FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0111 -X

SUBSYSTEM NAME: MAIN PROPULSION
REVISION: 2 02/21/01

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: LINE ASSEMBLY BOEING	V070-415771
LRU	: LINE ASSEMBLY BOEING	V070-415772

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINE ASSEMBLY, HELIUM, 750 PSIA, FROM REGULATOR INTERFACE (PR1,2,3,7,8,9) TO CHECK VALVES (CV5,6,7,29,40,45) AND INCLUDES LINE TO RELIEF VALVE (RV1,2,3,8,9,10). THE LINE ASSEMBLIES CONSIST OF TUBE SEGMENTS, SPECIAL MANIFOLD, SEALS, DYNATUBE FITTINGS, AND UNIONS.

QUANTITY OF LIKE ITEMS: 6
TWO PER ENGINE HE SUPPLY

FUNCTION:
PROVIDES THE FLOW PATH FOR HELIUM FROM THE 750 PSIA SUPPLY REGULATOR TO THE OUTLET CHECK VALVE FOR ENGINE REQUIREMENTS. THE LINE INCLUDES THE RELIEF VALVE SENSE LINE AND CONNECTION POINTS FOR A RELIEF VALVE (RV1,2,3,8,9,10) AND A PRESSURE TRANSDUCER.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0111-01

REVISION#: 2 02/21/01

SUBSYSTEM NAME: MAIN PROPULSION
LRU: GHE SSME REG OUT LINE ASSEMBLY
ITEM NAME: GHE SSME REG OUT LINE ASSEMBLY

CRITICALITY OF THIS FAILURE MODE: 1/1

FAILURE MODE:
RUPTURE/LEAKAGE

MISSION PHASE:
PL PRE-LAUNCH
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, DAMAGED/DEFECTIVE JOINT SEALS

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:
DURING ASCENT, HELIUM SUPPLY TO ONE ENGINE MAY BE LOST. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT. POSSIBLE UNCONTAINED ENGINE SHUTDOWN IF REDUNDANT LEG CANNOT PROVIDE ENGINE HELIUM REQUIREMENTS. EXCESSIVE HELIUM TANK PRESSURE DECAY (SM ALERT: 20 PSI/3 SECONDS; CAUTION AND

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0111-01

WARNING: 1150 PSIA LOWER LIMIT) AND/OR REGULATOR PRESSURE OUT OF LIMITS WILL BE INDICATED BY SM ALERT (BOTH LEGS: 679 LOWER AND 810 UPPER) OR CAUTION AND WARNING (LEG A ONLY: 680 LOWER LIMIT AND 810 UPPER LIMIT).

EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE USING HAZARDOUS GAS DETECTION SYSTEM (HGDS).

RUPTURE OF THE RELIEF VALVE SENSE LINE CAUSES THE RELIEF VALVE TO FAIL TO THE CLOSED POSITION AND NOT RELIEVE EXCESS HELIUM PRESSURE. POSSIBLE RUPTURE OF LINES/COMPONENTS DOWNSTREAM OF THE REGULATOR IF THE REGULATOR FAILS.

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. ENGINE ISOLATION VALVES ARE OPENED WHEN VEHICLE TRANSITIONS TO ORBITER SOFTWARE MAJOR MODE 303. RUPTURE ON THIS LINE DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED MAY RESULT IN OVERPRESSURIZATION OF THE AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

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

(C) MISSION:
ON GROUND, POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION. POSSIBLE ABORT DUE TO EARLY SHUTDOWN OF ONE ENGINE.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:
DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE MECHANICAL FITTINGS (DYNATUBE) ARE MANUFACTURED FROM INCONEL 718 WITH TUBE ENDS THAT ARE NICKEL PLATED. THE TUBE SEGMENTS ARE MANUFACTURED FROM 304L CRES 1/4 INCH DIAMETER BY 0.020 INCH WALL THICKNESS AND 3/4 INCH DIAMETER BY 0.028 INCH WALL THICKNESS. THE SPECIAL MANIFOLD (ME273-0194-1001) HAS A DYNATUBE FITTING THAT CONNECTS TO A CHECK VALVE, TWO NICKEL PLATED TUBE ENDS, AND TWO BOSSES. ONE BOSS CONNECTS TO A TRANSDUCER AND THE OTHER CONNECTS TO A RELIEF VALVE SENSE LINE.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0111-01

THE DYNATUBE FITTINGS ARE CONNECTED TO THE COMPONENTS USING UNIONS MADE OF INCONEL 718 (ME273-0115) AND METALLIC BOSS SEALS (ME261-0033 TYPE III) FABRICATED FROM A286 CORROSION RESISTANT STEEL THAT IS COATED WITH K-6 NICKEL-LEAD. THE TUBE SEGMENTS AND FITTINGS 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.

(B) TEST:
ATP

THE LINE ASSEMBLY IS PROOF PRESSURE TESTED TO 1500 PSIG AND LEAK CHECKED AT 750 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 304L CRES TUBING WAS CERTIFIED FOR THE APOLLO PROPULSION SYSTEM, 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.

DYNATUBE FITTINGS AND SEALS WITH 304L TUBING WAS 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

OMRSD
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0111-01

(C) INSPECTION:
RECEIVING INSPECTION
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 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:
ENGINE HELIUM BOTTLE PRESSURE IS ON A DEDICATED DISPLAY IN COCKPIT. CREW ACTION IS TO FOLLOW NORMAL LEAK ISOLATION PROCEDURE.

- APPROVALS -

S&R ENGINEERING	: W. P. MUSTY	:/S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P. A. STENGER-NGUYEN

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0111-01

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