

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE****NUMBER: 03-1-0745 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 02/21/01

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**PART DATA**

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<b>PART NAME</b>	<b>PART NUMBER</b>
<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU : TRANSDUCER, PRESSURE	ME449-0177-2179
STATHAM	PA8103-1M-22125

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

TRANSDUCER, PNEUMATIC ACCUMULATOR PRESSURE, 0 TO 1000 PSIA.

**REFERENCE DESIGNATORS:** V41P1650A**QUANTITY OF LIKE ITEMS:** 1**FUNCTION:**PROVIDES INDICATION OF MPS PNEUMATIC ACCUMULATOR SYSTEM PRESSURE.  
LOCATED AT OUTLET OF CV9 CHECK VALVE.

**FAILURE MODES EFFECTS ANALYSIS FMEA -- NON-CIL FAILURE MODE**

**NUMBER: 03-1-0745-01**

**REVISION#: 1 10/30/01**

**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: PNEUMATIC ACCUM. PRESSURE TRANSDUCER**

**ITEM NAME: PNEUMATIC ACCUM. PRESS TRANSDUCER**

**CRITICALITY OF THIS**

**FAILURE MODE: 1R3**

**FAILURE MODE:**

ERRONEOUS OUTPUT (READS HIGH).

**MISSION PHASE: LO LIFT-OFF**

<b>VEHICLE/PAYLOAD/KIT EFFECTIVITY:</b>	102	COLUMBIA
	103	DISCOVERY
	104	ATLANTIS
	105	ENDEAVOUR

**CAUSE:**

PIECE PART STRUCTURAL FAILURE, CONTAMINATION

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

**REDUNDANCY SCREEN**

- A) PASS
- B) PASS
- C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

PASSES B SCREEN BECAUSE FAILURE TO INDICATE REGULATOR OUTLET PRESSURE DURING POST MECO MPS POWER DOWN AND ISOLATION WILL BE READILY DETECTABLE.

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

LOSS OF MONITORING CAPABILITY.

MEASUREMENT IS MONITORED BY THE LCC FROM INITIATION OF PURGE SEQUENCE 3 TO GO FOR SSME START (T-31 SECONDS).

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**(B) INTERFACING SUBSYSTEM(S):**

SAME AS A.

**(C) MISSION:**

FIRST FAILURE - NO EFFECT.

**(D) CREW, VEHICLE, AND ELEMENT(S):**

SAME AS C.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

1R/3 3 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) ACCUMULATOR TRANSDUCER INDICATES HIGH.
- 2) ENGINE HELIUM SYSTEM LEAKS. CREW MANUALLY INTERCONNECTS PNEUMATIC SUPPLY TO EXTEND ENGINE OPERATION. WHEN PNEUMATIC HELIUM SUPPLY IS EXHAUSTED, PNEUMATIC REGULATOR OUTLET PRESSURE DECAYS DUE TO BACKFLOW THROUGH PILOT POPPET.
- 3) PNEUMATIC ACCUMULATOR LEG LEAKS.

AFTER EXHAUSTION OF PNEUMATIC SUPPLY AND DECAY OF PNEUMATIC REGULATOR OUTLET PRESSURE, ACCUMULATOR PRESSURE IS SOLE REMAINING CUE TO IDENTIFY ACCUMULATOR LEG LEAKS. FAILED TRANSDUCER PREVENTS CREW FROM RECEIVING CUE TO INTERCONNECT THE ENGINE 2 HELIUM SYSTEM AND PNEUMATIC PRESSURE WILL NOT BE AVAILABLE TO CLOSE THE LO2 PREVALVES AT MECO.

LOSS OF PNEUMATIC ACTUATION HELIUM RESULTS IN LO2 PREVALVE FAILING TO CLOSE AND INABILITY TO MAINTAIN INJECTED HELIUM AND LO2 PRESSURE TO THE HIGH PRESSURE OXYGEN TURBOPUMP TO PREVENT PUMP OVERSPEED AND CAVITATION AT MECO. RESULTS IN UNCONTAINED ENGINE DAMAGE, AFT COMPARTMENT OVERPRESSURIZATION, AND FIRE/EXPLOSION HAZARD. AT MECO, THE ENGINE 2 HELIUM SUPPLY IS SWITCHED IN TO THE PNEUMATIC VALVE SYSTEM (VIA LV10) AS A BACKUP, BY SOFTWARE COMMAND, WHICH WILL NOT ACTUATE THE LO2 PREVALVES CLOSED IN CASE OF LARGE ACCUMULATOR PRESSURE LOSS. POSSIBLE LOSS OF CREW/VEHICLE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

THE TRANSDUCER UTILIZES A STRAIN GAGE PRESSURE MONITORING CONCEPT. A BEAM WITH A STRAIN GAGE IS CONNECTED TO THE SENSING DIAPHRAGM WITH A LINKAGE PIN. THE DIAPHRAGM DEFLECTION DUE TO PRESSURE CHANGES IS TRANSMITTED TO THE BEAM THROUGH THE LINK PIN CAUSING BEAM DEFLECTION. THE STRAIN GAUGE WILL MEASURE THIS DEFLECTION.

GOLD LEAD WIRES CONNECT THE STRAIN GAUGE TO A STATIONARY YOKE (STAINLESS STEEL). NICKEL LEADS CONNECT THE STATIONARY YOKE TO THE FEEDTHROUGH

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CONNECTOR. MATERIALS AND PROCESSES USED ARE COMPATIBLE WITH THE ENVIRONMENTAL CONDITIONS. THE TRANSDUCER IS CAPABLE OF WITHSTANDING 1.5 TIMES MAXIMUM OPERATING PRESSURE WITHOUT CHANGING THE CALIBRATION.

THE CASE ASSEMBLY, INCLUDING THE FEEDTHROUGH TERMINALS, IS EVACUATED AND SEALED BY WELDING A BALL INTO THE LEAK CHECK PORT. THE INTERNAL VACUUM IS USED AS A REFERENCE CONDITION FOR PSIA TRANSDUCERS.

ERRONEOUS OUTPUT (HIGH OR LOW) IS DEFINED AS THE TRANSDUCER FALSELY INDICATING A PRESSURE HIGHER OR LOWER THAN THE ACTUAL PRESSURE. ERRONEOUS OUTPUT (LOW) CAN BE CAUSED BY DIAPHRAGM LEAKAGE OR EXTERNAL LEAKAGE INTO THE VACUUM CASE. ERRONEOUS OUTPUT (HIGH OR LOW) CAN BE CAUSED BY STRAIN GAUGE OR CIRCUIT FAILURE WITHIN THE TRANSDUCER. "STICTION" TYPE FAILURE OF THIS TRANSDUCER IS CONSIDERED NON CREDIBLE DUE TO THE SMALL TRAVEL OF THE DIAPHRAGM (0.001 INCH).

**(B) TEST:  
PRE-ATP**

THERMAL CYCLE

WITH POWER APPLIED, CYCLE BETWEEN -250 DEG F AND +350 DEG F SIX TIMES STAYING 2 HOURS AT EACH TEMPERATURE. DURING EACH 2 HOUR PERIOD, CYCLE PRESSURE FROM 0 TO 75 PERCENT MINIMUM OF FULL SCALE (FULL SCALE IS 0 TO 1000 PSIA) TWICE EACH HOUR.

ATP

EXAMINATION OF PRODUCT

PROOF PRESSURE

PRIMARY AND SECONDARY BARRIER  
1.5 TIMES MAXIMUM OPERATING PRESSURE

PERFORMANCE TESTS

INSULATION RESISTANCE

CALIBRATION

0, 20, 40, 60, 80, 100, 80, 60, 40, 20 AND 0 PERCENT OF FULL SCALE PRESSURE (1000 PSIA) AT -250 DEG F, +70 DEG F, AND +350 DEG F. RECORD ERROR DUE TO TEMPERATURE EFFECTS, LINEARITY, RESIDUAL IMBALANCE, REPEATABILITY, AND SENSITIVITY.

TRANSDUCERS ARE RE-CALIBRATED PERIODICALLY PER OMRS D REQUIREMENTS.

CERTIFICATION

BY SIMILARITY

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THE TRANSDUCER WAS CERTIFIED BY SIMILARITY, DESIGN ANALYSIS, AND TESTING, AND IS SIMILAR IN DESIGN AND CONSTRUCTION TO TRANSDUCERS CERTIFIED BY BELL AEROSYSTEMS, MCDONNELL DOUGLAS, GENERAL ELECTRIC, AND MARTIN MARIETTA. THE PREVIOUS TEST LIMITS EXCEEDED ORBITER SPECIFICATION REQUIREMENTS.

BY TEST

OFF-LIMITS VIBRATION TESTING WAS SUCCESSFULLY PERFORMED WITH NASA DESIGN AND RELIABILITY CONCURRENCE ON AN ME449-0179-0173 TRANSDUCER AFTER REDESIGN FOR THE HIGHER VIBRATION ENVIRONMENT EXPERIENCED BY SOME MPS PRESSURE TRANSDUCERS.

BURST TEST

PRIMARY AND SECONDARY BARRIER  
MINIMUM OF 3 TIMES MAXIMUM OPERATING PRESSURE

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

ALL RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIALS AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL IS VERIFIED TO 100A. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

PARTS ARE INSPECTED VISUALLY, DIMENSIONALLY, AND INCREMENTALLY PER REQUIREMENTS. TOOL CALIBRATION IS VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCESS.

CRITICAL PROCESSES

THE FOLLOWING ARE VERIFIED BY INSPECTION:

SOLDERING  
HEAT TREATMENT  
PARTS PASSIVATION  
WELDING

TESTING

ATP, INCLUDING PROOF PRESSURE TEST, IS OBSERVED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

SPECIAL HANDLING PER DOCUMENTED INSTRUCTIONS IS VERIFIED BY INSPECTION TO PRECLUDE DAMAGE, SHOCK, AND CONTAMINATION DURING COMPONENT HANDLING, TRANSPORTING, AND PACKAGING BETWEEN WORK STATIONS.

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**(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:**

PNEUMATIC TANK, REGULATOR, AND ACCUMULATOR PRESSURE ARE ON S/M ALERT FDA SYSTEM AND THE BFS SYSTEM SUMMARY DISPLAY. THIS ALLOWS THE FLIGHT CREW TO RESPOND TO A PNEUMATIC HELIUM SYSTEM LEAK INDEPENDENT OF GROUND CONTROL.

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**- APPROVALS -**

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S&R ENGINEERING	: L. DANG	:/S/ L. DANG
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	: BILL MCKEE	:/S/ BILL MCKEE
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