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PRINT DATE: 01/08/90

SHUTTLE CRITICAL ITEMS LIST - ORBITER

NUMBER: 06-1B3-0561-X

SUBSYSTEM NAME: ARS - COOLING

REVISION : 2 01/08/90

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: COLDPLATE	V070-613010
LRU	: COLDPLATE	V070-613160
LRU	: COLDPLATE	V070-613207
LRU	: COLDPLATE	V070-613208
LRU	: COLDPLATE	V070-613210
LRU	: COLDPLATE	V070-613211
LRU	: COLDPLATE	V070-613212
LRU	: COLDPLATE	V070-613213
LRU	: COLDPLATE	V070-613214
LRU	: COLDPLATE	V070-613215
LRU	: COLDPLATE	V070-613220
LRU	: COLDPLATE	V070-613225
LRU	: COLDPLATE	V070-613229
LRU	: COLDPLATE	V070-613231
LRU	: COLDPLATE	V070-613232
LRU	: COLDPLATE	V070-613233
LRU	: COLDPLATE	V070-613234
LRU	: COLDPLATE	V070-613237
LRU	: COLDPLATE	V070-613241
LRU	: COLDPLATE	V070-613242
LRU	: COLDPLATE	V070-613243

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LRU	:	COLDPLATE	V070-613371
LRU	:	COLDPLATE	V070-613373
LRU	:	COLDPLATE	V070-613374
LRU	:	COLDPLATE	V070-613596
LRU	:	COLDPLATE	V070-613597
LRU	:	COLDPLATE	V070-613598

QUANTITY OF LIKE ITEMS: 51

FUNCTION:

PROVIDES HEAT DISSIPATION OF AVIONICS BAY EQUIPMENT BY MEANS OF CONDUCTION TO THE WATER COOLANT LOOPS. FORTY-NINE COLDPLATES PER SET.

COLDPLATE P/N	QUANTITY	EQUIPMENT COOLED
V070-613207	2	RCDP'S
V070-613208	3	PWR CONT ASSY'S
V070-613210	1	GCILU
V070-613211	1	CCMSEC'S
V070-613212	1	CCUA, E/ASS, P/L DATA INTLVR
V070-613213	2	S-BAND XPDR'S, N/W S/P'S
V070-613214	2	P/L INTERR'S, P/L SIG PROC'S
V070-613215	1	MCA 3, E/A/ATC XCVR
V070-613220	1	FM XMT'S
V070-613226	3	KU BAND EA-1A & EA-2A, HUD'S
V070-613228	1	KU BAND SP
V070-613231	1	S/B PRE AMP, S/B PWR AMP
V070-613232	3	MSS PCM RCRDR, OP RCRDR'S
V070-613233	3	INVERTERS
V070-613234	2	PCM MSTR'S
V070-613237	3	INVERTERS
V070-613241	1	MTU
V070-613242	3	LOAD CONT ASSY'S
V070-613243	3	MDM & SIG COND'S
V070-613371	5	MDM'S
V070-613373	2	MASS MEM'S
V070-613374	2	RAD ALT & MDM'S
V070-613596	1	TEXT GRAPHICS
V070-613597	1	GPS 4
V070-613598	1	GPS 3

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TWO ADDITIONAL COLDPLATES PROVIDE HEAT DISSIPATION FOR MDM OF4 (FLIGHT DECK) AND FLOODLIGHT (PAYLOAD BAY); P/N'S V070-613010, V070-613180.

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SUBSYSTEM: ARS - COOLING
LRU :COLDPLATE
ITEM NAME: COLDPLATE

CRITICALITY OF THIS
FAILURE MODE:1R2

FAILURE MODE:
RESTRICTED FLOW

MISSION PHASE:

PL PRELAUNCH
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT
LS LANDING SAFING

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

CAUSE:
SILT, CONTAMINATION, CORROSION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) FAIL
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

A)
SCREEN A FAILS BECAUSE FLOW BLOCKAGE IN INDIVIDUAL COLDPLATES IS NOT
DETECTABLE.

B)
SCREEN B FAILS BECAUSE FLOW BLOCKAGE IN INDIVIDUAL COLDPLATES IS NOT
DETECTABLE.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
FUNCTIONAL DEGRADATION - REDUCED COOLING CAPABILITY OF COLDPLATE.

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(B) INTERFACING SUBSYSTEM(S):

INTERFACE DEGRADATION - UNABLE TO PROVIDE ADEQUATE COOLING FOR AVIONICS LRU ON AFFECTED COLDPLATE. LOSS OF COOLING OF ONE AVIONICS BOX IS NOT DETECTED UNTIL ITS PERFORMANCE IS AFFECTED BY OVERHEATING.

(C) MISSION:

NO EFFECT.

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

NO EFFECT.

(E) FUNCTIONAL CRITICALITY EFFECTS:

SECOND ASSOCIATED FAILURE IN OTHER WATER COOLANT LOOP MAY RESULT IN LOSS OF CREW/VEHICLE.

- DISPOSITION RATIONALE -

(A) DESIGN:

COLDPLATES ARE CONSTRUCTED OF TWO TYPE 347 CRES FACE SHEETS (LOOP 1 SIDE 0.012 IN THICK AND LOOP 2 SIDE 0.016 IN THICK) BRAZED TO A CORE 0.113 IN THICK. THE COLDPLATE CORE HAS PIN FINS ON BOTH SIDES AND BAFFLES TO MAKE UP FLOW PATHS FOR WCL 1 & 2. PIN FINS ARE 0.048 INCH IN DIAMETER AND 0.047 IN HIGH, AND ARE ARRANGED IN A STAGGERED EQUILATERAL TRIANGLE FORMATION WITH A PITCH DISTANCE OF 0.190 IN. THERE ARE NICKEL PLATED PADS AROUND PORTS, AND ETHYLENE PROPYLENE RUBBER (EPR) O-RING SEALS AT MANIFOLDS. THERE ARE NO MOVING PARTS. WATER COOLANT LOOPS CONTAIN 10 MICRON HIGH HOLDING CAPACITY SYSTEM FILTER AT THE PUMP PACKAGE INLET AND 61 MICRON FILTERS AT PUMP INLET AND OUTLET. COOLANT IS HIGH PURITY/LOW OXYGEN CONTENT WATER. MATERIAL COMPATIBILITY WITH WATER AND ALCOHOL BASED ON MATERIALS AND PROCESSES CERTIFICATION ANALYSIS (REF CAR D1A-22-610001-FCF-A).

(B) TEST:

ACCEPTANCE TEST - FLOW AND DELTA-P ARE VERIFIED. COLDPLATES ARE ULTRASONICALLY CLEANED, FLUSHED WITH WATER AND FREON TF, VERIFIED TO LEVEL 300 CLEANLINESS AND DRIED PRIOR TO STORAGE.

QUALIFICATION TEST - COLDPLATES CERTIFIED BY SIMILARITY TO APOLLO COLDPLATES (VIBRATION, SHOCK, AND ACCELERATION). COLDPLATES WERE SUBJECTED TO PRESSURE CYCLING, BURST PRESSURE, FLOW VS PRESSURE DROP AND THERMAL PERFORMANCE TESTS.

IN-VEHICLE TESTING - TESTING INCLUDES WATER PURITY, OXYGEN CONTENT, AND NON-VOLATILE RESIDUE. FLOW TO AVIONICS BAYS IS CHECKED BY FREEZE BLOCK TEST.

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QMRSD - CHEMICAL SAMPLES OF THE WATER COOLANT LOOPS ARE PERFORMED EVERY FIVE FLIGHTS. WATER IS ANALYZED FOR CHEMICAL PURITY AND CONTAMINATION PER SE-S-0073. WHEN LOOPS ARE DESERVICED, AS FOR HATCH LINE MODIFICATIONS, WATER IS SAMPLED AFTER RESERVICING. THE WATER COOLANT LOOPS ARE USED TO SUPPORT VEHICLE COOLING REQUIREMENTS AND COOLANT LOOP PERFORMANCE IS VERIFIED EVERY TURNAROUND.

SPECIAL TESTING - HARDWARE REMOVAL IS IN WORK TO EVALUATE EFFECTS OF LONG-TERM SYSTEM OPERATION AND LONG-TERM STORAGE WITH RESPECT TO POTENTIAL CORROSION.

(C) INSPECTION:

RECEIVING INSPECTION
MATERIAL ISSUED FOR FABRICATION IS VERIFIED BY INSPECTION ON MANUFACTURING ORDERS (CHECK MATERIAL FOR SCRATCHES).

CONTAMINATION CONTROL
CLEANLINESS LEVEL 300 IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
MACHINE TOLERANCES AND DETAIL PARTS ARE PER DRAWING, AND ARE VERIFIED BY INSPECTION. SEALING SURFACES PROTECTION IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
COLDPLATES ARE BRAZED PER DRAWING, AND ARE VERIFIED BY INSPECTION.
ELECTRO-DEPOSIT IS VERIFIED BY INSPECTION.

TESTING
PROOF PRESSURE AND LEAK CHECK ARE VERIFIED BY INSPECTION. ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CAR AB6473-010, 4-8-80. EARLY IN THE PROGRAM A PROBLEM OF PLATING SOLUTION LEAKING INTO THE COLDPLATE DURING THE ELECTRO-PLATING OF THE NICKEL REINFORCING PADS AROUND THE COLDPLATE PORTS WAS IDENTIFIED AS A CAUSE OF SILT GENERATION IN THE COLDPLATES. SILT, WHICH IS A PRODUCT OF CORROSION, WAS GENERATED FROM THE PLATING SOLUTION REACTING WITH THE BRAZING ALLOY. THE MANUFACTURING PROCESS AT THAT TIME REQUIRED THAT THE PORTS BE DRILLED THROUGH THE COLDPLATE FACE SHEETS PRIOR TO THE PLATING OPERATION. THE DRILLING OF THE PORTS PRIOR TO THE PLATING OPERATION REQUIRED THAT THE PORTS BE SEALED AGAINST PLATING SOLUTION ENTRY INTO THE INSIDE OF THE COLDPLATE. THESE SEALS WERE NOT ALWAYS LEAK PROOF AND THERE WAS NO WAY TO VERIFY THE SEAL PRIOR TO PLATING. THEREFORE, PLATING SOLUTION WOULD SOMETIMES LEAK INTO THE COLDPLATE AND LATER MANIFEST ITSELF AS SILT.

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THIS PROBLEM WAS CORRECTED BY A CHANGE IN THE MANUFACTURING PROCESS, I.E., DRILLING THE PORTS IN THE COLDPLATE FACE SHEETS AFTER THE COMPLETION OF THE PLATING OPERATION. THE REMEDIAL ACTION TAKEN ON A SPECIFIC COLDPLATE WAS DEPENDENT ON WHAT STEPS OF THE MANUFACTURING PROCESS HAD BEEN COMPLETED. ANY COLDPLATE WHICH HAD NOT HAD THE PORTS DRILLED WAS PLATED PRIOR TO DRILLING OF THE PORTS. COLDPLATES WHICH HAD BEEN DRILLED BUT NOT PLATED HAD THE PORTS WELDED CLOSED PRIOR TO PLATING. COLDPLATES WHICH HAD BEEN DRILLED PRIOR TO PLATING AND THEIR MANUFACTURING CYCLE COMPLETED BUT HAD NOT BEEN INSTALLED IN A VEHICLE WERE SUBJECTED TO A SPECIAL CLEANING PROCEDURE FOLLOWED BY A CLEANLINESS AND PH TEST. COLDPLATES THAT HAD COMPLETED THE MANUFACTURING CYCLE AND HAD BEEN INSTALLED IN A VEHICLE WERE ASSESSED FOR ACCEPTABILITY BY TESTS ON THE SUBSYSTEM IN THE VEHICLE (OV-102).

SAMPLES OF WATER FROM THE VEHICLE SUBSYSTEM WERE TESTED FOR NON-VOLATILE RESIDUE AND FOUND TO BE ACCEPTABLE. ADDITIONALLY, A WATER PUMP PACKAGE WAS REMOVED FROM THE VEHICLE AFTER THE FLIGHT READINESS FIRING OF THE MAIN PROPULSION ENGINES AND THE MAIN INLET FILTER WHICH IS LOCATED AT THE INLET TO THE WATER PUMP PACKAGE WAS DISASSEMBLED AND INSPECTED FOR EVIDENCE OF SILT. NONE WAS FOUND. A TEST WAS CONDUCTED TO DETERMINE THE DEBRIS HOLDING CAPACITY OF THE SUBSYSTEM FILTER. THE SUBSYSTEM FILTER WAS REDESIGNED, DOUBLING THE DEBRIS HOLDING CAPACITY AND REPLACED PRIOR TO THE FIRST FLIGHT.

IN SUMMARY, THE CORRECTIVE ACTION WAS A REVISION OF THE MANUFACTURING PROCESS REQUIRING THAT THE PLATING OPERATION BE COMPLETED PRIOR TO THE DRILLING OF THE PORTS IN THE COLDPLATE FACE SHEETS. THERE IS NO EVIDENCE OF SILT EVER CAUSING BLOCKED FLOW IN THE SUBSYSTEM.

(E) OPERATIONAL USE:

1. CREW ACTION
NONE.
2. TRAINING
NONE.
3. OPERATIONAL CONSIDERATIONS
FAILURE REMAINS VIRTUALLY UNDETECTABLE UNTIL AN LRU FAILURE MANIFESTS ITSELF DUE TO THE LACK OF COOLING.

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- APPROVALS -

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