FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 06-3A-0608 -X

SUBSYSTEM NAME: ACTIVE THERMAL CONTROL
REVISION: 0 02/04/88

PART DATA

	PART NAME **VENDOR NAME**	**PART NUMBER** **VENDOR NUMBER**
LRU	: WATER SPRAY BOILER ASSEMBLY	MC250-0019 ITEM 634
SRU	: WATER TANK	SV766504-1

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
WATER TANK

QUANTITY OF LIKE ITEMS: 3
ONE EACH BOILER ASSEMBLY

FUNCTION:
PROVIDES STORAGE OF WATER AND A POSITIVE METHOD OF EXPULSION DURING WATER SPRAY BOILER OPERATION.

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REVISION#: 1 08/25/98

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

FAILURE MODE:
INTERNAL LEAKAGE ACROSS BELLOWS ASSEMBLY, WATER/NITROGEN

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

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:
UNABLE TO COMPLETELY EXPEL WATER FROM STORAGE TANK.

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(B) INTERFACING SUBSYSTEM(S):
POSSIBLE LOSS OR LIMITED RUN TIME OF ONE APU/HYDRAULIC 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:
FUNCTIONAL CRITICALITY EFFECT - POSSIBLE LOSS OF CREW/VEHICLE WITH THIS FAILURE PLUS LOSS OF A SECOND APU/HYD SYSTEM.

-DISPOSITION RATIONALE-

(A) DESIGN:
BELLOWS IS CONSTRUCTED OF INCONEL 718 AND IS TIG WELDED TO THE TANK END FITTING. GN2/REGULATOR RELIEF VALVE PREVENTS SYSTEM OVERPRESSURIZATION. DESIGN SAFETY FACTOR - PROOF PRESSURE OF 1.5 AND BURST OF 2.0. MAXIMUM OPERATING PRESSURE IS 37 PSIG.

(B) TEST:
QUALIFICATION:

- WATER TANK BELLOWS ASSEMBLY IS TESTED TO WITHSTAND 2000 FULL STROKE CYCLES.
- 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 PERCENT AND

AT MAXIMUM OPERATING PRESSURE (FULL GN2 PRESSURE). HYDRAULIC AND APU LUBE OIL CIRCUITS PRESSURIZED TO MAX OPERATING PRESSURE THOUGHOUT 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 VALVE FOR 11 MS NOMINAL DURATION WITH FULL WATER LOAD. PASS/FAIL CRITERIA: UNIT MUST PASS SUBSEQUENT PERFORMANCE RECORD TEST (INCLUDING WATER CIRCUIT PROOF AND LEAK CHECKS, AND N2 PROOF AND LEAK CHECKS).

- 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 COMPLETE WATER LOAD EXPULSION TEST, PLUS A WATER CARRY OVER EFFICIENCY TEST WHICH COMPARES ACTUAL VS 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 TANK FAILURE). UNIT MUST PASS SUBSEQUENT PERFORMANCE TESTS (INCLUDING WATER CIRCUIT PROOF AND LEAK CHECKS, AND N2 CIRCUIT PROOF AND LEAK CHECKS).

ACCEPTANCE:

- WATER TANK COMPONENT TESTED PRIOR TO WSB ASSEMBLY AS FOLLOWS: PROOF TEST (BELLOWS (38 PSIG) AND TANK (58 PSIG) FOR 3 MINUTES), HELIUM LEAK TEST OF BELLOWS AND TANK, BURN IN/RUN IN (10 FULL STROKE CYCLES), TANK VOLUME TEST, AND EXPULSION 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).

- NITROGEN CIRCUIT PROOF TEST - TESTED AT 51 PSIG FOR 15 MINUTES MINIMUM WITH NITROGEN AND CIRCUIT RELIEF VALVE PREVENTED FROM OPENING. . PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND NITROGEN CIRCUIT LEAK CHECKS.

- WATER CIRCUIT PROOF TEST - TESTED AT 51 PSIG FOR 15 MINUTES MINIMUM WITH NITROGEN. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND NITROGEN CIRCUIT LEAK CHECKS.

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- LOW SIDE N2 LEAK CHECK - INCLUDES RELIEF VALVE CRACK TEST FOLLOWED BY N2 LEAK CHECK AT 28 PSIG WITH HELIUM. PASS/FAIL CRITERIA: 2.8 SCCM MAX HELIUM LEAKAGE.

- WATER CIRCUIT LEAK CHECK - TESTED AT 33.5 PSIG WITH HELIUM. PASS/FAIL CRITERIA: 0.933 SCCM MAX HELIUM LEAKAGE.

- CLEANLINESS - VERIFICATION OF WATER SYSTEM CLEANLINESS BY CONTAMINATION SAMPLE PRIOR TO FINAL ATP TESTING (WATER CLEANLINESS SPEC SE-S-0073 PARAGRAPH 6.1, TABLE 6.1).

- 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.

(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
CONTAMINATION CONTROL PROCESSES AND PLANS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION CLEANLINESS OF INTERNAL WATER AND INTERNAL NITROGEN PRIOR TO ASSEMBLY AND AFTER ASSEMBLY ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
EXAMINATION OF SURFACE WELDS FOR SURFACE AND SUBSURFACE DEFECTS IS VERIFIED BY X-RAY AND DYE PENETRANT INSPECTION.

ASSEMBLY/INSTALLATION
MANUFACTURING, INSTALLATION, AND ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. PART PROTECTION, COATING, AND PLATING ARE VERIFIED BY INSPECTION.

TESTING
INSPECTION POINTS PERFORMED DURING ACCEPTANCE TESTING ARE VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PROPER HANDLING AND STORAGE ENVIRONMENT IS 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.

(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.

- APPROVALS -

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