

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 03-1-0419 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 11/08/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LO2 MANIFOLD ARROWHEAD PRODUCTS	MC271-0074-0005 13545-303

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LO2 MANIFOLD. 17 INCH DIA. FOAM INSULATED.

REFERENCE DESIGNATORS: MA1**QUANTITY OF LIKE ITEMS:** 1**FUNCTION:**

THE 17 IN. DIA MANIFOLD EXTENDS FROM THE 17 IN. MAIN DUCT TO THE FLANGE ATTACHMENTS FOR THE 3 INDIVIDUAL PREVALVES. PROVIDES MEANS OF LOADING/DRAINING LO2 INTO THE ET AND LO2 FLOW FOR SSME OPERATION. THE MANIFOLD ASSY ALSO CONTAINS A FLANGE FOR ATTACHMENT OF THE INBOARD FILL VALVE. THE MANIFOLD IS FOAM INSULATED.

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LRU: LO2 MANIFOLD, FOAM INSULATED

ITEM NAME: LO2 MANIFOLD, FOAM INSULATED

CRITICALITY OF THIS

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:

FATIGUE, MATERIAL 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:

HAZARDS ASSOCIATED WITH LEAKAGE OF CRYOGENIC PROPELLANTS. DURING ENGINE OPERATION, POSSIBLE PREMATURE SHUTDOWN OF ALL SSME'S DUE TO LOSS OF PROPELLANT. POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPT OVERPRESS AND FIRE HAZARD. LEAKAGE IN THE AFT COMPT DETECTABLE DURING LOADING USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

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(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 PRESSURE CARRIER SUB-ASSEMBLY OF THE MANIFOLD IS CONSTRUCTED OF INCONEL 718. THE MANIFOLD HAS LUGS FOR STRUT ATTACHMENT TO THE AFT FUSELAGE STRUCTURE AND FIVE FLANGES TO PERMIT ATTACHMENT OF THREE ENGINE FEEDLINE PREVALVES, LO2 INLET LINE, AND A FILL/DRAIN LINE. THE MANIFOLD IS DESIGNED FOR A MAXIMUM OPERATING PRESSURE OF 200 PSIA AT 297 DEG F AND A NOMINAL FLOW RATE OF 2,658 POUNDS PER SECOND. MAXIMUM STATIC PRESSURE IS 260 PSIG. THE PROOF PRESSURE FACTOR IS 1.2 AND THE BURST PRESSURE FACTOR IS 1.5. THE USEFUL DYNAMIC LIFE IS 14.2 HOURS (EQUIVALENT TO 100 ORBITER MISSIONS). THE PRESSURE CARRIER MEETS THE FRACTURE ANALYSIS REQUIREMENT FOR 400 MISSIONS. STRUCTURAL ANALYSIS INDICATES A POSITIVE (GREATER THAN 1.4) MARGIN OF SAFETY FOR ALL CONDITIONS OF MANIFOLD OPERATION. THE MANIFOLD ASSEMBLY WILL WITHSTAND A IMPLOSION PRESSURE OF 22 PSI, PRESSURE SURGE FROM 200 PSIG TO 260 PSIG IN 200 MILLISECONDS, AND A THERMAL CHANGE FROM 200 DEG F TO MINUS 297 DEG F.

(B) TEST:

ATP

EXAMINATION OF PRODUCT.

PRESSURE CARRIER LEAKAGE (AMBIENT).

PROOF PRESSURE TEST.

OPERATIONAL TEST (CRYO).

ELEVATED AMBIENT TEMPERATURE TEST.

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FLANGE LEAKAGE TEST AT AMBIENT AND CRYO CONDITIONS.

CERTIFICATION

THE TYPE V LO2 MANIFOLD LINE ASSEMBLY WAS SUBJECTED TO THE FOLLOWING QUALIFICATION TEST:

THERMAL CYCLE - 100 CYCLES, ROOM AMBIENT TO -300 DEG F TO ROOM AMBIENT.

PRESSURE SURGE - 102 CYCLES FROM ZERO PSIG TO 200 PSIG TO 260 PSIG AND BACK TO ZERO PSIG.

LOAD TEST - 9 FLANGE LOAD CASES WERE RUN AT AMBIENT TEMP. AND 200 PSIG IN PRESSURE CARRIER. EACH LOAD CASE CONSISTED OF:

- A. 400 CYCLES AT 72% OF LIMIT LOAD.
- B. 40 CYCLES AT 90% OF LIMIT LOAD.
- C. 1 CYCLE AT 120% OF LIMIT LOAD.

PRESSURE CYCLING - 1940 CYCLES, 300 DEG F, PRESSURE CYCLES VARYING IN RANGE FROM 0 TO 220 PSIG.

VIBRATION - ALL THREE AXES.

SINUSOIDAL RESONANCE SURVEY FROM 5 TO 2000 HZ WAS CONDUCTED WITH THE LINE PRESSURIZED TO 60 PSIG WITH LIQUID NITROGEN.

RANDOM VIBRATION TEST WAS CONDUCTED WITH THE LINE FILLED WITH LIQUID OXYGEN AND PRESSURIZED TO 70 PSIG FOR THE FIRST 3.3 HOURS, 180 PSIG FOR THE NEXT 10 HOURS.

HEAT TRANSFER AND HUMIDITY - 48 HOURS EXPOSURE AT 80 DEG F AND 95% RELATIVE HUMIDITY. THE LINE WAS THEN FILLED WITH LO2 AND HEAT TRANSFER MEASURED.

BURST - NO LEAKAGE OR DAMAGE AFTER 5 MINUTES AT 390 PSIG.

EMERGENCY SHUTDOWN - NO LEAKAGE OR DAMAGE AFTER 3 MINUTES AT 440 PSIG.

THE PRESSURE CARRIER IMPLOSION TEST IS CERTIFIED BY SIMILARITY TO THE LH2 MANIFOLD (REFERENCE FMEA/CIL 0416).

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING/INSPECTION

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RAW MATERIALS, INCLUDING CHEMICAL AND MECHANICAL REQUIREMENTS, ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

ASSEMBLY/INSTALLATION

SPECIAL CONSIDERATIONS GIVEN TO HIGH STRENGTH STRUCTURAL STEELS (INCONEL 718), DURING FABRICATION, IS VERIFIED. ALL COMPONENTS ARE VISUALLY, DIMENSIONALLY, AND INCREMENTALLY INSPECTED DURING FABRICATION. SEALING SURFACES PROTECTION IS VERIFIED. MACHINING OPERATION OF FLANGE DETAIL PARTS ARE PER DRAWING AND APPLICABLE SPECIFICATION AND IS VERIFIED BY INSPECTION.

NON DESTRUCTIVE EVALUATION

WELDS ARE FLUORESCENT PENETRANT AND RADIOGRAPHICALLY INSPECTED. MACHINED PARTS ARE FLUORESCENT PENETRANT INSPECTED.

TESTING

ATP VERIFIED BY INSPECTION.

CRITICAL PROCESSES

HEAT TREATMENT VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

PARTS PROTECTION FROM DAMAGE AND CONTAMINATION ARE VERIFIED. CLEANLINESS TO LEVEL 800A VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

THE OV104 LH2 TYPE II (12 INCH) LINE HAD EXCESSIVE VACUUM PRESSURE RISE AFTER ATP ELEVATED TEMPERATURE TEST. CRACKS IN THE SEALING WELD (NON-STRUCTURAL) OF THE BALL STRUT TIE ROD ASSEMBLY BELLOWS ADAPTER WERE FOUND. SEALING WELD WAS REVISED TO REDUCE THE NUGGET SIZE AND MINIMIZE THERMAL EFFECTS. EFFECTIVELY IS FOR ALL OV104 AND SUBS LINES (REFERENCE CAR AC5228). THIS IS A ONE TIME OCCURRENCE. ALL PRIOR AND SUBSEQUENT LINES HAVE PASSED ATP. THIS FAILURE IS ATP SCREENABLE.

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.

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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	: EARL HIRAKAWA	: /S/ EARL HIRAKAWA
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: BILL LANE	: /S/ BILL LANE
USA SAM	: MIKE SNYDER	: /S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	: /S/ ERICH BASS