FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 06-3A-0603 -X

SUBSYSTEM NAME: ACTIVE THERMAL CONTROL

REVISION: C 02/04/88

PART DATA

	PART NAME **VENDOR NAME**	**PART NUMBER** **VENDOR NUMBER**
LRU	: WATER SPRAY BOILER ASSEMBLY	MC250-0019 ITEM 633
SRU	: HEAT EXCHANGER ASSEMBLY	SV766503-2

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HEAT EXCHANGER ASSEMBLY

QUANTITY OF LIKE ITEMS: 3
ONE EACH BOILER ASSEMBLY

FUNCTION:
PROVIDES TRANSFER OF WASTE HEAT FROM ORBITER HYDRAULIC SYSTEM AND AUXILIARY POWER UNIT LUBE OIL SYSTEM UTILIZING LATENT HEAT CAPACITY OF WATER.

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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: HEAT EXCHANGER ASSEMBLY **FAILURE MODE:** 1R2

FAILURE MODE:
INTERNAL LEAKAGE INTO CORE SHELL. APU LUBE OIL

MISSION PHASE:
LO LIFT-OFF
DO DE-ORBIT

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

CAUSE:
CORROSION, POROSITY, VIBRATION, MECHANICAL SHOCK

CRITICALITY 1/1 DURING INTACT ABORT ONLY? YES
RTLS RETURN TO LAUNCH SITE

REDUNDANCY SCREEN
A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
POSSIBLE REDUCTION IN THERMAL CONTROL DUE TO LEAKAGE AND OIL ON TUBE SURFACES.

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(B) INTERFACING SUBSYSTEM(S):
POSSIBLE LOSS OR LIMITED RUN TIME OF ONE APU/HYDRAULIC SYSTEM DUE TO LUBE OIL DEPLETION AND LOSS OF COOLING. LIMITED RUN TIME MAY NOT ALLOW 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 NOSE WHEEL 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. CRIT 1 FOR SSME INDUCED RTLS IF LOSS OF APU/HYD SYSTEM OCCURS DURING MAX Q SSME THROTTLE DOWN PHASE DUE TO THIS WSB FAILURE.

-DISPOSITION RATIONALE-

(A) DESIGN:
HEAT EXCHANGER TUBE BUNDLES CONSTRUCTED OF 347 STAINLESS STEEL AND ARE BRAZED TO HEADER ASSEMBLIES. EACH TUBE BUNDLE INCORPORATES 4 TUBE SUPPORTS FOR ADDED STRUCTURAL INTEGRITY. DESIGN SAFETY FACTOR - PROOF OF 1.5 AND BURST OF 2.0. NORMAL OPERATING PRESSURE OF APU LUBE OIL TUBES IS 40 - 60 PSIA. THE TUBES ARE 0.125 INCHES OUTSIDE DIAMETER WITH A WALL THICKNESS OF 0.010 INCHES.

(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

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OPERATING PRESSURE. APU LUBE OIL CIRCUIT 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 20 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.
  - APU LUBE OIL CIRCUIT LEAK CHECK-TESTED FOR 1 HOUR AT 150 PSIG WITH LUBE OIL. PASS/FAIL CRITERIA: NO VISIBLE EVIDENCE OF EXTERNAL LEAK

  - DESIGN POINT CHECK-VERIFICATION OF WSB SYSTEM OPERATING
  - PARAMETERS (INCLUDING LUBE OIL TEMP/PRESS) 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 (INCLUDES APU LUBE OIL LINE FITTING LEAKAGE).

- APU CIRCUIT BURST TEST-TESTED AT 300 PSIG FOR 1 MINUTE. PASS/FAIL CRITERIA: NO EVIDENCE OF LEAKAGE.

ACCEPTANCE:
- INDIVIDUAL TUBES ARE TESTED PRIOR TO ASSEMBLY AS FOLLOWS:

  - HYD/APU FLUID TUBES PRESSURE TESTED TO 2250 PSIG WITH HELIUM AFTER CRIMPING.

- 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.)

- LUBE OIL CIRCUIT PROOF PRESS TEST-TESTED FOR 15 MINUTES AT 225 PSIG WITH LUBE OIL. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT LEAK CHECKS.

- LUBE OIL CIRCUIT LEAK CHECK-TESTED FOR 1 HOUR AT 150 PSIG WITH LUBE OIL PASS/FAIL CRITERIA: NO VISIBLE EVIDENCE OF EXTERNAL LEAK (NO PRESSURE DECAY).

- CLEANLINESS - VERIFICATION OF APU LUBE OIL SYSTEM CLEANLINESS BY CONTAMINATION SAMPLE UPON COMPLETION OF WSB ATP AND PREP FOR SHIPMENT (LUBE OIL-CLEANLINESS LEVEL 300).

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- DESIGN POINT CHECK-VERIFICATION OF WSB SYSTEM OPERATING PARAMETERS (INCLUDING LUBE OIL TEMP PRESS) 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.

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 (APU LUBE OIL) ARE SAMPLED FOR CLEANLINESS. CONTAMINATION CONTROL PROCESSES AND PLANS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION. INTERNAL CLEANLINESS OF APU LUBE OIL LINES IS 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
BRAZING IS VERIFIED BY INSPECTION AS BEING IN ACCORDANCE WITH REQUIREMENTS.

NONDESTRUCTIVE EVALUATION
EXAMINATION OF WELDED AND BRAZED JOINTS FOR SURFACE AND SUB-SURFACE DEFECTS IS VERIFIED BY X-RAY AND PENETRANT INSPECTION.

TESTING
ACCEPTANCE TEST IS 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.

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(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