FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0455 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/22/01

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: LINE ASSEMBLY, LO2 RELIEF BOEING	V070-415408

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINE ASSEMBLY, LO2 RELIEF, 1 INCH DIAMETER. CONSISTS OF TUBING SEGMENTS, FLANGE FITTING, AND BRAZE JOINTS.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
THE LINE EXTENDS FROM THE OUTLET OF THE LO2 FEEDLINE RELIEF VALVE (RV5) TO A PORT ON THE RIGHT SIDE OF THE AFT FUSELAGE FORWARD OF THE T-0 UMBILICAL, PROVIDING A PATH FOR OVERBOARD FLOW LO2 RELIEF VALVE DOES NOT NORMALLY OPERATE (REFERENCE FMEA/CIL 03-1-LO2 FEEDLINE RELIEF VALVE, RV5).

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NUMBER: 03-1-0455-01

REVISION#: 1 02/22/01

SUBSYSTEM NAME: MAIN PROPULSION
LRU: LO2 RELIEF VALVE OUTLET LINE ASSEMBLY **CRITICALITY OF THIS**
ITEM NAME: LO2 RELIEF VALVE OUTLET LINE ASSEMBLY **FAILURE MODE:** 1R2

FAILURE MODE:
RUPTURE/LEAKAGE DURING POST MECO RELIEF OPERATIONS.

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF

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

CAUSE:
FATIGUE FAILURE, MATERIAL DEFECT, IMPROPER BRAZE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:
A)

B)
LINE RUPTURE IS STANDBY REDUNDANT TO RELIEF VALVE FUNCTION.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
NO EFFECT FIRST FAILURE. LO2 RELIEF VALVE DOES NOT NOMINALLY OPEN.

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

(C) MISSION:

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SAME AS A.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:
CASE 1.
1R/2 2 SUCCESS PATHS. TIME FRAME - POST MECO.
1) RUPTURE/LEAKAGE OF RELIEF LINE.
2) RELIEF VALVE (RV5) FAILS TO REMAIN CLOSED.

LO2 LEAKAGE INTO AFT COMPARTMENT. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE HAZARD. LEAKAGE INTO AFT COMPARTMENT DETECTABLE DURING PROPELLANT LOADING USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2.
1R/3 3 SUCCESS PATHS. TIME FRAME - PRELAUNCH AND ASCENT.
1) RUPTURE/LEAKAGE OF RELIEF LINE.
2) RELIEF SHUTOFF VALVE (PV7) FAILS TO REMAIN CLOSED.
3) RELIEF VALVE (RV5) FAILS TO REMAIN CLOSED.

LO2 LEAKAGE INTO AFT COMPARTMENT. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE HAZARD. LEAKAGE INTO AFT COMPARTMENT DETECTABLE DURING PROPELLANT LOADING USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
TUBE ASSEMBLY:

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, 1.0 INCH O.D AND 0.020 INCH WALL THICKNESS. THE FLANGE IS MANUFACTURED FROM 21-6-9 CRES MATERIAL.

THE TUBE SEGMENTS AND FLANGE ARE CONNECTED TOGETHER BY INDUCTION BRAZING USING A 21-6-9 CRES UNION AND BRAZE ALLOY PERFORM (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.

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SYSTEM:

PRESENT SYSTEM CONFIGURATION ALLOWS 12 INCH FEEDLINE VENTING THROUGH SSME HPOT SEALS. PRESENT DUMP SEQUENCE PREVENTS EXCESSIVE MANIFOLD PRESSURE BUILDUP. FLIGHT AND GROUND TEST EXPERIENCE HAS SHOWN THAT MANIFOLD PRESSURE DOES NOT INCREASE TO MINIMUM RELIEF VALVE CRACKING PRESSURE FOR NOMINAL OPERATION.

(B) TEST:
ATP

THE FLANGE IS PROOF PRESSURE TESTED TO 600 PSIG AND LEAK CHECKED AT 300 PSIG WITH GHE. AFTER INSTALLATION THE LINE ASSEMBLY IS PROOF PRESSURE TESTED TO 300 PSIG AND LEAK CHECKED AT 40 PSIG WITH GHE.

CERTIFICATION

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 PSI. 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

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RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
CLEANLINESS TO LEVEL 800A 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.

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

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 OXYGEN 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

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NASA SR&QA	: ERICH BASS	: /S/ ERICH BASS