

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- GIL HARDWARE  
NUMBER: 06-3A-0607 -X**

**SUBSYSTEM NAME: ACTIVE THERMAL CONTROL**

**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 ITEM 609
SRU	: NITROGEN REGULATOR	SV766509-1

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
NITROGEN REGULATOR**

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

**FUNCTION:**  
PROVIDES NITROGEN UPON DEMAND TO THE WATER STORAGE TANK. A BUILT IN RELIEF VALVE PREVENTS OVER PRESSURIZATION OF SYSTEM DOWNSTREAM OF REGULATOR.

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

NUMBER: 06-3A-0607-01

REVISION#: 1 08/25/98

**SUBSYSTEM NAME:** ATCS - WATER SPRAY BOILER**LRU:** WATER SPRAY BOILER ASSEMBLY**ITEM NAME:** NITROGEN REGULATOR**CRITICALITY OF THIS****FAILURE MODE:** 1R2**FAILURE MODE:**

FAILS IN CLOSED POSITION OR RESTRICTED FLOW

**MISSION PHASE:** DO DE-ORBIT

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

**CAUSE:**MECHANICAL SHOCK, VIBRATION, CORROSION, PHYSICAL BINDING/JAMMING,  
CONTAMINATION**CRITICALITY 1/1 DURING INTACT ABORT ONLY?** NO

<b>REDUNDANCY SCREEN</b>	A) PASS
	B) PASS
	C) PASS

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -****(A) SUBSYSTEM:**LOSS OF FUNCTION - UNABLE TO PROVIDE THERMAL CONTROL IN ONE APU LUBE  
OIL/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 ENTRY PHASE. LOSS OF HYDRAULIC LANDING GEAR DEPLOY AND NOSEWHEEL STEERING IF SYSTEM ONE IS LOST. LOSS OF ONE OF THREE HYDRAULIC POWER SYSTEMS TO FLIGHT CONTROL SURFACES AND BRAKES.

**(C) MISSION:**

NO EFFECT

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

SAME AS C.

**(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:**

25 MICRON FILTER IS INCORPORATED AT THE INLET TO EACH REGULATOR. THE LENGTH/DIAMETER OF THE STEM WHICH DRIVES OPEN THE BALL (POPPET) MINIMIZES BINDING/JAMMING. ALL VALVE COMPONENTS ARE COMPATIBLE WITH WORKING FLUIDS. REGULATOR COMPONENTS ARE: HOUSING - 304 STAINLESS STEEL (SS), VALVE SEAT - VESPEL SP-1, BALL - TUNGSTEN CARBIDE, STEM - 17-4 PH SS, SPRING - 302 SS. SHOULD GN2 REGULATOR FAIL TO OPEN, REMAINING PRESSURE DOWNSTREAM WOULD ALLOW LIMITED COOLING AND SUPPORT NOMINAL ASCENT PHASE. PROBABLY WOULD NOT SUPPORT ENTRY PHASE.

**(B) TEST:**

**QUALIFICATION:**

- NITROGEN REGULATORS SUBJECTED TO 10,000 OPERATIONAL CYCLES PRIOR TO INSTALLATION INTO WBS ASSEMBLY.
- RANDOM VIBRATION TEST (BOILER AND VENT AREA) - ACCELERATION SPECTRAL DENSITY INCREASING AT RATE OF 6 DB/ OCTAVE FROM 20 TO 50 HZ; CONSTANT AT 0.01 (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 CIRCUITS PRESSURIZED TO MAX OPERATING PRESSURE THROUGHOUT TEST. PASS/FAIL CRITERIA: NO DAMAGE OR PERMANENT DEFORMATION; NO ELECTRICAL CIRCUIT INTERRUPTIONS DURING TEST.

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- SHOCK TEST - (PER MIL-STD-810, METHOD 516.1, PROCEDURE 1) 18 SHOCKS TOTAL, 6 EACH AXIS, AT 15 G'S PEAK VALUE FOR 15 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 (INCLUDING SPRAYING).
- 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 F TO 70 DEG F WITH A DWELL OF 3 HOURS AT EACH LEVEL FOR 3 CYCLES. PASS/FAIL CRITERIA: NO DAMAGE OR PERMANENT DEFORMATION (INCLUDING VALVE FAILURE).

**ACCEPTANCE:**

- NITROGEN REGULATORS ARE TESTED PRIOR TO INSTALLATION INTO WSB ASSEMBLY AS FOLLOWS: PROOF TEST AND REGULATION/FLOW TEST (INLET PRESS VS FLOW/OUT PRESS).
- 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 NITROGEN PROOF PRESSURE TEST-TESTED AT 4770 PSIG FOR 15 MINUTES MINIMUM WITH HELIUM AND WITH CIRCUIT RELIEF VALVE PREVENTED FROM OPENING. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND NITROGEN CIRCUIT LEAK CHECKS.
- HIGH SIDE N2 LEAK CHECK-TESTED AT 3180 PSIG WITH HELIUM AND CIRCUIT R/V PREVENTED FROM OPENING. 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.

**GROUND TURNAROUND TEST**

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

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**(C) INSPECTION:**

**RECEIVING INSPECTION**

RAW MATERIALS ARE VERIFIED BY LAB ANALYSIS. VERIFICATION OF MATERIAL AND EQUIPMENT CONFORMING TO CONTRACTS IS PERFORMED BY INSPECTION.

**CONTAMINATION CONTROL**

CLEANLINESS OF NITROGEN LINES IS VERIFIED BY INSPECTION. CONTAMINATION CONTROL PROCESSES AND PLANS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

TORQUING PER DRAWING REQUIREMENTS IS VERIFIED BY INSPECTION. MANUFACTURING, INSTALLATION, AND ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. PART PROTECTION, COATING, AND PLATING ARE VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

WELDING IS VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**

X-RAY AND PENETRANT INSPECTION ARE VERIFIED BY INSPECTION.

**TESTING**

INSPECTION POINTS PERFORMED DURING ACCEPTANCE TESTING ARE VERIFIED BY INSPECTION.

**HANDLING/PACKAGING**

PROPER HANDLING AND STORAGE ENVIRONMENT 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:**

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  
TECHNICAL APPROVAL

. BNA  
. VIA APPROVAL FORM

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: 95-CIL-009\_06-3A