FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0143 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 02/21/01

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: LINE ASSEMBLY BOEING	V070-415752

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINE ASSEMBLY, HELIUM BLOWDOWN, 750 PSIA PNEUMATIC HELIUM, FROM UPSTREAM HELIUM SUPPLY BLOWDOWN SOLENOID VALVE (LV26) TO DOWNSTREAM SOLENOID VALVE (LV27). THE LINE ASSEMBLY CONSISTS OF DYNATUBE FITTINGS, UNIONS, SEALS, AND TUBE SEGMENT.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
PROVIDES THE FLOW PATH FOR HELIUM FROM THE UPSTREAM BLOWDOWN VALVE (LV26) TO THE DOWNSTREAM BLOWDOWN VALVE (LV27) FOR PURGING THE AFT AND OMS/RCS COMPARTMENT DURING ENTRY.

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SUBSYSTEM NAME: MAIN PROPULSION
LRU: GHE BLOWDOWN VALVE LINE ASSEMBLY **CRITICALITY OF THIS**
ITEM NAME: GHE BLOWDOWN VALVE 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, DEFECTIVE BRAZE JOINTS, 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:
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 AND THE AFT COMPARTMENT PURGE IS COMMANDED ON (5300 FT/SEC) MAY RESULT IN OVERPRESSURIZATION OF AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

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(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:
1R/2 2 SUCCESS PATHS. TIME FRAME - PRELAUNCH, ASCENT.
1) LINE RUPTURES.
2) INBOARD BLOWDOWN VALVE (LV26) FAILS TO REMAIN CLOSED.

RESULTS IN LOSS OF PNEUMATIC HELIUM SUPPLY. HELIUM PRESSURE WILL NOT BE AVAILABLE TO CLOSE THE PREVALVES AT MECO OR THE ET/ORBITER UMBILICAL DISCONNECTS PRIOR TO ET SEPARATION. DISCONNECTS WILL CLOSE IN MECHANICAL BACKUP MODE DURING UMBILICAL RETRACT. FAILURE TO CLOSE THE LO2 PREVALVES AT MECO WILL RESULT IN UNCONTAINED ENGINE DAMAGE. RESULTS IN THE INABILITY TO MAINTAIN INJECTED HELIUM AND LO2 PRESSURE AT THE SSME PUMP, RESULTING IN POSSIBLE PUMP OVERSPEED AND EXPLOSION. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSIVE HAZARD.

ENGINE HELIUM SUPPLY SYSTEM IS CONNECTED TO VALVE ACTUATION SUPPLY BY THE CROSSOVER VALVE (LV10) AT MECO BY SOFTWARE COMMAND. THE ADDITIONAL HELIUM SUPPLY MAY NOT ACTUATE LO2 PREVALVES CLOSED.

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

RESULTS IN LOSS OF PNEUMATIC AND LEFT ENGINE HELIUM SUPPLY IF THE FAILURE OCCURS AFTER THE LEFT ENGINE HELIUM CROSSOVER VALVE (LV10) OPENS AT MECO. LOSS OF PNEUMATIC, E1 AND E3 HELIUM SUPPLIES IF FAILURE OCCURS WHILE THE E1 AND E3 INTERCONNECT "OUT" VALVES (LV60 AND 64) AND LV10 ARE OPEN, BEGINNING AT MECO+20 SECONDS.

HELIUM WILL NOT BE AVAILABLE FOR AFT COMPARTMENT PURGE.

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

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(A) DESIGN:
THE LINE IS DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE MECHANICAL FITTINGS (DYNATUBE) ARE MANUFACTURED FROM INCONEL 718 WITH TUBE ENDS THAT ARE NICKEL PLATED. THE TUBE SEGMENT IS MANUFACTURED FROM 304L CRES TUBING 3/8 INCH DIAMETER BY 0.020 INCH WALL THICKNESS.

THE DYNATUBE FITTINGS ARE CONNECTED TO THE COMPONENTS USING UNIONS MADE OF INCONEL 718 (ME273-0115) AND METALLIC BOSS SEALS (ME261-0063 TYPE III) FABRICATED FROM A286 CORROSION RESISTANT STEEL COATED WITH K-6 NICKEL LEAD. THE TUBE SEGMENT 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 LINE IS PROOF PRESSURE TESTED TO 1500 PSIG AND LEAK CHECKED AT 750 PSIG DURING PANEL ASSEMBLY ACCEPTANCE TEST.

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 SYSTEMS, 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 PTA 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. DETAIL HARDWARE ARE INSPECTED VISUALLY 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:
DURING THE ENTRY TIME FRAME, THE CREW MAY BE DIRECTED (UPON GROUND CALL) TO CLOSE THE PNEUMATIC ISOLATION VALVES (LV7,8) AND THE CROSSOVER VALVE (LV10).

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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