

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- GIL HARDWARE

NUMBER: 06-3A-0607 -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 609
SRU	: NITROGEN REGULATOR	SV766509-1

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

NITROGEN REGULATOR

QUANTITY OF LIKE ITEMS: 3

ONE EACH BOILER ASSEMBLY

FUNCTION:

PROVIDES NITROGEN UPON DEMAND TO THE WATER STORAGE TANK. A BUILT IN RELIEF VALVE PREVENTS OVER PRESSURIZATION OF SYSTEM DOWNSTREAM OF REGULATOR.

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REVISION#: 1 08/25/98

SUBSYSTEM NAME: ATCS - WATER SPRAY BOILER

LRU: WATER SPRAY BOILER ASSEMBLY

ITEM NAME: NITROGEN REGULATOR

CRITICALITY OF THIS

FAILURE MODE: 1R2

FAILURE MODE:

EXTERNAL LEAKAGE

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, POROSITY

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. NO WATER EXPULSION CAPABILITY.

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(B) INTERFACING SUBSYSTEM(S):

POSSIBLE LOSS OR LIMITED RUN TIME OF ONE APU/HYD SYSTEM DUE TO LOSS OF COOLING CAPABILITY. 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:

POSSIBLE LOSS OF CREW/VEHICLE WITH THIS FAILURE PLUS LOSS OF A SECOND APU/HYD SYSTEM

-DISPOSITION RATIONALE-

(A) DESIGN:

VALVE BODY IS FABRICATED FROM 304 STAINLESS STEEL AND ASSEMBLED WITH LOCK-WIRED FASTENERS. DESIGN SAFETY FACTOR - PROOF PRESSURE OF 1.5 AND BURST OF 2.0.

(B) TEST:

QUALIFICATION:

- NITROGEN REGULATORS SUBJECTED TO 10,000 OPERATIONAL 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

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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 RECORD TEST.
- 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 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 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:

- NITROGEN REGULATORS ARE TESTED PRIOR TO INSTALLATION INTO WSB ASSEMBLY AS FOLLOWS: PROOF TEST, LEAK TEST (SEAT LEAK AND EXTERNAL LEAK).
- 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 N2 PROOF TEST - TESTED AT 4770 PSIG FOR 15 MINUTES WITH HELIUM AND CIRCUIT RELIEF VALVE PREVENTED FROM OPENING (REGULATOR PRESSURE IS MONITORED DURING TEST). PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND N2 CIRCUIT LEAK CHECKS.
- LOW SIDE N2 PROOF TEST - TESTED AT 51 PSIG FOR 15 MINUTES WITH HELIUM AND CIRCUIT RELIEF VALVE PREVENTED FROM OPENING. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF SUBSEQUENT WATER AND N2 CIRCUIT LEAK CHECKS.
- HIGH SIDE N2 LEAK CHECK - TESTED AT 3180 PSIG WITH HELIUM AND CIRCUIT RELIEF VALVE PREVENTED FROM OPENING (REGULATOR PRESSURE IS MONITORED DURING TEST). PASS/FAIL CRITERIA: 2.8 SCCM MAXIMUM HELIUM LEAKAGE.

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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.
- 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.

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

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

X-RAY AND PENETRANT INSPECTION ARE VERIFIED BY 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:

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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.

(AB0250-010) (1978) WHILE PRESSURIZING THE GN2 SYSTEM WITH HELIUM, LEAKAGE WAS NOTED AT THE INTERFACE OF THE INLET PORT OF THE REGULATORS S/N 4 (QUALIFICATION REGULATOR), 5 (PRODUCTION REGULATOR), 6 (PRODUCTION REGULATOR). LEAKAGE CONDITION WAS VERIFIED AT THE VENDOR. UNITS WERE DISASSEMBLED AND IT WAS FOUND THAT THE SILICONE "O" RING HAD EXTRUDED AROUND THE INTERNAL DIAMETER OF THE BACKUP RING AND OUTSIDE DIAMETER OF THE GOOVE. THE SEAL GROOVE DIMENSIONS WERE VERIFIED TO BE IN SPEC BASED ON THE EXISTING DIAMETRAL CLEARANCE BETWEEN THE KEL-F BACKUP RING AND THE GROOVE DIAMETERS. IT WAS DETERMINED THAT SILICONE "O" RINGS CAN EXTRUDE AT THE REGULATOR INLET PRESSURES. THEREFORE ETHYLENE PROPYLENE (EPR) "O" RINGS, WHICH HAVE A SLIGHTLY HIGHER DUROMETER AND GREATER TEAR RESISTANCE, WERE SUBSTITUTED FOR THE SILICONE "O" RINGS. THE UNITS WERE SUBSEQUENTLY PROOF AND LEAK TESTED SUCCESSFULLY, AND THE MATERIAL CHANGE WAS INCORPORATED INTO THE WSB DESIGN.

(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
TECHNICAL APPROVAL

: BNA
: VIA APPROVAL FORM

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