

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 03-1-0410 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 02/20/01**PART DATA**

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: TRANSDUCER, PRESSURE, LO2 BOEING	MC449-0164-0001
LRU	: TRANSDUCER, PRESSURE, LH2 BOEING	MC449-0164-0002

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

TRANSDUCER, DIFFERENTIAL PRESSURE, LH2 (MT50) AND LO2 (MT44). THE DIFFERENTIAL PRESSURE TRANSDUCER IS NO LONGER SUPPORTED AND IS DELETED FROM OV-105 AND SUBS.

REFERENCE DESIGNATORS: MT44
MT50

QUANTITY OF LIKE ITEMS: 2

FUNCTION:

THE TRANSDUCERS WITH THEIR SIGNAL CONDITIONERS PROVIDE A MEANS OF SENSING THE PROPELLANT LEVEL IN THE ET LH2 AND LO2 TANKS BETWEEN THE POINT SENSORS IN THE BOTTOM AND THE TOP OF THE TANKS. THE SYSTEM SENSES DIFFERENTIAL PRESSURE BETWEEN THE ORBITER 17-INCH FEEDLINES AND THE GH2/GO2 ORBITER 2-INCH PRESSURIZATION LINES. THEY ARE USED TO PROVIDE GROSS INDICATION OF PROPELLANT LEVEL IN THE TANKS DURING PROPELLANT LOADING . THEY HAVE NO INFLIGHT FUNCTION. THIS SYSTEM IS ELECTRICALLY POWERED BUT PRESENTLY IT IS NOT ACTIVELY USED, AND IS NOT INSTALLED ON OV-105.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0410-03

REVISION#: 1 02/20/01

SUBSYSTEM NAME: MAIN PROPULSION

LRU: TRANSDUCER, PRESSURE, LH2/LO2

ITEM NAME: TRANSDUCER, PRESSURE, LH2/LO2

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE (INTERNAL) OF DIAPHRAGM ASSEMBLY DURING GROUND OPERATIONS.

MISSION PHASE: PL PRE-LAUNCH

VEHICLE/PAYLOAD/KIT EFFECTIVITY:	102	COLUMBIA
	103	DISCOVERY
	104	ATLANTIS

CAUSE:

FATIGUE FAILURE, MATERIAL DEFECTS, DEFECTIVE WELDS

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 PREPRESS, THE FAILURE RESULTS IN GHE INJECTION INTO THE FEEDLINE THROUGH THE RUPTURED DIAPHRAGM. DURING ENGINE START, INGESTION OF ACCUMULATED GHE INTO THE SSME LH2 SYSTEM MAY CAUSE PUMP OVERSPEED AND CAVITATION, RESULTING IN UNCONTAINED ENGINE DAMAGE. THE GHE ACCUMULATION IS NOT A CONCERN FOR THE LO2 SYSTEM DUE TO THE CONTINUOUS LO2 BLEED AND THE HIGHER DENSITY LO2 PREVENTING TURBINE OVERSPEED ON THE LO2 TURBOPUMPS.

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FOLLOWING ENGINE START TRANSIENT, NO EFFECT. ORIFICES IN THE TRANSDUCER WILL MINIMIZE PRESSURANT GAS INJECTION INTO THE FEEDLINE. PRESSURANT GAS WILL RECONDENSE UPON EXPOSURE TO FEEDLINE PROPELLANT WITH NO EFFECT ON ENGINE OPERATION.

(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:

NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE TRANSDUCER UTILIZES THE VARIABLE RELUCTANCE PRINCIPLE FOR SENSING PRESSURE. IT CONTAINS A DIAPHRAGM WHICH IS EB WELDED IN AN ASSEMBLY WITH TWO BACKUP PLATES. INCORPORATED WITHIN EACH BACKUP PLATE ARE INDUCTANCE COILS AND TEMPERATURE COMPENSATING CIRCUITS. PRESSURE TRANSMITTING CAPILLARY TUBES ARE FURNACE BRAZED TO THE BACKUP PLATES AND TERMINATE IN DYNATUBE FITTINGS FOR SYSTEM HOOKUP. THE CAPILLARY TUBE IS MADE FROM 321 CRES, 0.094 INCH OD; 0.028 INCH WALL THICKNESS. INCORPORATED INTO EACH BACKUP PLATE IS AN 0.015 INCH DIAMETER ORIFICE TO RESTRICT GAS FLOW THROUGH A FAILED DIAPHRAGM. THE DIAPHRAGM ASSEMBLY IS MOUNTED IN A HOUSING WHICH CONTAINS TWO COVER PLATES AND AN ELECTRICAL CONNECTOR.

THE DIAPHRAGM IS MADE FROM 0.012 INCH THICK 17-7 STEEL, SANDWICHED BETWEEN TWO BACKUP PLATES OF 304 STEEL. THE DIAPHRAGM IS TOTALLY CONTAINED BETWEEN THE TWO BACKUP PLATES WHICH RESTRICT THE AMOUNT OF DIAPHRAGM DEFORMATION IN BOTH DIRECTIONS (0.0090 INCH MAX IN THE PRESSURIZATION LINE DIRECTION AND 0.0030 INCH MAX IN THE FEEDLINE DIRECTION). IN AN ANALYSIS PERFORMED BY THE MANUFACTURER, THE DIAPHRAGM WAS FOUND TO HAVE A SAFETY FACTOR OF 22.

THE DIAPHRAGM IS WELDED TO THE BACKUP PLATES. AN ANALYSIS PERFORMED BY THE MANUFACTURER INDICATED THE WELD SAFETY FACTOR AT 745 PSID MAXIMUM OPERATING PRESSURE (EQUIVALENT TO 109% POWER LEVEL) TO BE 2.11 YIELD AND 5.27 ULTIMATE. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF TRANSDUCER OPERATIONS.

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(B) TEST:

ATP

EXAMINATION OF PRODUCT

LEAKAGE (TRANSDUCER DIAPHRAGM ASSEMBLY ONLY)

PRESSURIZATION LINE SIDE - 600 PSID
FEEDLINE SIDE (LO2) - 220 PSID
FEEDLINE SIDE (LH2) - 55 PSID

PERFORMANCE (SIGNAL CONDITIONER AND TRANSDUCER)

CURRENT CONSUMPTION
REVERSE VOLTAGE OPERATION
OUTPUT SIGNAL IMPEDANCE AND NOISE
SYSTEM LINEARITY, HYSTERESIS AND REPEATABILITY (OVER TRANSDUCER
PRESSURE AND TEMPERATURE EXTREMES)
SIGNAL CONDITIONER MEMORY VERIFICATION

PROOF PRESSURE (TRANSDUCER)

PRESSURIZATION LINE SIDE - 600 PSID
FEEDLINE SIDE (LO2) - 220 PSID
FEEDLINE SIDE (LH2) - 55 PSID
POST TEST PERFORMANCE VERIFICATION.

ELECTRICAL CHARACTERISTICS

INSULATION RESISTANCE
DIELECTRIC STRENGTH

VIBRATION

RANDOM - 30 SECONDS PER AXIS AT AMBIENT CONDITIONS

THERMAL CYCLE (SIGNAL CONDITIONER ONLY)

+70 DEG F TO -45 DEG F TO +145 DEG F TO -45 DEG F TO +70 DEG F.

CERTIFICATION (2 UNITS)

VIBRATION (AT AMBIENT CONDITIONS)

RANDOM - 48 MINUTES IN EACH OF 3 AXES

TRANSIENT - (5 TO 35 HZ) IN EACH OF 3 AXES

QAVT (QUALIFICATION - ACCEPTANCE VIBRATION TEST)

RANDOM - 25 MINUTES IN EACH OF 3 AXES

LEAKAGE (TRANSDUCER DIAPHRAGM ASSEMBLY ONLY)

PRESSURIZATION LINE SIDE - 600 PSID
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SHOCK (MIL-STD-810)
DESIGN
BENCH

EXPLOSIVE ATMOSPHERE (MIL-STD-810 WITH BUTANE)

BURST (TRANSDUCER ONLY)
PRESSURIZATION LINE SIDE - 1200 PSIG
FEEDLINE SIDE - 440 PSIG
PERFORM LEAKAGE TEST

OMRSD
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
INCOMING PARTS ARE VISUALLY INSPECTED FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
CLEANLINESS LEVELS OF TRANSDUCER SURFACES ARE VERIFIED; 800A IN CONTACT WITH OXYGEN, 400 IN CONTACT WITH HYDROGEN. EXTERNAL SURFACES MAINTAINED TO VISIBLE CLEAN LEVEL ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
CLEANLINESS OF SENSOR PARTS PRIOR TO ASSEMBLY IS INSPECTED. DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. TORQUE APPLIED TO BASE PLATE IS CHECKED TO REQUIREMENT. ALUMINUM BASES AND HOUSINGS FINISHED WITH CHEM FILM FOR ELECTRICAL BONDING APPLICATION ARE VERIFIED. ALIGNMENT AND SEALING WITH EPOXY BETWEEN ADAPTER FITTINGS AND COVERS ARE VISUALLY EXAMINED. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

CRITICAL PROCESSES
EB WELDING OF THE DIAPHRAGM ASSEMBLY WITH THE ASSEMBLY AT REDUCED TEMPERATURE (-130 DEG F) IS VERIFIED IN ACCORDANCE WITH APPLICABLE REQUIREMENT. ALL SOLDERING AREAS OF ELECTRONIC CONNECTIONS ARE INSPECTED PER REQUIREMENT. CONFORMAL COATING CONDUCTED ON TERMINAL BOARDS WITH SOLITHANE 115 TYPE II IS EXAMINED. BRAZING CONDUCTED ON ASSEMBLY IS VERIFIED BY INSPECTION. BLACK ANODIZED EXTERNAL SURFACES AND MOUNTING HOLES OF BASE PLATES ARE INSPECTED PER REQUIREMENTS. EPOXY BONDING OF LOOSE WIRES IS VERIFIED.

NONDESTRUCTIVE EVALUATION
RADIOGRAPHIC INSPECTION OF BRAZES AND WELDS IS VERIFIED. HELIUM LEAK DETECTION IS PERFORMED TO DETECT ANY POSSIBLE LEAKAGE IN THE ASSEMBLY.

TESTING
ATP, INCLUDING PROOF PRESSURE TEST, IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

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PACKAGING PER DOCUMENTED INSTRUCTIONS IS VERIFIED. SHOCK AND CONTAMINATION PREVENTION DURING HANDLING/SHIPPING/PACKAGING BETWEEN STATIONS IS MONITORED.

(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:

FLIGHT: NO CREW ACTION CAN BE TAKEN.

GROUND: GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN PROPELLANT SYSTEMS.

- 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	: HERB WOLFSON	: /S/ HERB WOLFSON
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
INSTRUMENTATION	:	: /S/ N/A
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