICATION PLAN SD-75-SH-205". THE 21-6-9 CRES TUBING WAS PREVIOUSLY QUALIFIED FOR THE DC-10, L1011, AND 747 AIRCRAFT. THE APOLLO INDUCTION BRAZING TECHNIQUE USING 302L AND 21-6-9 CRES TUBING WITH ROCKWELL INTERNATIONAL BRAZE UNION AND BRAZE ALLOY WAS CERTIFIED BY SUBJECTING A REPRESENTATIVE SAMPLE OF TUBE SEGMENTS TO PROOF PRESSURE, IMPULSE FATIGUE, FLEXURE FATIGUE, RANDOM VIBRATION AND BURST TEST.

TUBE SEGMENTS WERE SUBJECTED TO THE FOLLOWING:

PROOF PRESSURE
PRESSURIZED TO TWO TIMES MAX OPERATING AND HELD FOR 5 MINUTES.

IMPULSE FATIGUE
200,000 CYCLES, BENDING STRESS 20,000 PRESSURE 1000 PSIG (2 UNITS), 1500 PSIG (1 UNIT), 2000 PSIG (1 UNIT) AND 3000 PSIG (2 UNITS)

FLEXURE FATIGUE
PRESSURIZE TO OPERATING PRESSURE, 10,000,000 CYCLES

RANDOM VIBRATION
(7 UNITS) WERE SUBJECTED TO VIBRATION AT AMBIENT PRESSURE AND TEMPERATURE CONDITIONS

BURST TESTS
2 TIMES MAX OPERATING PRESSURE

OMRSD
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
CLEANLINESS TO LEVEL 400 IS VERIFIED BY INSPECTION. 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. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE. INSTALLATION PER SPECIFICATION REQUIREMENTS IS VERIFIED.

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

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NONDESTRUCTIVE EVALUATION
RADIOGRAPHIC INSPECTION OF INDUCTION BRAZED JOINTS IS VERIFIED BY INSPECTION.
PENETRANT INSPECTION OF DETAIL PARTS IS VERIFIED.

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.

(E) OPERATIONAL USE:
FLIGHT: NO CREW ACTION CAN BE TAKEN.

GROUND: GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE HYDROGEN SYSTEM.

- 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