

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0115 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 02/21/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: LINE ASSEMBLY BOEING	V070-415772

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

LINE, HELIUM, HIGH PRESSURE, FROM INTERCONNECT "IN" VALVE (LV59,61,63) TO DOWNSTREAM CHECK VALVE (CV27,38,43). THE TUBE ASSEMBLY CONSISTS OF A TUBE SEGMENT AND A REDUCER.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3
ONE PER ENGINE HE SUPPLY

FUNCTION:

PROVIDES THE FLOW PATH FOR ENGINE HELIUM FROM PNEUMATIC HELIUM SUPPLY INTERCONNECT "IN" VALVE (LV59,61,63) TO INTERCONNECT "IN" CHECK VALVE (CV27,38,43). THE LINE IS PRESSURIZED WITH HIGH PRESSURE HELIUM FROM THE PNEUMATIC SUPPLY TANK WHEN THE E2 INTERCONNECT "IN" VALVE IS OPENED AT MECO+20 SECONDS AND AT ENTRY, MM303.

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: GHE INTERCONNECT "IN" LINE ASSEMBLY

CRITICALITY OF THIS

ITEM NAME: GHE INTERCONNECT "IN" 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

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 LOSS OF THE PNEUMATIC HELIUM SUPPLY WHEN THE ENGINE 2 INTERCONNECT "IN" VALVE IS OPENED AT MECO+20 SECONDS. NO EFFECT DURING NOMINAL MAIN ENGINE OPERATION BECAUSE THE INTERCONNECT "IN" VALVES ARE NOT OPENED UNTIL MECO. MANUAL INTERCONNECT "IN" CAPABILITY WILL BE LOST TO THE AFFECTED ENGINE.

DURING NOMINAL AND TAL ENTRY, INTERCONNECT "IN" VALVE ON THE LEFT ENGINE SYSTEM WILL OPEN. FAILURE OF THIS LINE ON THE LEFT ENGINE SYSTEM WILL RESULT IN

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LOSS OF GHE FROM THE PNEUMATIC, CENTER ENGINE, AND RIGHT ENGINE GHE SUPPLIES (THE INTERCONNECT "OUT" VALVES FOR THE CENTER AND RIGHT ENGINE GHE SYSTEMS ARE OPEN). POSSIBLE LOSS OF AFT COMPARTMENT PURGE DURING ENTRY.

ALSO DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. RUPTURE OF THE LEFT ENGINE'S SYSTEM DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED MAY RESULT IN OVERPRESSURIZATION OF AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

(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 - ENGINE OPERATION
1) LINE RUPTURE
2) HELIUM LEAK (ON SAME ENGINE) REQUIRING INTERCONNECTING OF PNEUMATIC HELIUM SUPPLY BEFORE MECO

WHEN THE HELIUM SUPPLY PRESSURE ON THE AFFECTED ENGINE REACHES 1150 PSIA (CAUTION & WARNING WILL ALERT CREW), THE CREW WILL INTERCONNECT THE PNEUMATIC HELIUM SUPPLY TO SUPPORT ENGINE OPERATION BY OPENING THE INTERCONNECT "IN" VALVE. THIS ACTION RESULTS IN LOSS OF THE PNEUMATIC HELIUM SUPPLY. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT. POSSIBLE LOSS OF AFT COMPARTMENT PURGE DURING ENTRY.

HELIUM TRAPPED IN THE ACCUMULATOR LEG OF THE PNEUMATIC SYSTEM SHOULD BE ADEQUATE FOR LO2 PREVALVE CLOSURE AT MECO, AND WILL BE SUPPLEMENTED WHEN THE LEFT ENGINE HELIUM CROSSOVER VALVE (LV10) OPENS AT MECO.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE TUBE SEGMENT IS MANUFACTURED FROM 21-6-9 CRES 3/8 INCH DIAMETER BY 0.028 INCH WALL

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THICKNESS. THE REDUCER IS MACHINED FROM A 21-6-9 CRES BAR. THE DIMENSIONS ARE 1/2 INCH DIAMETER, 0.049 INCH WALL THICKNESS BY 3.8 INCH DIAMETER, 0.035 INCH WALL THICKNESS.

THE CHECK VALVE, TUBE SEGMENTS, REDUCER, AND SOLENOID VALVE ARE JOINED BY INDUCTION BRAZING USING A 21-6-9 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.

(B) TEST:
ATP

THE REDUCER WAS PROOF PRESSURE TESTED TO 9000 PSIG AND LEAK CHECKED AT 4500 PSIG. THE LINE ASSEMBLY IS PROOF PRESSURE TESTED TO 6750 PSIG AND LEAK CHECKED AT 4400 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 21-6-9 CRES TUBING WAS CERTIFIED FOR THE DC10, L1011, AND 747 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.

THE CRES TUBING AND FITTINGS WERE 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

BURST TEST
FOUR TIMES OPERATING PRESSURE

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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 TUBING 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 POST MECO/MPS DUMP TIME FRAME, THE CREW WILL BE DIRECTED (UPON GROUND CALL) TO CLOSE THE INTERCONNECT "IN" VALVE ON THE AFFECTED ENGINE IN AN ATTEMPT TO SAVE HELIUM FOR LATER MISSION USAGE.

- 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	: BILL PRINCE	:/S/ BILL PRINCE