

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE  
NUMBER: 06-3A-0605 -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 607
SRU	: WATER SUPPLY VALVE	SV766507-1

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
WATER SUPPLY VALVE

**QUANTITY OF LIKE ITEMS: 6**  
TWO EACH BOILER ASSEMBLY

**FUNCTION:**  
ELECTRICALLY OPERATED WATER CONTROL VALVE TO REGULATE THE RATE OF WATER SUPPLIED TO THE HYDRAULIC AND APU LUBE OIL HEAT EXCHANGER SECTION, ALSO ISOLATES WATER FROM THE HEAT EXCHANGER DURING ORBITAL OPERATIONS. VALVE HAS REDUNDANT COILS.

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NUMBER: 06-3A-0605- 03

REVISION#: 1 08/25/98

SUBSYSTEM NAME: ATCS - WATER SPRAY BOILER

LRU: WATER SPRAY BOILER ASSEMBLY

ITEM NAME: WATER SUPPLY VALVE

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

LEAKAGE, EXTERNAL (WATER)

**MISSION PHASE:**

LO LIFT-OFF

DO DE-ORBIT

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

**CAUSE:**

MECHANICAL SHOCK, VIBRATION, CORROSION, POROSITY

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

**PASS/FAIL RATIONALE:**

A)

B)

C)

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

LOSS OF WATER IN TANK - UNABLE TO PROVIDE THERMAL CONTROL IN ONE APU LUBE OIL/HYD SYSTEM.

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

POSSIBLE LOSS OR LIMITED RUN TIME OF ONE APU/HYD SYSTEM DUE TO PREMATURE DEPLETION OF WATER SUPPLY. 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:**

POSSIBLE ABORT DECISION IF APU COOLING IS LOST - REMAINING TWO SYSTEMS PROVIDE SAFE RETURN.

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

NO EFFECT

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

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

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

VALVE BODIES ARE FABRICATED FROM A 304L STAINLESS STEEL WELDED TO EBRITE 26-1. THE VALVE'S EXTERNAL EBRITE SURFACES ARE COATED WITH A 0.020 INCH MINIMUM THICKNESS SILICONE FOR CORROSION PROTECTION. DESIGN SAFETY FACTOR PROOF PRESSURE OF 1.5 AND BURST OF 2.0.

**(B) TEST:**

**QUALIFICATION:**

- 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. HYDRAULIC AND APU LUBE OIL CIRCUITS PRESSURIZED TO MAX OPERATING PRESSURE THROUGHOUT TEST. PASS/FAIL CRITERIA. NO DAMAGE

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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 RECORD TEST.
- 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 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).
- WATER CIRCUIT BURST TEST-TESTED AT 67 PSIG FOR 1 MINUTE MINIMUM. PASS/FAIL CRITERIA: NO EVIDENCE OF LEAKAGE.

**ACCEPTANCE:**

- COMPONENTS FUNCTIONALLY TESTED PRIOR TO WSB ASSEMBLY AS FOLLOWS:
  - WATER SPRAY VALVES-FLOW DELTA PRESSURE TEST, PULSING TEST, INSULATION RESISTANCE TEST, INTERNAL/EXTERNAL LEAK TESTS (PER SPEC SE-G-0020), AND PROOF TEST
- 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).
- WATER CIRCUIT PROOF CHECK-PROOFED TO 51 PSIG MIN WITH NITROGEN.
- PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER CIRCUIT LEAK CHECK.
- WATER CIRCUIT LEAK CHECK-AT MAX WATER OPERATING PRESS (33.5 PSIG) WITH HELIUM. PASS/FAIL CRITERIA: 0.933 SCC/MIN MAX HELIUM LEAKAGE.
- CLEANLINESS-VERIFICATION OF WATER SYSTEM CLEANLINESS BY CONTAMINATION SAMPLE PRIOR TO FINAL ATP TESTING (WATER CLEANLINESS SPEC SE-S-0073).

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- 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.

**PRELAUNCH:**

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

**GROUND TURNAROUND TEST**

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

**(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 WATER 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**

EXAMINATION OF SURFACE WELDS FOR SURFACE AND SUBSURFACE DEFECTS IS VERIFIED BY X-RAY AND DYE PENETRANT 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. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE.

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(AC8842-010) INTERGRANULAR CORROSION RESULTED IN FAILURE OF TWO VALVES TO PASS THEIR INSULATION RESISTANCE TEST WHILE A WSB WAS BEING REACCEPTANCE TESTED AT THE SUBCONTRACTOR FOLLOWING EMI MODIFICATION. CORROSION ALLOWED WATER TO ENTER COIL AREA RESULTING IN A LOW RESISTANCE TO GROUND CORROSION CAUSED BY A CONTAMINATED LOT OF VALVE JACKETS. THREE OF EIGHT VALVES FROM THIS LOT HAVE EXPERIENCED CORROSION. FOUR WERE INSTALLED IN WSB S/N'S 00003, 00004 (REF VALVE S/N'S 004, 006, 008 AND 011), AND ONE VALVE IS INSTALLED IN WSB S/N 00014 (REF VALVE S/N 023). CORRECTIVE ACTION: WSB H2O SPRAY VALVES IR TEST (V58ALO.040) IS BEING PERFORMED AT INTERVALS OF 5 FLIGHTS PER VEHICLE TO CHECK FOR RESISTANCE BETWEEN COILS AND FROM COIL TO GROUND OF EACH WATER SPRAY VALVE. VALVES WILL BE CHANGED OUT ON AN ATTRITION BASIS.

**(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  
TECHNICAL APPROVAL

: BNA  
: VIA APPROVAL FORM

: *J. Kimura 8-25-98*  
: 95-CIL-009\_06-3A