

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : ACTIVE THERMAL CONTROL FMEA NO 06-3C -0207 -5 REV: 03/09/81

ASSEMBLY : FREON THERMAL LOOP CRIT. FUNC:  
P/N RI : MC250-0001-0610 CRIT. HDW:  
P/N VENDOR: SV755519 VEHICLE 102 103 104  
EFFECTIVITY: X X X  
QUANTITY : 1 PHASE(S): PL LO X OO DO LS  
: ONE, LOCAL LOOP OPERATION

PREPARED BY: O. TRAN *cat* DES APPROVED BY: *[Signature]* DES REDUNDANCY SCREEN: A- B- C-  
REL D. RISING *rel* REL APPROVED BY (NASA): *[Signature]* SSM 7/18  
QE W. SMITH QE *[Signature]* REL *[Signature]* 9/16  
QE *[Signature]* QE *[Signature]*

ITEM:  
HEAT EXCHANGER, FUEL CELL - FC-40 COOLANT/FREON

FUNCTION:  
TRANSFERS HEAT FROM FUEL CELL COOLANT LOOPS TO FREON LOOPS SO THAT THE FUEL CELLS CAN BE COOLED TO THE PROPER OPERATING TEMPERATURE.

FAILURE MODE:  
LEAKAGE, FC-40 TO FC-40

CAUSE(S):  
MECHANICAL SHOCK, VIBRATION, CORROSION FATIGUE AT BRAZED JOINTS.

EFFECT(S) ON:  
(A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE  
  
(A) THE TWO FC-40 LOOPS WILL BE TIED TOGETHER RESULTING IN FLUID TRANSFER DUE TO PRESSURE IMBALANCE, FILLING ONE FC-40 ACCUMULATOR AND DRAINING THE OTHER FC-40 ACCUMULATOR.  
  
(B,C,D) THERMAL EXPANSION DURING LAUNCH COULD OVERPRESSURIZE THE FULL FUEL CELL ACCUMULATOR. IF ACCUMULATOR RUPTURES, THE EXTERNAL LEAKAGE WILL CAUSE LOSS OF COOLING TO TWO FUEL CELLS. LOSS OF TWO FUEL CELLS DURING ASCENT WILL RESULT IN LOSS OF CREW/VEHICLE.

DISPOSITION & RATIONALE:  
(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE  
  
(A) DESIGN  
THE HEAT EXCHANGER IS MADE FROM STAINLESS STEEL AND NICKEL BRONZE ALLOY WHICH ARE COMPATIBLE WITH FC-40 AND FREON 21, AND CONTAINS NO MOVING PARTS SUBJECT TO WEAR. THE FLOW HEADERS ARE MADE FROM A SINGLE PIECE BAR. THE HEADERS ARE WELDED TO THE CORE, WHICH IS MADE OF STACKED FLAT FIN PARTING SHEETS (THICKNESS = 0.005 INCH). DESIGN PROOF PRESSURE IS 1.5 AND BURST PRESSURE IS 2.0 TIMES MAXIMUM OPERATING PRESSURE.

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(B) TEST

QUALIFICATION TEST - QUALIFICATION TESTED FOR 100 MISSION LIFE. THE HEAT EXCHANGER WAS SUBJECTED TO A PROOF/RUPTURE TEST FOR QUALIFICATION. DESIGN PROOF IS 575 PSIG AND UNIT DID NOT RUPTURE UNTIL 2440 PSIG (NOMINAL FC-40 OPERATING PRESSURE IS 65 PSIA). VIBRATION TESTED AT 0.0 G<sup>2</sup>/HZ FOR 52 MIN/AXIS, SHOCK TESTED AT +/- 20 G EACH AXIS.

ACCEPTANCE TEST - CORE IS LEAK TESTED PRIOR TO INSTALLING THE HEADERS AND AGAIN IN ATP OF ITEM.

OMRSD - FCL'S MONITORED FOR LEAKAGE AND PRESSURE DECAY TESTED. FC-40 COOLANT LOOP ULLAGE IS VERIFIED PRIOR TO EACH FLIGHT.

(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

HEADER WELDS TO THE TUBES ARE PENETRANT AND X-RAY INSPECTED. OTHER WEL (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 GENERIC FAILURES ON PRIOR PROGRAMS FOR THIS MODE. NO APPLICABLE FAILURE HISTORY.

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(E) OPERATIONAL USE

IF FAILURE OCCURS ON-ORBIT, AND THE FC-40 ACCUMULATOR RUPTURES INTO THE FUEL CELL O<sub>2</sub> SYSTEM, THEN POWER DOWN ASSOCIATED FUEL CELL. IF THE FC-40 PUMP CAVITATES, THEN POWER DOWN THAT FUEL CELL. ABORT DECISION FOR LOSS OF FUEL CELLS.