FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0507 -X

SUBSYSTEM NAME: MAIN PROPULSION
REVISION: 1 02/22/01

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: LINE ASSEMBLY BOEING	V070-415409

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
LINE ASSEMBLY, GO2 PRESSURIZATION SUPPLY. THE LINE ASSEMBLY CONSISTS OF TUBE SEGMENTS.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 3

FUNCTION:
PROVIDES THE FLOW PATH FOR GO2 FROM EACH ENGINE INTERFACE TO THE FLOW CONTROL VALVE THAT REGULATES THE FLOW RATE TO THE ET (ULLAGE PRESSURE CONTROL). EACH LINE CONNECTS THE ENGINE ISOLATION CHECK VALVE (CV18,19,20) TO ITS RESPECTIVE GO2 FLOW CONTROL VALVE (LV53,54,55).

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SUBSYSTEM NAME: MAIN PROPULSION
LRU: GO2 PRESS LINE ASSEMBLY, CV TO FCV **CRITICALITY OF THIS**
ITEM NAME: GO2 PRESS LINE ASSEMBLY, CV TO FCV **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 FAILURE, DAMAGED/DEFECTIVE WELD 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:
GO2 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).

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THE FLOW CONTROL VALVES WILL OPEN IN AN ATTEMPT TO MAINTAIN ET ULLAGE PRESSURE (ACTIVE CONFIGURATION ONLY). LOSS OF ET LO2 ULLAGE PRESSURE WILL RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE LOSS OF ADJACENT CRITICAL COMPONENTS DUE TO IMPINGEMENT OF HIGH PRESSURE GAS. POSSIBLE UNCONTAINED SSME SHUTDOWN DUE TO LOW NPSP LATE IN ENGINE OPERATION.

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 IS DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 2.0 PROOF AND 4.0 BURST. THE TUBE SEGMENTS ARE MANUFACTURED FROM INCONEL 718 5/8 INCH DIAMETER BY 0.065 INCH WALL THICKNESS. THE TUBE SEGMENTS ARE HEAT TREATED FOR MAXIMUM CREEP RESISTANCE.

THE TUBE SEGMENTS, ENGINE ISOLATION CHECK VALVES, AND FLOW CONTROL VALVES ARE JOINED TOGETHER BY WELDING PER SPECIFICATION MAO107-313 USING AN INCONEL 718 WELD UNION.

(B) TEST:
ATP

PROOF TEST
PRESSURE: 975 PSIG

LEAK TEST
PRESSURE: 650 PSIG

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VERIFICATION

QUALIFICATION TESTING OF WELDED INCONEL LINE ASSEMBLIES WERE NOT PERFORMED, BUT THE LINE ASSEMBLIES WERE VERIFIED BY ANALYSIS. FOR OV103 REFER TO REPORT STS85-0254 (STRUCTURAL ANALYSIS FOR 6.0 LOADS, DATED APRIL 1988), VOLUME 10 (THRUST STRUCTURE, MPS, AND SECONDARY STRUCTURE). THE DESIGN OF THE LINE ASSEMBLIES FOR OV102 AND OV104 ARE IDENTICAL TO OV103.

THE PARTICLE IMPACT TEST PROGRAM HAS VERIFIED THAT THE TYPE IV FLOW CONTROL VALVE (FCV) AND MANIFOLD SYSTEM ARE NOT SUSCEPTIBLE TO IGNITION WHEN SUBJECTED TO METALLIC PARTICULATE THAT COULD BE INTRODUCED DURING NORMAL OPERATION. A TOTAL OF 160 CONTAMINANT INJECTIONS WERE PREFORMED WITH 10 MILLIGRAM SAMPLES OF A MIXTURE OF INCONEL 718, 21-6-9 CRES, AND ALUMINUM 2219 PARTICLES RANGING FROM 0 TO 250 MICRONS IN DIAMETER. EIGHTY TESTS WERE PERFORMED AT 104% RPL ENGINE CONDITIONS OF 490 DEG F AND 710 DEG F FOR PARTICLE IMPACT IGNITION. ALL 160 TESTS WERE COMPLETED WITHOUT INCIDENT.

NOTE: VALVE FLOW RATES (NORMALIZED TO 3600 PSIA AND 380 DEG F) WERE 2.60 POUNDS/SECOND AND 1.09 POUNDS/SECOND.

OMRSD
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(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 TUBING IS VERIFIED. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURES.

CRITICAL PROCESSES
ELECTRICAL BONDING, HEAT TREATMENT, AND PARTS PASSIVATION ARE VERIFIED BY INSPECTION. WELDS JOINING COMPONENTS TOGETHER ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
RADIOGRAPHIC INSPECTION OF WELDED JOINTS IS VERIFIED.

TESTING
ATP IS VERIFIED BY INSPECTION.

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HANDLING/PACKAGING
PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
DURING OV104 ASSEMBLY AT PALMDALE, A SUCKBACK CONDITION WAS DETECTED BY X-RAYS ON THE INCONEL 718 WELDED SLEEVES (REFERENCE CAR AD0622). INVESTIGATION FOUND OXIDE FOLDS IN THE FLOW CONTROL VALVE/VEHICLE TUBE INTERFACE WELDS (UPSTREAM). IN THE WORST CASE CONDITION SEEN, THE AXIAL LOAD CARRYING CAPABILITY FOR THE WELD JOINT WAS REDUCED BY 36%. WITH A PRESSURE FACTOR OF SAFETY OF 4 AND THE LOAD CARRYING REDUCTION, A PRESSURE FIVE TIMES THE MAXIMUM OPERATING PRESSURE WOULD BE NEEDED FOR A FAILURE. THEREFORE; THE INCONEL 718 WELD JOINTS AND SLEEVES WERE CONSIDERED TO BE ACCEPTABLE FOR FLIGHT. THE INSPECTION PROCEDURES WERE CONSIDERED TO BE SUFFICIENT TO DETECT WELD/MATERIAL DEFECTS.

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:
NO CREW ACTION CAN BE TAKEN.

- 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