

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0508 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 0 06/23/88

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: GH2 ET PRESSURIZATION MANIFOLD ASSEMBLY BOEING	V070-415413

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LINE ASSEMBLY, GH2 PRESSURIZATION SUPPLY. THE LINE ASSEMBLY CONSISTS OF GIMBAL JOINTS, LINE FLANGES, TRANSDUCER BOSS, DYNATUBE FITTINGS, TEE, AND TUBE SEGMENTS.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

PROVIDES THE FLOW PATH FOR ET PRESSURIZATION GH2 FROM THE FLOW CONTROL VALVE MANIFOLD TO THE ET/ORBITER DISCONNECT DURING ENGINE OPERATION. IT ALSO PROVIDES THE FLOW PATH FOR GSE SUPPLIED HELIUM (INCLUDING PRE-PRESSURIZATION FILTER FL10), FROM THE FLOW CONTROL VALVE MANIFOLD FOR PROPELLANT LOADING PRESSURIZATION, ANTI- ICING AND PREPRESSURIZATION PRIOR TO SSME START. THE LINE ASSEMBLY INCLUDES THE LINE TO THE GH2 PRESSURIZATION LINE VENT VALVE (LV52) INLET; THE LINE FROM THE REPRESSURIZATION CHECK VALVE (CV24) OUTLET; THE LINE TO THE GH2 DISCONNECT PRESSURE TRANSDUCER PORT; AND THE DELTA PRESSURE TRANSDUCER LINE.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0508-01

REVISION#: 1 02/22/01

SUBSYSTEM NAME: MAIN PROPULSION

LRU: GH2 ET PRESSURIZATION MANIFOLD ASSEMBLY

CRITICALITY OF THIS

ITEM NAME: GH2 ET PRESSURIZATION MANIFOLD ASSEMBLY

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE.

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

MATERIAL DEFECT, FATIGUE, DAMAGED BRAZE JOINTS, DAMAGED/DEFECTIVE JOINT

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:

GH2 AND/OR GHE LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD. GHE LEAKAGE FROM ANTI-ICING PURGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS) PRIOR TO T-9 MINUTES.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0508-01**

GH2 FLOW CONTROL VALVES WILL OPEN IN AN ATTEMPT TO MAINTAIN ULLAGE PRESSURE. LOSS OF ET LH2 ULLAGE PRESSURE WILL RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE UNCONTAINED SSME SHUTDOWN DUE TO LOW LH2 NPSP.

ALSO RESULTS IN POSSIBLE LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION CAUSING LOSS OF AFT COMPARTMENT PURGE.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

ON GROUND, VIOLATION OF HGDS LCC WILL RESULT IN LAUNCH SCRUB.

(D) CREW, VEHICLE, AND ELEMENT(S):

POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE LINE ASSEMBLY CONSISTS OF A 2 INCH DIAMETER LINE ASSEMBLY AND 1/4 INCH DIAMETER TUBE SEGMENTS AND FITTINGS.

THE 2.0 INCH LINE ASSEMBLY WAS MANUFACTURED USING TWO FLANGE ASSEMBLIES, 3 TYPE I GIMBAL JOINTS AND 3 STRAIGHT TUBE SEGMENTS. THE GIMBAL JOINTS, MANUFACTURED BY AMETEK STRAZA, WERE DESIGNED TO DEFLECT A MINIMUM OF 13 DEGREES IN ANY PLANE. THE BENDING MOMENT AT MAXIMUM OPERATING TEMPERATURE AND PRESSURE IS DESIGNED TO A MAXIMUM OF 450 INCH POUNDS IN THE PIN AXIS AND 700 INCH POUNDS IN THE OTHER AXES. 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 CLEANLINESS LEVEL 400A. THE GIMBAL JOINT WAS FABRICATED USING AN INCONEL 718 THREE PLY BELLOWS, AN INCONEL 718 GIMBAL RING, TWO INCONEL 718 GIMBAL FORKS, FOUR INCONEL 718 PINS, TWO INCONEL 718 LINERS AND ONE 321 CRES RETAINER. THE GIMBAL JOINT IS ASSEMBLED USING FUSION WELDING. EACH 21-6-9 CRES FLANGE HAS A LEAK TEST PORT FOR MEASURING THE FLANGE/SEAL LEAKAGE. THE FLANGE AT THE DISCONNECT END HAS A PORT FOR DFI INSTRUMENTATION (NOW PLUGGED) AND ANOTHER PORT WHICH CONNECTS TO THE LH2 PRESSURIZATION LINE VENT VALVE SOLENOID (LV52), A PRESSURE TRANSDUCER, GH2 REPRESS CHECK VALVE (CV24), AND THE DELTA P TRANSDUCER. THE THREE STRAIGHT TUBES ARE MANUFACTURED FROM 21-6-9 CRES 2

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INCH DIAMETER BY 0.035 INCH WALL THICKNESS. THEY ARE CONNECTED TO THE GIMBAL JOINTS AND FLANGE JOINTS BY BUTT WELDING USING INCONEL 718 WELD WIRE ON ALL BUT THE FLANGE/TUBE WELD.

THE 1/4 INCH TUBE SEGMENTS (0.020 INCH WALL THICKNESS) AND BRAZE FITTINGS ARE MANUFACTURED FROM 304L CRES AND ARE CONNECTED TOGETHER BY INDUCTION BRAZING USING A 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.

THE DYNATUBE MECHANICAL FITTINGS ARE MADE OF INCONEL 718. THE COMPONENTS ARE CONNECTED TO THE DYNATUBE FITTING USING A UNION MADE OF INCONEL 718 AND METALLIC BOSS SEALS (TYPE III) FABRICATED FROM A286 CORROSION RESISTANT STEEL THAT IS COATED WITH K-6 NICKEL-LEAD. ALL INCONEL TUBE ENDS ARE NICKEL PLATED.

(B) TEST:
ATP

THE 2 INCH LINE ASSEMBLY WAS PROOFED TO 975 PSIG AND LEAK CHECKED AT 650 PSIG PRIOR TO INSTALLATION INTO THE VEHICLE. THE LINE ASSEMBLY (2 INCH AND 1/4 INCH) WAS PROOF PRESSURE TESTED AT 950 PSIG AND LEAK TESTED AT 550 PSIG AFTER INSTALLATION INTO THE VEHICLE.

CERTIFICATION

GIMBAL JOINT (6 UNITS)

VIBRATION

43 MINUTES IN EACH OF TWO AXES
PRESSURIZED TO 650 PSIG AT +600° F (TWO UNITS)
PRESSURIZED TO 275 PSIG AT -297° F (TWO UNITS)
AMBIENT PRESSURE AND TEMPERATURE (TWO UNITS)
LEAK TEST

PRESSURE IMPULSE TEST (TWO UNITS)

500 CYCLES
PRESSURE: 28 TO 650 PSIG
TEMPERATURE: 600 DEG F
RADIAL 13 DEG POSITION

LIFE CYCLE

200 CYCLES AT +/- 11.7 DEGREES ROTATION
2000 CYCLES AT +/- 9.36 DEGREES ROTATION
650 PSIG AND +600 DEG F (TWO UNITS)
400 PSIG AND -300 DEG F (TWO UNITS)

BURST TEST

2808 PSIG (THREE UNITS)
1664 PSIG (ONE UNIT)

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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1/4 INCH TUBE SEGMENTS AND FITTINGS

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 MPTA 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
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/H
10 MINUTES AT 0.2 G²/HZ

BURST TEST
FOUR TIMES OPERATING PRESSURE

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

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ALL DETAIL HARDWARE IS VERIFIED INDIVIDUALLY, BY INSPECTION, AT DETAIL LEVEL ON MANUFACTURING ORDERS, WITH ALL PROCESSES INCORPORATED. 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. COMPONENTS ARE INSPECTED VISUALLY, DIMENSIONALLY, AND INCREMENTALLY 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, HEAT TREATMENT, 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:

LH2 ULLAGE PRESSURE IS ON SYSTEMS MANAGEMENT (SM) ALERT. CREW WILL OPEN THE LH2 FLOW CONTROL VALVES (VIA COCKPIT SWITCH S53 ON PANEL R2) FOR A LOW LH2 ULLAGE PRESSURE CONDITION.

IF THE LH2 NPSP DROPS BELOW THE PRE-FLIGHT ACCEPTED LEVELS (PER FLIGHT RULES), THE CREW WILL MANUALLY THROTTLE THE ENGINES TO KEEP THE NPSP HIGH ENOUGH TO PREVENT LH2 TURBOPUMP CAVITATION.

- APPROVALS -

S&R ENGINEERING

: W.P. MUSTY

:/S/ W.P. MUSTY

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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