

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0652 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/22/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LINE ASSY, LH2 RTLS DUMP BOEING	V070-415281

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LINE ASSEMBLY, RTLS LH2 DUMP, 1.50 INCH DIAMETER. CONSISTS OF TUBE SEGMENTS, THREE GIMBAL JOINTS, AND FLANGES.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

PROVIDES A FLOW PATH TO DUMP LH2 OVERBOARD THROUGH THE RTLS DUMP VALVE. THE LINE ASSEMBLY EXTENDS FROM THE RTLS INBOARD VALVE (PV17) TO THE OUTBOARD VALVE (PV18).

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LRU: LH2 RTLS DUMP LINE (BTW PV17/18)

ITEM NAME: LH2 RTLS DUMP LINE (BTW PV17/18)

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE POST MECO.

MISSION PHASE:

PL PRE-LAUNCH

LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA

103 DISCOVERY

104 ATLANTIS

105 ENDEAVOUR

CAUSE:

FATIGUE, MATERIALS DEFECT

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:

RESULTS IN LEAKAGE OF LH2 INTO THE AFT COMPARTMENT WHEN RTLS VALVES ARE OPENED POST MECO. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. LOSS OF CRITICAL FUNCTIONS DUE TO COMPONENT EXPOSURE TO CRYOGENICS.

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LOSS OF REDUNDANCY TO PROTECT AGAINST LH2 LEAKAGE INTO THE AFT COMPARTMENT IF THE INBOARD RTLS VALVE (PV17) FAILS TO CLOSE/REMAIN CLOSED DURING LOADING OR ASCENT. LEAKAGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

(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 - LOADING, ASCENT.

- 1) INBOARD RTLS DUMP VALVE FAILS TO REMAIN CLOSE/INTERNAL LEAKAGE.
- 2) RTLS DUMP LINE RUPTURE/LEAKAGE.

LH2 WILL LEAK INTO THE AFT FUSELAGE, POSSIBLE AFT COMPARTMENT OVERPRESS, AND FIRE/EXPLOSION HAZARD. THIS WILL NOT AFFECT ENGINE INLET CONDITIONS OR CAUSE A LOW LEVEL CUTOFF. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE LINE ASSEMBLY IS MANUFACTURED USING FLANGES MACHINED OF 304L CRES, TUBE SEGMENTS MADE OF 21-6-9 CRES (1.5 INCH DIAMETER BY 0.035 INCH WALL THICKNESS) AND THREE GIMBAL JOINTS WITH BELLOWS.

THE GIMBAL JOINTS ARE WELDED TO THE TUBE SEGMENTS USING INCONEL 718 WELD WIRE. THE FLANGES ARE ALSO WELDED TO THE TUBE SEGMENTS.

ALL THE GIMBAL JOINTS WERE DESIGNED AND MANUFACTURED BY AMETEK STRAZA. THE GIMBAL JOINT WAS DESIGNED TO DEFLECT A MINIMUM OF PLUS AND MINUS 13 DEGREES IN ANY PLANE. THE GIMBAL ASSEMBLY CONSISTS OF TWO OPPOSITE FORMED FORKS LOCATED 90-DEGREES TO EACH OTHER AND LINKED TOGETHER WITH ENTRAPPED PINS THROUGH A GIMBAL RING. THE BELLOWS WERE DESIGNED TO PRECLUDE FLOW INDUCED VIBRATION BY USING TWO INCONEL 718 FLOW LINERS. THE GIMBAL JOINT WAS DESIGNED TO PRECLUDE GENERATION OF PARTICLES IN EXCESS OF 400A PER MA0110-301. THE GIMBAL JOINT WAS FABRICATED FROM INCONEL 718 MATERIAL AND IS ASSEMBLED USING FUSION WELDING.

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STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF LINE OPERATIONS.

(B) TEST:
ATP

LINE ASSEMBLY

BOTH LINE ASSEMBLIES WERE PROOF PRESSURE TESTED AT 150 PSIG AND LEAK CHECKED AT 100 PSIG PRIOR TO INSTALLING THEM INTO THE VEHICLE. AFTER INSTALLATION THE SYSTEM WAS PROOF PRESSURE TESTED AT 66 PSIG AND LEAK CHECKED AT 30 PSIG.

GIMBAL JOINT ASSEMBLY

EXAMINATION OF PRODUCT
DIMENSIONAL VERIFICATION

PROOF AT 2 TIMES MAXIMUM OPERATING PRESSURE

EXTERNAL LEAKAGE AT 200 PSIG GHE

ANGULATION

- +/- 13 DEGREES IN EACH PLANE (4 TESTS; BENDING MOMENT IS MEASURED);
- 1 TEST IN EACH OF THE 2 PIN AXES;
- 1 TEST 45 DEGREES FROM EACH OF THE 2 PIN AXES.

REPEAT EXTERNAL LEAKAGE TEST AT 200 PSIG GHE

CERTIFICATION

GIMBAL JOINT ASSEMBLY

QUALIFICATION TESTS WERE PERFORMED ON FOUR 2 INCH AND TWO 1.5 INCH GIMBAL JOINTS.

VIBRATION (6 GIMBAL JOINTS) VIBRATED ALONG AXES OF BELLOWS AND NORMAL TO THE BELLOWS AXES

2 INCH GIMBALS (2 UNITS): +600 DEG F, 650 PSIG SINUSOIDAL TEST FROM 5 TO 35 HZ, +/- 0.25 G'S PEAK RANDOM VIBRATION MAINTAINED FOR 13 HOURS AND 18 MINUTES

2 INCH GIMBALS (2 UNITS): CRYO (-300 DEG F), 275 PSIG SINUSOIDAL TEST FROM 5 TO 35 HZ, +/- 0.25 G'S PEAK RANDOM VIBRATION MAINTAINED FOR 13 HOURS AND 18 MINUTES

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1.5 INCH GIMBALS (2 UNITS): AMBIENT PRESSURE & TEMPERATURE SINUSOIDAL TEST FROM 5 TO 35 HZ, +/- 0.25 G'S PEAK RANDOM VIBRATION MAINTAINED FOR 48 MINUTES

NO LEAKAGE OR BINDING NOTED AFTER COMPLETION OF VIBRATION TESTS

PRESSURE IMPULSE (2 UNITS)
500 CYCLES, 28 PSIG TO 650 PSIG WITH NO LEAKAGE OR BINDING

LIFE CYCLE FLEXURE TEST (4 UNITS)
200 CYCLES AT PLUS AND MINUS 11.7 DEGREES
2000 CYCLES AT PLUS AND MINUS 9.36 DEGREES
NO LEAKAGE OR WEAR NOTED

BURST TEST (3 UNITS)
2 INCH GIMBAL (2 UNITS) - PRESSURIZED TO 2850 PSIG ROOM AMBIENT TEMPERATURE FOR 5 MINUTES
1.5 INCH GIMBAL (1 UNIT) - PRESSURIZED TO 1664 PSIG AT ROOM AMBIENT TEMPERATURE FOR 5 MINUTES

LEAKAGE - 200 PSIG GHE, 1X10⁻⁵ SCC/SEC.

TUBING

THE 21-6-9 CRES TUBING WAS PREVIOUSLY QUALIFIED WITH THE DC-10, L1011, AND 747 AIRCRAFT. THE MAIN PROPULSION TEST ARTICLE MISSION DUTY CYCLE FIRINGS CONTRIBUTED TO THE CERTIFICATION OF THE MPS TUBING INSTALLATIONS.

VERIFICATION

QUALIFICATION TESTING OF A COMPLETED GIMBAL LINE ASSEMBLY WAS NOT PERFORMED, BUT THE GIMBAL LINE ASSEMBLIES WERE VERIFIED BY ANALYSIS. FOR OV103/OV104 REFER TO REPORT STS85-0254 (STRUCTURAL ANALYSIS FOR 6.0 LOADS, DATED APRIL 1988), VOLUME 10 (THRUST STRUCTURE, MPS, AND SECONDARY STRUCTURE). FOR OV102 REFER TO REPORT SD77-SH-0178 (DESIGN STRESS ANALYSIS OV102, DATED JULY 1988), VOLUME 10; AND REPORT SOD80-0173 (OV102 STRESS ANALYSIS AND 5.4 LOADS ASSESSMENT, DATED JULY 1980), VOLUME 10.

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIALS AND PROCESSES CERTIFICATION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL VERIFIED TO 400. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

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ASSEMBLY/INSPECTION

PARTS ARE INSPECTED VISUALLY AND DIMENSIONALLY DURING FABRICATION. FABRICATION OF FLANGES AND TUBES IS VERIFIED TO MEET DRAWING AND SPECIFICATION REQUIREMENTS. PROTECTION OF SEALING SURFACES IS VERIFIED. DIMENSIONS AND SURFACE FINISHES ARE VERIFIED TO MEET SPECIFICATION REQUIREMENTS. INSTALLATION PER SPECIFICATION REQUIREMENTS IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

WELDING AND PASSIVATION ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

RADIOGRAPHIC AND DYE PENETRANT INSPECTION OF GIMBAL TO TUBE/FLANGE WELDS ARE VERIFIED BY INSPECTION. PENETRANT INSPECTION OF DETAIL PARTS IS VERIFIED. HELIUM LEAKAGE DETECTION IS CONDUCTED TO MEET SPECIFICATION REQUIREMENTS.

TESTING

ATP, INCLUDING PROOF PRESSURE TEST, IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING COVERS ARE PROVIDED TO PREVENT DAMAGE DURING STORAGE/INSTALLATION/SHIPPING. 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:

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