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PRINT DATE: 08/30/93

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: 06-1B-0557-X**

SUBSYSTEM NAME: ARS - COOLING

REVISION: 4 08/25/93

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|     | PART NAME<br>VENDOR NAME                   | PART NUMBER<br>VENDOR NUMBER |
|-----|--|------------------------------|
| LRU | : HEAT EXCHANGER, IMU<br>HAMILTON STANDARD | MC621-0008-0017<br>SV767215  |

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**PART DATA**

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

**QUANTITY OF LIKE ITEMS: 1**

**FUNCTION:**

HEAT EXCHANGER, INERTIAL MEASUREMENT UNITS (IMU)

PROVIDES FOR REMOVAL OF IMU HEAT. THIS HEAT EXCHANGER COOLS THE AIR AFTER PASSING OVER THE IMU'S, BEFORE RETURNING TO THE CABIN. THE HEAT EXCHANGER TRANSFERS THIS HEAT TO THE WATER COOLANT LOOPS.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE  
NUMBER: 06-18-0557-06**

REVISION# 4 08/25/93 R

SUBSYSTEM: ARS - COOLING  
LRU: HEAT EXCHANGER, IMU  
ITEM NAME: HEAT EXCHANGER, IMU

CRITICALITY OF THIS  
FAILURE MODE: 2/2

**FAILURE MODE:**  
RESTRICTED FLOW, AIR

**MISSION PHASE:**

LQ LIFT-OFF  
OO ON-ORBIT  
DO DE-ORBIT

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

**CAUSE:**  
MECHANICAL SHOCK, VIBRATION, CONTAMINATION

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

**REDUNDANCY SCREEN** A) N/A  
B) N/A  
C) N/A

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

INCREASED IMU FAN DELTA P. REDUCED IMU COOLING UNTIL CORRECTING ACTION (C/A) IS IMPLEMENTED.

**(B) INTERFACING SUBSYSTEM(S):**

INCREASED TEMPERATURE IN CABIN. C/A RESULTS IN IMU FAN OUTLET AIR RETURNING DIRECTLY TO CABIN WITHOUT BEING COOLED.

**(C) MISSION:**

POSSIBLE LOSS OF MISSION OBJECTIVES IF PAYLOADS HAVE TO BE POWERED DOWN TO REDUCE CABIN TEMPERATURE.

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

NO EFFECT. C/A WILL PRECLUDE LOSS OF CREW/VEHICLE.

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**(E) FUNCTIONAL CRITICALITY EFFECTS:**

**-DISPOSITION RATIONALE-**

**(A) DESIGN:**

HEAT EXCHANGER IS AN OVEN-BRAZED CRES PLATE-FIN UNIT. HEADER, BOSSES AND FLUID LINES WELDED ON THE PLATE-FIN CORE. THE HEAT TRANSFER FLUID IS HIGH PURITY/LOW OXYGEN CONTENT WATER. SINCE THE HEAT EXCHANGER IS DOWNSTREAM OF THE IMU'S AND FANS, LARGE PIECES OF DEBRIS WILL NOT REACH IT. THERE IS NO SOURCE OF DEBRIS GENERATION BETWEEN THE FAN OUTLET AND THE HEAT EXCHANGER.

**(B) TEST:**

ACCEPTANCE TEST - PERFORMANCE TEST, INCLUDING FLOW VS. DELTA-P, PERFORMED. NET Q (BTU/HR) OF 1553 AT OPERATING FLOW CONDITIONS. PROOF PRESSURE TEST AT 135 PSID. LEAKAGE TEST: INTERNAL AT 90 PSID, 3.2 X 10 EXP -5 SCCS GHE MAX; EXTERNAL AT 90 PSID, 3.2 X 10 EXP -4 SCCS GHE MAX. VISUAL INSPECTION OF AIR AND COOLANT CIRCUITS PERFORMED.

CERTIFICATION - CERTIFIED BY ANALYSIS AND BY SIMILARITY TO AVIONICS BAY HEAT EXCHANGER: VIBRATION CERTIFIED TO A LEVEL OF 20 - 150 HZ, INCREASING AT 6 DB/OCTAVE; 150 - 1000 HZ CONSTANT AT 0.09 G\*\*2/HZ; 1000 - 2000 HZ DECREASING AT 6 DB/OCTAVE FOR 48 MINUTES PER AXIS. SHOCK CERTIFIED TO 20 G TERMINAL SAWTOOTH PULSE OF 11 MS DURATION IN EACH OF THREE ORTHOGONAL AXES. BURST PRESSURE - CERTIFIED BY ANALYSIS TO 180 PSI. HUMIDITY - CERTIFIED BY ANALYSIS TO 200,000 HOURS AT 100% RELATIVE HUMIDITY.

OMRSD - THE IMU MUFFLER IS INSPECTED FOR DEBRIS BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND WHENEVER MUFFLER IS REINSTALLED. IMU FAN DELTA-P IS MONITORED CONTINUOUSLY WHEN IMU'S ARE POWERED UP DURING EACH TURNAROUND AND SERVES AS AN INDICATION OF RESTRICTED FLOW.

**(C) INSPECTION:**

**RECEIVING INSPECTION**

RAW MATERIAL AND PURCHASED COMPONENTS REQUIREMENTS ARE VERIFIED BY INSPECTION. PARTS PROTECTION IS VERIFIED BY INSPECTION.

**CONTAMINATION CONTROL**

SYSTEMS FLUID ANALYSES FOR CONTAMINATION ARE VERIFIED BY INSPECTION. CONTAMINATION CONTROL PLAN IS VERIFIED BY INSPECTION. CONTAMINATION CONTROL PROCESSES AND CLEAN AREAS ARE VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

MANUFACTURING, INSTALLATION AND ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. SHEET METAL PARTS ARE INSPECTED AND VERIFIED BY INSPECTION. SURFACE FINISHES VERIFIED BY INSPECTION. DIMENSIONS VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

WELDING IS VERIFIED BY INSPECTION. ALL WELDS ARE STRESS RELIEVED AFTER WELDING, VERIFIED BY INSPECTION. BRAZING IS VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**

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HEADER WELDS TO THE TUBES ARE PENETRANT AND X-RAY INSPECTED. OTHER WELDS (MOUNTING PADS AND HEADER WELDS TO THE CORES) ARE PENETRANT AND 10X MAGNIFICATION VISUALLY INSPECTED. BRAZES ARE VERIFIED BY PROOF AND LEAK TESTS.

**TESTING**

INSPECTION VERIFIES THAT RESULTS OF ACCEPTANCE TESTING AND FLOWRATES ARE WITHIN SPECIFIED LIMITS.

**HANDLING/PACKAGING**

HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

NO FAILURE HISTORY APPLICABLE TO RESTRICTED FLOW / AIR FAILURE MODE. THE IMU HEAT EXCHANGER HAS SUCCESSFULLY PERFORMED WITHOUT FAILURE THROUGH THE DURATION OF THE SHUTTLE PROGRAM.

**(E) OPERATIONAL USE:**

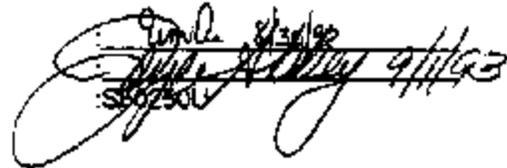
NONE.

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**- APPROVALS -**

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EDITORIALLY APPROVED : RI  
EDITORIALLY APPROVED : JSC  
TECHNICAL APPROVAL : VIA CR



Handwritten signature and date: 8/30/93