

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: 06-3B-0401-X****SUBSYSTEM NAME: ATCS - AMMONIA BOILER SYSTEM****REVISION: 1 08/25/93 W**

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	<b>PART NAME VENDOR NAME</b>	<b>PART NUMBER VENDOR NUMBER</b>
<b>LRU</b>	<b>: AMMONIA BOILER SUB-SYSTEM</b>	<b>MC250-0005-0007 74716050</b>
<b>SRU</b>	<b>: BOILER, AMMONIA</b>	<b>74716050</b>

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**PART DATA**

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
BOILER, AMMONIA****QUANTITY OF LIKE ITEMS: 1  
ONE****FUNCTION:  
PROVIDES COOLING FOR FREON COOLANT LOOPS WITH VAPORIZATION OF AMMONIA  
AS THE COOLING SOURCE. THE AMMONIA BOILER SYSTEM IS USED DURING  
POSTLANDING OPERATIONS, LAUNCH ABORTS, AND AS A BACKUP DURING NORMAL  
DEORBITS.**

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE  
NUMBER: 06-JB-0401-03**

REVISION: 1 08/25/93 W

SUBSYSTEM NAME: ATCS - AMMONIA BOILER SYSTEM  
LRU: AMMONIA BOILER SUB-SYSTEM  
ITEM NAME: BOILER, AMMONIA

CRITICALITY OF THIS  
FAILURE MODE: 1R2

**FAILURE MODE:**  
INTERNAL LEAKAGE, FREON TO AMMONIA

**MISSION PHASE:**  
LO LIFT-OFF  
OO ON-ORBIT  
DO DE-ORBIT

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

**CAUSE:**  
CORROSION, MECHANICAL SHOCK, VIBRATION

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

**REDUNDANCY SCREEN** A) PASS  
B) PASS  
C) FAIL

**PASS/FAIL RATIONALE:**  
A)

B)

C)  
FAILS SCREEN "C" BECAUSE A SINGLE SOURCE OF CHLORIDE CONTAMINATION IN AMMONIA CAN CAUSE CORROSION IN BOTH FREON LOOPS RESULTING IN POSSIBLE LOSS OF REDUNDANT LOOP.

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**  
LOSS OF ONE FREON LOOP. FREON WILL VENT OUT THE AMMONIA VENT.

**(B) INTERFACING SUBSYSTEM(S):**  
LOSS OF ONE FREON COOLANT LOOP FOR VEHICLE COOLING. SOME NEGLIGIBLE ADDITIONAL UNCONTROLLED COOLING.

**(C) MISSION:**  
POSSIBLE LOSS OF MISSION. EARLY MISSION TERMINATION MAY BE REQUIRED FOR FIRST FAILURE.

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**(D) CREW, VEHICLE, AND ELEMENT(S):**

SECOND ASSOCIATED FAILURE (LOSS OF REDUNDANT FREON COOLANT LOOP) WILL CAUSE LOSS OF ALL VEHICLE COOLING AND MAY RESULT IN LOSS OF CREW/VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

NONE

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

STANDARD BRAZED TUBE-SHELL CONSTRUCTION. THICKNESS OF NH3 TUBES IS 0.008 INCHES WITH A DIAMETER OF 0.094 INCHES. MATERIALS ARE CRES STAINLESS STEEL, WHICH IS CORROSION RESISTANT AND COMPATIBLE WITH AMMONIA AND FREON 21.

**(B) TEST:**

QUALIFICATION TEST - QUALIFICATION TESTED FOR 100 MISSION LIFE. VIBRATION TESTED AT 0.01 G\*\*2/HZ FOR 48 MIN/AXIS AND SHOCK TESTED AT +/- 20 G/AXIS.

ACCEPTANCE TEST - THE SHELL-SIDE AND TUBE-SIDE SYSTEMS ARE INDEPENDENTLY LEAK CHECKED BY HELIUM MASS SPECTROMETER DURING ACCEPTANCE TESTS. DESIGN PROOF PRESSURE OF 1.5 AND BURST PRESSURE OF 2.0 TIMES MAXIMUM EXPECTED OPERATING PRESSURE.

OMRSD - AMMONIA AND FREON SAMPLES VERIFIED TO MEET SE-S-0073 REQUIREMENTS PRIOR TO SERVICING. FREON COOLANT LOOP PRESSURE DECAY LEAK CHECKS PERFORMED PRIOR TO EACH FLIGHT.

**(C) INSPECTION:**

**RECEIVING INSPECTION**

RAW MATERIAL CERTIFICATION VERIFIED BY INSPECTION. PART PROTECTION, COATING AND PLATING PROCESSES ARE VERIFIED BY INSPECTION.

**CONTAMINATION CONTROL**

CONTAMINATION CONTROL PROCESSES, CONTAMINATION CONTROL PLAN, AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION. SYSTEM FLUID SAMPLES FOR CONTAMINATION VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

MANUFACTURING, INSTALLATION, AND ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION PENETRANT INSPECTION OF INDUCTION BRAZED JOINTS IS VERIFIED.

**CRITICAL PROCESSES**

TUBE BRAZING PROCESS IS VERIFIED BY INSPECTION. PASSIVATION OF CRES MATERIALS IS VERIFIED BY INSPECTION.

**TESTING**

FLOWRATES ARE VERIFIED TO SPECIFIED LIMITS BY INSPECTION.

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**HANDLING/PACKAGING**

HANDLING AND STORAGE ENVIRONMENTS ARE VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

(CAR AB9436) LEAKAGE WAS DETECTED DURING IN-PROCESS LEAK CHECK AFTER FINAL BRAZE. TUBING WAS FOUND TO BE 304 CRES STEEL INSTEAD OF 304L, WHICH MAY HAVE BEEN CAUSED BY REDRAWING OF TUBING. CORRECTIVE ACTION WAS A DESIGN CHANGE TO USE AUSTENITIC 347 STAINLESS STEEL TUBING AND A PROCEDURE CHANGE TO MINIMIZE GRAIN GROWTH.

(CAR AB8042) DURING QUALIFICATION TEST, FREON LEAKED INTO THE AMMONIA SYSTEM THROUGH CORROSION PITS IN THE AMMONIA TUBE WALLS. THESE PITS WERE CAUSED BY EXCESSIVE WATER IN THE FREON. CORRECTIVE ACTION WAS TO CONTROL THE WATER AND CHLORIDE CONTENT OF THE FREON.

(CAR AD7659) FREON LEAKAGE (FCL 1) INTO AMMONIA SIDE OF HEAT EXCHANGER ON OV-103 PRIOR TO STS-41. LEAKAGE CAUSED BY CHLORIDE-INDUCED CORROSION. THIS PROBLEM IS TRACKED ON CAR KP0002.

(CAR KP0002) FCL 2 LEAKAGE IN AMMONIA HEAT EXCHANGER ON OV-102 DURING FERRY FLIGHT TO PALMDALE FOR MAJOR MOD. LEAKAGE CAUSED BY CHLORIDE-INDUCED CORROSION ON AMMONIA SIDE OF TUBING. CORRECTIVE ACTION INCLUDES A REQUIREMENT OF NO MORE THAN 4 PPM CHLORIDES IN AMMONIA SUPPLY.

(CAR AD8233) FCL 2 ALSO FOUND TO LEAK DURING FAILURE INVESTIGATION OF OV-103 HEAT EXCHANGER LEAKAGE (REF. CAR AD7659). CAUSE IDENTIFIED AS CHLORIDE-INDUCED CORROSION. THIS PROBLEM IS TRACKED ON CAR KP0002.

**(E) OPERATIONAL USE:**

ON-BOARD ALARMS, FREON INLET PRESSURE AND ACCUMULATOR QUANTITY, WILL PROVIDE INDICATION OF HARDWARE FAILURE. FREON PUMP WILL BE TURNED OFF AND LOSS OF ONE FREON LOOP POWERDOWN WILL BE PERFORMED. ENTRY AT NEXT PRIMARY LANDING SITE.

**- APPROVALS -**

EDITORIALLY APPROVED  
EDITORIALLY APPROVED  
TECHNICAL APPROVAL

: RI  
: JSC  
: VIA CR

*Handwritten signature and date: 8/25/93*  
*Handwritten signature and date: 8/27/93*  
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