

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 06-3A-0605 -X**

SUBSYSTEM NAME: ACTIVE THERMAL CONTROL

REVISION: 0 02/04/88

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: WATER SPRAY BOILER ASSEMBLY	MC250-0019 ITEM 607
SRU	: WATER SUPPLY VALVE	SV766507-1

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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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:

FAILS TO CLOSE OR INTERNAL LEAKAGE THRU VALVE

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, PHYSICAL BINDING/JAMMING,
CONTAMINATION, DAMAGED SPRING/SEAT**

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 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 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:

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

-DISPOSITION RATIONALE-

(A) DESIGN:

40 MICRON FILTER IS INCORPORATED AT THE INLET TO EACH WATER SUPPLY VALVE. VALVE'S POPPET SEALING SURFACE IS VITON AND THE ASSEMBLY IS SPRING LOADED CLOSED BY MEANS OF A WAVE SPRING ONTO A DOUBLE KNIFE EDGE SEAT. VALVE HOUSING IS 304L STAINLESS STEEL/EBRITE 26-1. VALVE ARMATURE IS EBRITE 26-1. VALVE'S WAVE SPRING IS 302 STAINLESS STEEL. VALVE IS NORMALLY CLOSED, REQUIRING ELECTRICAL SIGNAL TO OPEN. UPON REMOVAL OF SIGNAL, INTERNAL SPRING FORCE PLUS WATER FORCE CLOSES VALVE. WSB WATER CONSUMPTION IS APPROXIMATELY 35 PERCENT OF LOADED WATER FOR A NOMINAL MISSION.

(B) TEST:

QUALIFICATION:

- RANDOM VIBRATION TEST (BOILER AND VENT AREA) - ACCELERATION SPECTRAL DENSITY INCREASING AT RATE OF 6 DB/OCT AVE FROM 20 TO 50 HZ; CONSTANT AT 0.01 (G SQ)/HZ FROM 50 TO 2000 HZ FOR 48 MINUTES/AXIS (100 MISSION)

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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 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:
 - WATER CIRCUIT LEAK CHECK - TESTED AT 33.5 PSIG WITH HELIUM. PASS/FAIL CRITERIA: 0.933 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.
- MISSION PROFILE TEST AT ALTITUDE - SIMULATION OF A BASELINE FLIGHT PROFILE AT MAXIMUM HEAT LOAD AND NORMAL OPERATION TO VERIFY PROPER WSB PERFORMANCE (INCLUDE 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 WATER 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, PROOF TEST, AND PULL-IN AND DROP-OUT VOLTAGE TESTS.
- 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 PRESSURE TEST - TESTED AT 51 PSIG FOR 15 MINUTES MINIMUM WITH NITROGEN. PASS/FAIL CRITERIA: NO PERMANENT DEFORMATION PLUS PASSAGE OF SUBSEQUENT WATER AND NITROGEN CKT LEAK CHECKS.
- WATER CIRCUIT LEAK CHECK: AT MAX WATER OPERATING PRESS (33.5 PSIG) WITH HELIUM, 0.933 SCC/MIN MAX HELIUM LEAKAGE.

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- **CLEANLINESS - VERIFICATION OF WATER SYSTEM CLEANLINESS BY CONTAMINATION SAMPLE PRIOR TO FINAL ATP TESTING (WATER CLEANLINESS SPEC SE-S-0073)**
- **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**
- **CLEANLINESS - VERIFICATION OF WATER TANK CLEANLINESS BY CONTAMINATION SAMPLE (100 CC) AFTER FINAL TESTING (WATER CLEANLINESS SPEC SE-S-0073)**

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

ALL FLUIDS (WATER) ARE SAMPLED FOR CLEANLINESS. 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.

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(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.

(AC6188-010) WATER SUPPLY VALVE EXHIBITED INTERNAL LEAKAGE DURING WSB CHECKOUT ON OV103 PRIOR TO STS-14. THE PROBLEM WAS NOT DUPLICATED AT THE SUBCONTRACTOR BUT INSPECTION WITHIN THE VALVE REVEALED SOME GLASS BEADS OF THE SAME TYPE DETECTED WITHIN TWO OTHER VALVES WHILE THEY WERE BEING ACCEPTANCE TESTED AT THE SUBCONTRACTOR. THE SUBCONTRACTOR'S PROCEDURES WERE REVISED TO ASSURE PROPER MASKING OF ANY FUTURE VALVES PRIOR TO GLASS BEAD PEENING.

(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 START UP IF FAILURE KNOWN PRIOR TO DEORBIT.

- APPROVALS -

EDITORIALLY APPROVED
TECHNICAL APPROVAL

: BNA
: VIA APPROVAL FORM

: J. Kumara 8-25-98
: 95-CIL-009_05-3A