

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0743 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/21/01

PART DATA

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

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

TRANSDUCER, ENGINE REGULATOR OUTLET PRESSURE, 0 TO 1000 PSIA.

REFERENCE DESIGNATORS: (LEG A: V41P1154A, V41P1254A, V41P1354A)
(LEG B: V41P1153A, V41P1253A, V41P1353A)

QUANTITY OF LIKE ITEMS: 6
TWO PER ENGINE LEG

FUNCTION:

PROVIDES INDICATION FOR MPS ENGINE REGULATED HELIUM OUTLET PRESSURE.
LOCATED IN THE LINE BETWEEN THE REGULATOR (PR1,2,3,7,8,9) AND THE CHECK VALVE
(CV5,6,7,29,40,45).

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0743-01

REVISION#: 1 10/30/01

SUBSYSTEM NAME: MAIN PROPULSION

LRU: SSME SUPPLY REG OUT PRESS TRANSDUCER

CRITICALITY OF THIS

ITEM NAME: SSME SUPPLY REG OUT PRESS TRANSDUCER

FAILURE MODE: 1R2

FAILURE MODE:

ERRONEOUS OUTPUT - INDICATES WITHIN LCC LIMITS (LCC DECEPTION).

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

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-10 SECONDS).

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0743-01**

(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:

CASE 1

1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT.

- 1) REGULATOR OUTLET PRESSURE TRANSDUCER FAILS WITHIN LCC LIMITS.
- 2) ASSOCIATED REGULATOR FAILS OPEN OR DOWNSTREAM LEAKAGE BETWEEN REGULATOR AND REG ISOLATION CHECK VALVE AFTER TERMINATION OF AFT COMPARTMENT HELIUM HGDS LCC AND HELIUM SUPPLY PRESSURE LCC (T-13 SECONDS).

AFTER LIFTOFF, HELIUM SUPPLY DP/DT ALARM WILL PROMPT CREW TO BEGIN HELIUM LEAK ISOLATION PROCEDURE. SINCE BOTH REGULATOR OUTLET PRESSURE MEASUREMENTS ARE INDICATING IN THE NOMINAL BAND, CREW WILL ISOLATE REGULATOR "A" FIRST, WHICH MAY INTERRUPT THE ENGINE HELIUM SUPPLY IF THE REGULATOR AND TRANSDUCER FAILURES ARE IN LEG "B". IF LEAK IS LARGE ENOUGH, INTERRUPTION OF ENGINE HELIUM SUPPLY WILL RESULT IN UNCONTAINED ENGINE FAILURE. POSSIBLE AFT OVERPRESSURIZATION MAY OCCUR DUE TO DELAY IN CREW ISOLATION OF LEAK.

REGULATOR OUTLET PRESSURE LCC CONTINUES UNTIL T-10 SECONDS. THESE FAILURES AFTER T-13 SECONDS RESULT IN LCC DECEPTION AND LIFTOFF WITH FAILED OPEN REGULATOR.

POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2

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

- 1) REGULATOR OUTLET PRESSURE TRANSDUCER FAILS WITHIN LCC LIMITS.
- 2) ASSOCIATED REGULATOR FAILS OPEN OR DOWNSTREAM LEAKAGE BETWEEN REGULATOR AND REG ISOLATION CHECK VALVE AFTER TERMINATION OF AFT COMPARTMENT HELIUM HGDS LCC AND HELIUM SUPPLY PRESSURE LCC (T-13 SECONDS). ASSUMES LEAKAGE SMALL ENOUGH THAT CREW ACTION CAN SAFE SYSTEM.
- 3) ANY COMPONENT FAILURE THAT PREVENTS CREW ISOLATION OF LEAK (ISOLATION VALVE FAILS OPEN, SWITCH FAILURE, ETC.) OR LOSS OF DP/DT INSIGHT (HELIUM SUPPLY MEASUREMENT FAILS, BFS FAILS, ETC.).

REGULATOR OUTLET PRESSURE LCC CONTINUES UNTIL T-10 SECONDS. THESE FAILURES AFTER T-13 SECONDS RESULT IN LCC DECEPTION AND LIFTOFF WITH FAILED OPEN REGULATOR. FLIGHT WITH THIS CONDITION MAY RESULT IN OVERPRESSURIZATION OF THE

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0743-01**

AFT COMPARTMENT. POSSIBLE UNCONTAINED ENGINE SHUTDOWN DUE TO HELIUM DEPLETION.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(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.

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

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0743-01**

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 OMRSD REQUIREMENTS.

CERTIFICATION

BY SIMILARITY

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

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NUMBER: 03-1-0743-01**

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.

(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:

AFTER LIFTOFF, HELIUM SUPPLY DP/DT ALARM WILL PROMPT CREW TO BEGIN HELIUM LEAK ISOLATION PROCEDURE. SINCE BOTH REGULATOR OUTLET PRESSURE MEASUREMENTS ARE INDICATING IN THE NOMINAL BAND, CREW WILL ISOLATE REGULATOR "A" FIRST, WHICH MAY INTERRUPT THE ENGINE HELIUM SUPPLY IF THE REGULATOR AND TRANSDUCER FAILURES ARE IN LEG "B". INTERRUPTION OF ENGINE HELIUM SUPPLY MAY RESULT IN UNCONTAINED ENGINE FAILURE.

- APPROVALS -

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