

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**  
**NUMBER: 06-3A-0619 -X**

**SUBSYSTEM NAME: ATCS - WATER SPRAY BOILER**

**REVISION: 0 02/04/88**

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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 : WATER SPRAY BOILER ASSEMBLY	MC250-0019
P-PART : LINES AND FITTINGS, NITROGEN	

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
LINES AND FITTINGS, NITROGEN

**QUANTITY OF LIKE ITEMS: 3**  
ONE SET FOR EACH BOILER ASSEMBLY

**FUNCTION:**  
PROVIDE NITROGEN FROM SUPPLY TANK TO WATER TANK.

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**REVISION#: 1 08/25/98**

**SUBSYSTEM NAME: ATCS - WATER SPRAY BOILER**

**LRU: WATER SPRAY BOILER ASSEMBLY**

**ITEM NAME: LINES AND FITTINGS, NITROGEN**

**CRITICALITY OF THIS**

**FAILURE MODE: 1R2**

**FAILURE MODE:**

**EXTERNAL LEAKAGE**

**MISSION PHASE:**

LO LIFT-OFF  
DO DE-ORBIT

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

102 COLUMBIA  
103 DISCOVERY  
104 ATLANTIS  
105 ENDEAVOUR

**CAUSE:**

MECHANICAL SHOCK, VIBRATION, CORROSION, POROSITY, WELD FLAW

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

**REDUNDANCY SCREEN**

A) PASS  
B) PASS  
C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

LOSS OF NITROGEN - UNABLE TO PROVIDE THERMAL CONTROL IN ONE APU/HYD SYSTEM DUE TO LOSS OF CAPABILITY TO EXPEL WATER FROM STORAGE TANK.

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

POSSIBLE LOSS OR LIMITED RUN TIME OF ONE APU/HYD SYSTEM DUE TO LOSS OF COOLING. LIMITED RUN TIME MAY NOT ALLOW APU/HYD SYSTEM TO SUPPORT ENTIRE POWERED FLIGHT OR ENTRY PHASE. LOSS OF HYDRAULIC CAPABILITY TO THROTTLE ONE MAIN ENGINE. LOSS OF HYDRAULIC LANDING GEAR DEPLOY AND NOSEWHEEL STEERING IF SYSTEM ONE IS LOST, AND LOSS OF ONE OF THREE ET UMBILICAL RETRACT ACTUATORS FOR EACH UMBILICAL PLATE. LOSS OF REDUNDANT HYDRAULIC POWER SYSTEM FOR FOUR TVC ACTUATORS. LOSS OF ONE OF THREE HYDRAULIC POWER SYSTEMS TO FLIGHT CONTROL SURFACES AND BRAKES.

**(C) MISSION:**

ABORT DECISION - REMAINING TWO SYSTEMS PROVIDE SAFE RETURN.

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

NO EFFECT

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

POSSIBLE LOSS OF CREW/VEHICLE WITH THIS FAILURE PLUS LOSS OF A SECOND APU/HYD SYSTEM.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

LINES AND FITTINGS ARE CONSTRUCTED OF 347 STAINLESS STEEL FOR CORROSION RESISTANCE AND COMPATIBILITY WITH WORKING FLUIDS. DESIGN SAFETY FACTOR - PROOF PRESSURE OF 2.0 AND BURST OF 4.0, FOR HIGH PRESSURE GN2 LINES, 1.5 AND 2.0 FOR LOW PRESSURE GN2 LINES, RESPECTIVELY. GN2 RELIEF VALVE PROVIDES OVERPRESSURIZATION PROTECTION DOWNSTREAM OF REGULATOR.

**(B) TEST:****QUALIFICATION:**

- NITROGEN REGULATORS SUBJECTED TO 10,000 OPERATIONAL CYCLES PRIOR TO INSTALLATION INTO WSB ASSEMBLY.
- RANDOM VIBRATION TEST (BOILER AND VENT AREA) - ACCELERATION SPECTRAL DENSITY INCREASING AT RATE OF 5 DB/OCTAVE FROM 20 TO 50 HZ; CONSTANT AT 0.012 (G SQ)/HZ FROM 50 TO 2000 HZ FOR 48 MINUTES/AXIS (100 MISSION EQUIVALENCY). TEST PERFORMED WITH STORAGE TANK LOADED 100% AND AT MAX OPERATING PRESSURE (FULL GN2 PRESSURE). HYDRAULIC AND APU LUBE OIL

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CIRCUITS PRESSURIZED TO MAX OPERATING PRESSURE THROUGHOUT TEST.  
PASS/FAIL CRITERIA: NO DAMAGE OR PERMANENT DEFORMATION; NO ELECTRICAL CIRCUIT INTERRUPTIONS DURING TEST.

- SHOCK TEST - (PER MIL-STD-810, METHOD 516.1, PROCEDURE 1) 18 SHOCKS TOTAL, 6 EACH AXIS, AT 15 G'S PEAK VALUE FOR 11 MS NOMINAL DURATION WITH FULL WATER LOAD. PASS/FAIL CRITERIA: UNIT MUST PASS SUBSEQUENT PERFORMANCE TESTS.
- PERFORMANCE RECORD TEST INCLUDES:
  - DESIGN POINT CHECK-VERIFICATION OF WSB SYSTEM OPERATING PARAMETERS DURING POOL BOILING (SEA LEVEL TESTING) AND SPRAY BOILING (AT ALTITUDE). TESTING INCLUDES A WATER CARRY OVER EFFICIENCY TEST WHICH COMPARES ACTUAL VERSUS THEORETICAL WATER USAGE AT ALTITUDE ONLY WITH A KNOWN HEAT SINK.
- MISSION PROFILE TEST AT ALTITUDE - SIMULATION OF A BASELINE FLIGHT PROFILE AT MAXIMUM HEAT LOAD AND NORMAL OPERATION TO VERIFY PROPER WSB PERFORMANCE.
- THERMAL CYCLE TEST-TESTED AT OPERATING CONDITIONS AT 70 TO 275 TO 70 DEG F WITH DWELL OF 10 MINUTES AT EACH LEVEL FOR 5 CYCLES. ALSO TESTED WITH WSB NOT OPERATING AT 70 TO -65 TO 70 DEG F WITH A DWELL OF 3 HOURS AT EACH LEVEL FOR 3 CYCLES. PASS/FAIL CRITERIA: NO DAMAGE OR PERMANENT DEFORMATION.

**ACCEPTANCE:**

- LOW PRESSURE LINES PROOF AND LEAK TEST-TESTED WITH HELIUM AT 58 PSIG PRIOR TO ASSEMBLY.
- HIGH PRESSURE LINES PROOF AND LEAK TEST - PROOF TESTED AT 6920 PSIG, LEAK TESTED WITH HELIUM AT 3500 PSIG PRIOR TO ASSEMBLY.
- EXAMINATION OF PRODUCT - VERIFICATION OF WORKMANSHIP, FINISH, DIMENSIONS, CONSTRUCTION, CLEANLINESS, IDENTIFICATION, TRACEABILITY LEVEL AND PROCESSES PER DRAWINGS AND MC250-0019 (WATER SPRAY BOILER PROCUREMENT SPEC).
- HIGH SIDE N2 PROOF TEST - TESTED AT 4770 PSIG FOR 15 MINS WITH HELIUM AND RELIEF VALVE PREVENTED FROM OPENING. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT N2 CKT LEAK CHECKS.
- LOW SIDE N2 PROOF TEST-TESTED AT 51 PSIG FOR 15 MINS WITH HELIUM AND RELIEF VALVE PREVENTED FROM OPENING. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND N2 CKT LEAK CHECKS.
- HIGH SIDE N2 LEAK CHECK-TESTED AT 3180 PSIG WITH HELIUM AND RELIEF VALVE PREVENTED FROM OPENING. PASS/FAIL CRITERIA: 2.8 SCCM MAX HELIUM LEAKAGE.
- LOW SIDE N2 LEAK CHECK-INCLUDES R/V CRACK TEST AND N2 LEAK CHECK AT 28 PSIG WITH HELIUM. PASS/FAIL CRITERIA: 2.8 SCCM MAX HELIUM LEAKAGE.
- DESIGN POINT CHECK-VERIFICATION OF WSB SYSTEM OPERATING PARAMETERS DURING POOL BOILING (SEA LEVEL TESTING) AND SPRAY BOILING (AT ALTITUDE). TESTING INCLUDES A COMPLETE WATER LOAD EXPULSION TEST, PLUS A WATER CARRY OVER EFFICIENCY TEST WHICH COMPARES ACTUAL VERSUS THEORETICAL WATER USAGE AT ALTITUDE ONLY WITH A KNOWN HEAT SINK.

**PRELAUNCH:**

- WSB IS OPERATING DURING PRELAUNCH PHASE AND INTEGRITY IS VERIFIED BEFORE LAUNCH, USING VEHICLE INSTRUMENTATION.

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**GROUND TURNAROUND TEST**

- ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:****RECEIVING INSPECTION**

RAW MATERIALS ARE SENT TO A TEST LAB FOR MATERIAL AND CHEMICAL ANALYSIS AND CERTIFICATION. SHOP TRAVELER INSPECTION IS PERFORMED FOR CORRECT RAW MATERIAL PRIOR TO MACHINING.

**CONTAMINATION CONTROL**

INSPECTION VERIFIES CONTAMINATION CONTROL ON SHOP TRAVELERS

**ASSEMBLY/INSTALLATION**

IN-PROCESS INSPECTION IS REQUIRED FOR CRITICAL DIMENSIONS CERTIFICATION. FLUID CONNECTION TORQUE REQUIREMENTS ARE VERIFIED FOR PHYSICAL AND SEALING DAMAGE.

**NONDESTRUCTIVE EVALUATION**

X-RAY OF WELDS IS PERFORMED BY OUTSIDE VENDOR AND CERTIFICATION IS VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

WELDING IS PERFORMED BY OUTSIDE VENDOR AND CERTIFICATION IS VERIFIED BY INSPECTION. HEAT TREATMENT IS VERIFIED BY INSPECTION.

**TESTING**

LEAKAGE IS VERIFIED BY PROOF PRESSURE AND HELIUM TESTS.

**HANDLING/PACKAGING**

HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

**(E) OPERATIONAL USE:**

ASCENT: SHUT DOWN AFFECTED APU/HYD SYSTEM AT AN APPROPRIATE TIME BASED ON FLIGHT PHASE AND SYSTEM TEMPERATURES.

ENTRY: SHUT DOWN AFFECTED APU/HYD SYSTEM OR DELAY APU START IF FAILURE KNOWN PRIOR TO DEORBIT.

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- APPROVALS -

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EDITORIALLY APPROVED : BNA : J. Kimura 8-25-98  
TECHNICAL APPROVAL : VIA APPROVAL FORM : 95-CIL-009\_06-3A