FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 06-3A-0610 -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 612
SRU	: HYDRAULIC BYPASS/RELIEF VALVE	SV766502-2

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HYDRAULIC BYPASS/RELIEF VALVE

QUANTITY OF LIKE ITEMS: 3
ONE EACH BOILER ASSEMBLY

FUNCTION:
PROVIDES CAPABILITY TO BYPASS THE HYDRAULIC HEAT EXCHANGER SECTION DURING PERIODS WHEN HYDRAULIC COOLING IS NOT REQUIRED AND RELIEF VALVE LIMITS THE PRESSURE DROP ACROSS THE SPRAY BOILER FOR HIGH FLOW CONDITIONS.

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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: HYDRAULIC BYPASS/RELIEF VALVE **FAILURE MODE:** 1R2

FAILURE MODE:
FAILS TO OPERATE, BYPASS VALVE FAILS IN BYPASS POSITION

MISSION PHASE: DO DE-ORBIT

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

CAUSE:
MECHANICAL SHOCK, VIBRATION, CORROSION, CONTAMINATION, PHYSICAL BINDING/JAMMING, ELECTRICAL OPEN OR SHORT

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 FUNCTION - UNABLE TO PROVIDE THERMAL CONTROL IN HYDRAULIC SYSTEM. INADEQUATE COOLING WOULD CAUSE EXCESSIVE SPRAYING AND POSSIBLE WATER DEPLETION.

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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):
NO EFFECT

(E) FUNCTIONAL CRITICALITY EFFECTS:
FUNCTIONAL CRITICALITY EFFECT - POSSIBLE LOSS OF CREW/VEHICLE WITH THIS FAILURE PLUS LOSS OF SECOND APU/HYD SYSTEM.

-DISPOSITION RATIONALE-

(A) DESIGN:
BYPASS VALVE IS A SPOOL TYPE VALVE WHICH IS OPERATED BY AN ELECTRICAL/MECHANICAL ACTUATOR. THE ACTUATOR INCORPORATES REDUNDANT MOTORS AND LIMIT SWITCHES WITH EACH DEDICATED TO ONE OF TWO CONTROLLERS. THE VALVE HOUSING IS CONSTRUCTED OF 17-4 PH STAINLESS STEEL, WITH A TEFLON THRUST WASHER. ALL MATERIALS ARE COMPATIBLE WITH WORKING FLUIDS.

(B) TEST:
QUALIFICATION:

- BYPASS VALVE IS FUNCTIONALLY TESTED TO WITHSTAND 2,000 OPERATING CYCLES (BYPASS-HEAT EXCHANGER-BYPASS).

- 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 THROUGHOUT

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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 RECORD TEST (INCLUDING HYDRAULIC CIRCUIT PROOF AND LEAK CHECKS AND DESIGN POINT CHECK).

- PERFORMANCE RECORD TEST INCLUDES:
  - ELECTRICAL POWER CHECK - INCLUDES ELECTRICAL FUNCTIONAL CHECK OF HYDRAULIC BYPASS VALVE
  - 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.

- 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. UNIT MUST PASS SUBSEQUENT PERFORMANCE RECORD TEST (INCLUDING BYPASS VALVE FUNCTIONAL CHECK).

ACCEPTANCE:
- BYPASS VALVE ACTUATOR IS TESTED PRIOR TO ASSEMBLY OF BYPASS VALVE AT 104 VAC.
- BYPASS VALVE COMPONENT TESTED PRIOR TO WSB ASSEMBLY AS FOLLOWS: HOUSING PROOF TESTING, HELIUM LEAKAGE TEST, PERFORMANCE TEST (FLOW VERSUS DELTA P IN BYPASS/HEX POSITION), ELECTRICAL POWER TEST (SWITCH VERIFICATION).

- EXAMINATION OF PRODUCT - VERIFICATION OF WORKMANSHIP, FINISH, DIMENSIONS, CONSTRUCTION, CLEANLINESS, IDENTIFICATION, TRACEABILITY LEVEL AND PROCESSES PER DRAWINGS AND MC250-0019 (WSB PROCUREMENT SPEC).

- HYDRAULIC CIRCUIT PROOF TEST - TESTED AT 2250 PSIG FOR 5 MINUTES MINIMUM WITH HYDRAULIC FLUID. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT HYDRAULIC CIRCUIT LEAK CHECK.

- HYDRAULIC CIRCUIT LEAK CHECK - TESTED AT 1500 PSIG WITH HYDRAULIC FLUID. PASS/FAIL CRITERIA: NO VISIBLE EVIDENCE OF EXTERNAL LEAKAGE AND NO PRESSURE DECAY.

- ELECTRICAL POWER CHECK - INCLUDES ELECTRICAL FUNCTIONAL CHECK OF HYDRAULIC BYPASS VALVE.

- LOW VOLTAGE VALVE ACTUATION TEST - VERIFICATION OF AUDIBLE VALVE ACTUATION AT 110-112 VAC.

- 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
VERIFY INTERNAL CLEANLINESS OF HYDRAULIC LINES PER SPECIFIED REQUIREMENTS. 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. SEALS ARE VERIFIED BY INSPECTION TO BE ASSEMBLED USING HYDRAULIC FLUID. VERIFICATION THAT SPOOL SEAL HAS NOT BEEN EXTRUDED AT LOWER LEVEL OF ASSEMBLY IS 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. ELECTRICAL POWER TO BYPASS VALVE IS VERIFIED TO BE WITHIN SPECIFIED LIMITS BY INSPECTION.

HANDLING/PACKAGING
PROPER HANDLING AND STORAGE ENVIRONMENT IS 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

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FOUND IN THE PRACA DATA BASE. THE FAILURE HISTORY DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE.

(07F014-010) (1983, OV099) DURING DESCENT OF STS-7, THE NO. 3 WSB (S/N 00007) VENTED ALMOST ALL OF IT'S COOLING WATER AND FAILED TO COOL HYDRAULIC FLUID PROPERLY FLIGHT DATA INDICATED A PROBLEM WITH THE BYPASS VALVE ALTHOUGH THE FAILURE ANALYSIS RESULTS WERE INCONCLUSIVE. THE BYPASS VALVE ACTUATOR (S/N 04) WAS REMOVED FROM THE ASSEMBLY AND RETESTED SUCCESSFULLY. THE WSB FUNCTIONED PROPERLY WITH A REPLACEMENT ACTUATOR.

(AD0927-010) (1986, 0V102) DURING DESCENT OF STS-61C, THE NO 1 WSB (S/N 00004) EXPERIENCED A FAILURE SIMILAR TO THE PROBLEM ENCOUNTERED DURING STS-7. SUBSEQUENT VALVE DISASSEMBLY REVEALED THAT THE BYPASS VALVE SPOOL WAS MANUFACTURED OUT OF TOLERANCE (TOO LONG). THIS CAUSED BINDING AND THE VALVE FAILED IN THE BYPASS POSITION. THIS PREVENTED COOLING OF THE HYDRAULIC FLUID AND THE CONTROLLER COMMANDED CONTINUED SPRAYING, RESULTING IN WATER DEPLETION. CORRECTIVE ACTION: THE VALVE SPOOL FREEPLAY IS BEING MEASURED ON THE BYPASS VALVES ON ALL OTHER WSB'S.

(E) OPERATIONAL USE:
SHUTDOWN AFFECTED APU/HYD SYSTEM OR DELAY APU START IF FAILURE KNOWN PRIOR TO DE-ORBIT.

- APPROVALS -

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