

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE****NUMBER: 03-1-0724 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 02/20/01

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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, LH2 TEMPERATURE RDF	ME449-0013-0021 21035

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

TRANSDUCER, LH2 17 INCH FEEDLINE MANIFOLD DISCONNECT TEMPERATURE (V41T1428A).

**REFERENCE DESIGNATORS:****QUANTITY OF LIKE ITEMS:** 1**FUNCTION:**

MEASURES TEMPERATURE OF LH2 IN THE FEEDLINE MANIFOLD NEAR THE 17-INCH DISCONNECT. THIS TRANSDUCER IS USED TO DETECT THE TEMPERATURE OF LH2 AND WILL INDICATE THE PRESENCE OF GH2 DUE TO EXCESSIVE HEAT LEAK INTO THE FEED SYSTEM, INADEQUATE RECIRCULATION FLOW, OR THE HIGH POINT BLEED VALVE AND/OR THE T-0 DISCONNECT NOT OPEN.

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

**NUMBER: 03-1-0724-03**

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

**SUBSYSTEM NAME:** MAIN PROPULSION  
**LRU:** TRANSDUCER, LH2 TEMPERATURE  
**ITEM NAME:** TRANSDUCER, LH2 TEMPERATURE

**CRITICALITY OF THIS FAILURE MODE:** 1R2

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**FAILURE MODE:**  
PROBE STRUCTURAL FAILURE

**MISSION PHASE:** PL PRE-LAUNCH  
LO LIFT-OFF

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

**CAUSE:**  
FATIGUE, MATERIAL DEFECTS

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES**

RTLS RETURN TO LAUNCH SITE  
TAL TRANS-ATLANTIC LANDING  
AOA ABORT ONCE AROUND  
ATO ABORT TO ORBIT  
PAD PAD ABORT

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**REDUNDANCY SCREEN** A) PASS  
B) PASS  
C) PASS

**PASS/FAIL RATIONALE:**  
A)

B)  
PASSES B SCREEN BECAUSE TEMPERATURE MEASUREMENT WILL GO OFF SCALE.

C)

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

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NO EFFECT DURING NORMAL ENGINE OPERATION. LOSS OF CAPABILITY TO ISOLATE THE ET PROPELLANT SUPPLY FROM SSME.

FOR ABORTS, STRUCTURAL FAILURE OF THE PROBE PREVENTS LH2 PREVALVE FROM CLOSING. FAILS TO ISOLATE A SHUTDOWN ENGINE WITH UNCONTAINED DAMAGE (ASSUMES ENGINE IS DAMAGED ONLY TO THE EXTENT THAT ISOLATION OF THE DAMAGE WILL SAFE THE SYSTEM) CAUSING POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION, FIRE/EXPLOSION HAZARD, AND POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. FOR PAD ABORTS, A PARTIALLY OPEN MAIN FUEL VALVE RESULTS IN HAZARDOUS OVERBOARD LEAKAGE OF LH2.

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

SAME AS A.

**(C) MISSION:**

NO EFFECT FOR NOMINAL MISSIONS. FOR ENGINE OUT ABORTS, POSSIBLE LOSS OF CREW/VEHICLE.

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

SAME AS C.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

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

- 1) ENGINE SHUTDOWN WITH UNCONTAINED DAMAGE (ASSUMES ENGINE IS DAMAGED ONLY TO THE EXTENT THAT ISOLATION OF THE DAMAGE WILL SAFE THE SYSTEM).
- 2) LH2 PREVALVE (PV4, 5, OR 6) FAILS TO CLOSE DUE TO PROBE DEBRIS ON PREVALVE SCREEN.

PREVALVE WOULD FAIL TO ISOLATE THE AFFECTED ENGINE. RESULTS IN LH2/GH2 LEAKAGE IN AFT FUSELAGE LEADING TO OVERPRESSURIZATION, FIRE/EXPLOSION HAZARD, AND POSSIBLE LOSS OF CRITICAL ADJACENT COMPONENTS DUE TO CRYO EXPOSURE. MAIN FUEL VALVE LEAKAGE AFTER A PAD ABORT RESULTS IN HAZARDOUS OVERBOARD LEAKAGE OF LH2. POSSIBLE LOSS OF CREW/VEHICLE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

THE TRANSDUCER IS HERMETICALLY SEALED AND IS DESIGNED AND CONSTRUCTED TO WITHSTAND THE STATIC AND DYNAMIC LOADS IMPOSED BY OPERATIONAL SERVICE AND ALL OTHER HANDLING ASPECTS. THE PROBE IS CYLINDRICAL CONSISTING OF A ONE PIECE HEX NUT AND THREADED SECTION WHICH IS TUNGSTEN-INERT GAS (TIG) WELDED TO AN EXTENDED MANDREL. THE PROBE FROM THE SEALING SURFACE TO THE TIP IS 4.0 INCHES IN LENGTH. THE SENSING WIRE AND MANDREL IS CONTAINED WITHIN AN OUTER

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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 3,000 PSIA WITHOUT ANY STRUCTURAL FAILURE.

**(B) TEST:**

ATP

EXAMINATION OF PRODUCT

LEAKAGE TEST

LEAK TESTING PRECLUDES LEAKAGE GREATER THAN  $1 \times 10^{-6}$  SCC/SEC.

INSULATION RESISTANCE TEST

USING 100 VOLTS DC AND AN ELECTRIFICATION TIME OF 2 MINUTES BEFORE MEASUREMENT THE RESISTANCE SHALL BE LESS THAN 50 MEGOHMS WHEN MEASURED BETWEEN INSULATED TERMINALS AND BETWEEN THE TERMINAL AND THE CASE.

CALIBRATION

CALIBRATED AT 5 POINTS (-450, -410, -320, +32, AND +212 DEG F)

CERTIFICATION

CALIBRATION

CALIBRATED AT 5 POINTS (-450, -410, -320, +32, AND +212 DEG F)

THERMAL SHOCK

10 CYCLES FROM +75 TO -320 DEG F

RANDOM VIBRATION AND LOW TEMPERATURE TEST:

13.3 HOURS OF RANDOM VIBRATION AT -320 DEG F IN EACH OF THE 2 AXES.

BURST PRESSURE TESTING

NO LEAKAGE SHALL OCCUR WHEN SUBJECTED TO 3000 PSI.

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 400 IS MAINTAINED AND VERIFIED IN ACCORDANCE WITH APPLICABLE REQUIREMENT.

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**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 APPLIED TO THREADS IS VERIFIED PER DRAWING SPECIFICATION. TIG WELDING IS VERIFIED BY INSPECTION AND LEAK CHECK.

**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**

PACKAGING AND PROTECTION ARE VERIFIED BY INSPECTION TO APPLICABLE REQUIREMENTS. SPECIAL HANDLING PER DOCUMENTED INSTRUCTIONS IS VERIFIED TO PRECLUDE DAMAGE, SHOCK, AND CONTAMINATION DURING COMPONENT HANDLING/TRANSPORTING/ 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:**

FLIGHT: NO CREW ACTION CAN BE TAKEN.

GROUND: GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE HYDROGEN SYSTEM.

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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