FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 06-3A-0606 -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 608
SRU	: NITROGEN SHUTOFF VALVE	SV766508-1

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
NITROGEN SHUTOFF VALVE

QUANTITY OF LIKE ITEMS: 3
ONE EACH BOILER ASSEMBLY

FUNCTION:
ELECTRICALLY OPERATED SHUTOFF VALVE TO ISOLATE THE NITROGEN SUPPLY DURING DORMANT MISSION MODES AND GROUND OPERATION

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REVISION#: 1 08/25/98

SUBSYSTEM NAME: ATCS - WATER SPRAY BOILER
LRU: WATER SPRAY BOILER ASSEMBLY
ITEM NAME: NITROGEN SHUTOFF VALVE

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
FAILS TO OPEN OR RESTRICTED FLOW

MISSION PHASE: DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
MECHANICAL SHOCK, VIBRATION, CORROSION, PHYSICAL BINDING/JAMMING, CONTAMINATION, ELECTRICAL 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 ONE APU LUBE OIL/HYD SYSTEM DUE TO LOSS OF CAPABILITY TO EXPEL WATER FROM THE STORAGE TANK.

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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):
SAME AS C.

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

-DISPOSITION RATIONALE-

(A) DESIGN:
10 MICRON FILTER IS INCORPORATED AT THE INLET TO EACH NITROGEN SHUTOFF VALVE. BI-FILAR WOUND SOLENOID WINDINGS PERMIT VALVE ACTUATION FROM EITHER CONTROLLER AND THE VALVE IS MAGNETICALLY LATCHED IN THE OPEN OR CLOSED POSITION. VALVE HOUSING IS MADE UP OF 304L/17-4 PH STAINLESS STEEL. SHOULD VALVE FAIL TO OPEN, REMAINING PRESSURE DOWNSTREAM OF GN2 SHUTOFF VALVE WOULD ALLOW LIMITED COOLING AND SUPPORT NOMINAL ASCENT PHASE. PROBABLY WOULD NOT SUPPORT ENTRY PHASE.

(B) TEST:
QUALIFICATION:

- NITROGEN VALVE LOW VOLTAGE TEST - VERIFY MAX PULL IN VOLTAGE OF 18 VDC.
- 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. (FULL GN2 PRESSURE) HYDRAULIC AND APU LUBE OIL

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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 RECORD TEST.

- PERFORMANCE RECORD TEST INCLUDES:
  - ELECTRICAL POWER CHECK - INCLUDES ELECTRICAL FUNCTIONAL CHECK OF GN2 SHUTOFF VALVE.

  - 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 F 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).

ACCEPTANCE:

- GN2 SHUTOFF VALVE COMPONENT TESTED PRIOR TO WSB ASSEMBLY AS FOLLOWS: PROOF TESTED, LEAK CHECKED (INTERNAL/EXTERNAL), FUNCTIONAL CHECKOUT (FLOW VERSUS DELTA P WITH N2), PLUS VERIFY MAX PULL IN VOLTAGE OF 18 VDC.

- 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).

- HIGH SIDE NITROGEN PROOF PRESSURE TEST-TESTED AT 4770 PSIG FOR 15 MINUTES MINIMUM WITH HELIUM AND WITH CIRCUIT RELIEF VALVE PREVENTED FROM OPENING. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND NITROGEN CIRCUIT LEAK CHECKS.

- ELECTRICAL POWER CHECK - INCLUDES ELECTRICAL FUNCTIONAL CHECK OF NITROGEN SHUTOFF VALVE.

- LOW VOLTAGE VALVE ACTUATION TEST - VERIFICATION OF AUDIBLE VALVE ACTUATION AT 24 VDC (APPLIED TO CONTROLLER).

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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, 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
CLEANLINESS OF NITROGEN 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.

(E) OPERATIONAL USE:
ASCENT: NONE

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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