

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0748 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/20/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:TRANSDUCER, TEMPERATURE, GH2/GO2 RDF	ME449-0010-0010 RDF 21018

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

TRANSDUCER, GO2/GH2 PRESSURIZATION OUTLET TEMPERATURE, GO2: -250 TO 1000 °F,
GH2: -325 TO 500 °F

REFERENCE DESIGNATORS: GH2 - V41T1161A, V41T1261A, V41T1361A
GO2 - V41T1171A, V41T1271A, V41T1371A

QUANTITY OF LIKE ITEMS: 6
ONE EACH GH2 AND GO2 PER SSME LEG

FUNCTION:

PROVIDES MEASUREMENT OF THE TEMPERATURE OF THE GO2 AND GH2 BEING SUPPLIED BY THE ENGINE TO THE FLOW CONTROL VALVES FOR PRESSURIZATION OF THE EXTERNAL TANK. LOCATED ON THE ORBITER SIDE OF THE ORBITER/SSME INTERFACE, INSTALLED INTO THE SSME INTERFACE CHECK VALVES.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0748-03

REVISION#: 1 10/30/01

SUBSYSTEM NAME: MAIN PROPULSION

LRU: GO2/GH2 PRESS TEMPERATURE TRANSDUCER

CRITICALITY OF THIS

ITEM NAME: GO2/GH2 PRESS TEMPERATURE TRANSDUCER

FAILURE MODE: 1/1

FAILURE MODE:

PROBE STRUCTURAL FAILURE

MISSION PHASE: LO LIFT-OFF

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

CAUSE:

MATERIAL DEFECT, FATIGUE

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: PROBE FRAGMENTS MOVING FREELY WITHIN A HOT GO2 ENVIRONMENT MAY CAUSE PARTICLE IMPACT/IGNITION OF DOWNSTREAM COMPONENTS. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE/EXPLOSION HAZARD. FLOW CONTROL VALVE (FCV) BODY COMBUSTION IS LIKELY TO DAMAGE REMAINING ADJACENT FCVS AND OTHER CRITICAL FUNCTIONS.

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GH2: PROBE FRAGMENTS MAY INTERFERE WITH FUNCTION OF ENGINE INTERFACE CHECK VALVE. LOSS OF REDUNDANCY AGAINST LEAKAGE IN CASE OF PREMATURE SSME SHUTDOWN.

(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:

CASE 1:

1R/2 2 SUCCESS PATHS. TIME FRAME - ENGINE OPERATION (ACTIVE CONFIGURATION ONLY).

- 1) SSME PREMATURE MECO REQUIRING ISOLATION OF SSME.
- 2) FRAGMENTS FROM TEMPERATURE PROBE STRUCTURAL FAILURE LODGE IN ENGINE INTERFACE CHECK VALVE (ASSUMES FAILURE SUCH THAT ISOLATION WOULD SAFE SYSTEM).

RESULTS IN INABILITY TO ISOLATE SSME FROM ORBITER PRESSURIZATION SYSTEM. MAY RESULT IN GO2/GH2 AND/OR GHE LEAKAGE INTO THE AFT COMPARTMENT OR OVERBOARD. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD.

THE FLOW CONTROL VALVES WILL OPEN IN AN ATTEMPT TO MAINTAIN ET ULLAGE PRESSURE (ACTIVE FLOW CONTROL VALVES ONLY). LOSS OF ET LO2/LH2 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.

CASE 2:

1R/2 2 SUCCESS PATHS. TIME FRAME - ENGINE OPERATION (GH2 AND ACTIVE GO2 CONFIGURATION ONLY).

- 1) FRAGMENTS FROM TEMPERATURE PROBE STRUCTURAL FAILURE LODGE IN FCV.
- 2) EITHER OF THE REMAINING TWO FCVS FAIL TO OPERATE.

IF FRAGMENTS BLOCK FCV FROM CLOSING, AND SECOND FCV FAILS TO CLOSE, EXCESSIVE GO2 ULLAGE PRESSURE WOULD CAUSE ET VENT VALVE TO RELIEVE EXCESS PRESSURE. POTENTIAL FIRE HAZARD AT THE VEHICLE EXTERIOR. POSSIBLE VIOLATION OF THE ET MAXIMUM STRUCTURAL CAPABILITY REQUIREMENTS.

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IF FRAGMENTS OBSTRUCT FLOW TO THE FCV, AND SECOND FCV FAILS TO OPEN/REMAIN OPEN, LOSS OF GO2 ULLAGE PRESSURE WILL RESULT IN VIOLATION OF ET MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS. MASS OF LO2 AND VEHICLE ACCELERATION SHOULD BE SUFFICIENT TO MAINTAIN PROPER ENGINE NPSP, DELAYING UNCONTAINED SSME SHUTDOWN DUE TO LOW NPSP UNTIL LATE IN POWERED FLIGHT.

POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE TRANSDUCER USES A PLATINUM WIRE TEMPERATURE SENSING ELEMENT (POSITIVE COEFFICIENT OF RESISTANCE FOR TEMPERATURE). THE RESISTANCE CHANGES PROPORTIONALLY WITH TEMPERATURE. THE UNIT IS POWERED AND MONITORED BY AN EXTERNAL SIGNAL CONDITIONER. THE PLATINUM SENSING WIRE IS WOUND AROUND A HOLLOW MANDREL TO PROVIDE A RAPID RESPONSE.

THE TRANSDUCER IS HERMETICALLY SEALED. THE PROBE IS CYLINDRICAL CONSISTING OF A ONE PIECE HEX NUT AND THREADED SECTION WHICH IS TIG WELDED TO THE HOLLOW MANDREL. THE PLATINUM SENSING WIRE IS COILED AROUND THE MANDREL. IT IS INSULATED FROM THE MANDREL BY PLASMA DEPOSITED ALUMINUM OXIDE (Al_2O_3). THE PLATINUM SENSING WIRE AND MANDREL IS CONTAINED WITHIN AN OUTER STAINLESS STEEL SHEATH THAT IS TIG WELDED TO THE THREADED PART AND ALSO AT THE TIP OF THE MANDREL. THE STRUCTURE IS ALL STAINLESS STEEL. THE PROBE IS DESIGNED AND CONSTRUCTED TO WITHSTAND 10,000 PSIA WITHOUT ANY STRUCTURAL FAILURE.

THE PROBE FROM THE SEALING SURFACE TO THE TIP IS 1.5 INCHES IN LENGTH. STRUCTURAL ANALYSIS INDICATES A POSITIVE MARGIN OF SAFETY FOR ALL OPERATING CONDITIONS.

(B) TEST:

ATP

EXAMINATION OF PRODUCT

LEAKAGE TEST

1X10⁻⁶ SCC/SEC MAXIMUM

HIGH PRESSURE

10,000 PSIA

RESISTANCE TEST (+32 °F)

SENSING ELEMENT RESISTANCE

INSULATION RESISTANCE TEST

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CALIBRATION

CALIBRATED AT 5 POINTS (-452, -320, +32, +212, +450 DEG F)

CERTIFICATION

CERTIFIED BY SIMILARITY TO ME449-0010-0008 TRANSDUCER WHOSE DESIGN REQUIREMENTS ARE MORE STRINGENT. ME449-0010-0008 WAS SUBJECTED TO THE FOLLOWING TESTS:

THERMAL SHOCK

10 CYCLES FROM +75 TO -320 °F

RANDOM VIBRATION TEST

13.3 HOURS OF RANDOM VIBRATION AT +75 °F IN EACH OF THE 2 AXES.

BURST

PRIMARY BARRIER: 22,000 PSI FROM SEALING FACE OF HEX TO PROBE TIP

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RECEIVING INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATION OF ALL INCOMING PARTS. CERTIFICATION RECORDS/TEST REPORTS ARE MAINTAINED CERTIFYING MATERIALS AND PHYSICAL PROPERTIES.

CONTAMINATION CONTROL

CLEANLINESS LEVEL 100A IS MAINTAINED AND VERIFIED IN ACCORDANCE WITH APPLICABLE REQUIREMENTS.

ASSEMBLY/INSTALLATION

MANDATORY INSPECTION POINTS ARE INCLUDED IN MANUFACTURING PROCESS. TOOL CALIBRATION IS VERIFIED TO THE REQUIREMENT. PARTS ARE INSPECTED VISUALLY, DIMENSIONALLY, AND INCREMENTALLY IN ACCORDANCE WITH SPECIFICATION.

CRITICAL PROCESSES

DRY FILM LUBRICANT AND WELDING ARE VERIFIED PER DRAWING SPECIFICATION.

NONDESTRUCTIVE EVALUATION

HELIUM LEAK TEST IS VERIFIED BY INSPECTION. RADIOGRAPHIC INSPECTION IS CONDUCTED TO VERIFY THE EXISTENCE OF STRAIN RELIEF ON THE WINDING ELEMENT AND TO DETECT METALLIC CONTAMINATION IN THE HOUSING WHERE THE CONNECTOR IS WELDED.

TESTING

ATP AND PROOF PRESSURE TESTS ARE OBSERVED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

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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:

NO CREW ACTION CAN BE TAKEN.

- 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