

**CRITICAL ITEMS LIST**

PROJECT: SRMS  
 ASS'Y NOMENCLATURE: THERMAL SYSTEM

SYSTEM: MECHANICAL ARM SUBSYSTEM  
 ASS'Y P/N: 5114011857

SHEET: 1

P/N & REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOUR / FUNC. 3/1RAD CRITICALITY	RATIONALE FOR ACCEPTANCE
4350	0	HEATER ELEMENT SPAR-SG.459 QTY-BUNCH	MODE: ONE HEATER ELEMENT FAILS.  CAUSE(S): (1) ELEMENT OPEN CIRCUIT.	NONE - LOSS OF REDUNDANCY "WARM UP" TIME BETWEEN LIMITS MAY INCREASE.  WORST CASE ----- NO EFFECT ON CREW/VEHICLE OR MISSION.  REDUNDANT PATHS REMAINING ----- OTHER HEATER ELEMENTS IN FAILED SYSTEM AND ALTERNATE SYSTEM HEATER ELEMENTS	DESIGN FEATURES ----- THE BASIC DESIGN FEATURES OF THE SRMS HEATERS ARE IDENTICAL TO THE ORBITER HEATERS DEFINED BY ROCKWELL SPECIFICATIONS MC363-0024, -0031, AND -0037. THE SPECIFIC FEATURES FOR SRMS USE (SHAPE, SIZE, ELEMENT RESISTANCE) ARE DEFINED BY SPAR-SG.459/008.  CONNECTION TO THE HEATER ELEMENT, IS BY MEANS OF A PAIR OF TEFLON-INSULATED WIRES. IN GENERAL, THESE WIRES ARE TERMINATED IN CRIMP-STYLE CONTACTS AND THE CONTACTS ARE INSERTED BY DEUTCH BLOCK CONNECTORS. WHERE NECESSARY TO TERMINATE A WIRE DIRECTLY AT A THERMAL SWITCH, CONNECTIONS ARE MADE BY SOLDER JOINT. ALL SOLDER JOINTS ARE COVERED WITH SOLITHANE TO PRECLUDE SHORT CIRCUITS. ALL WIRE RUNS ARE STRAPPED AT INTERVALS TO ENSURE NO RELATIVE MOTION DUE TO VIBRATION/SHOCK.  THE HEATER SYSTEMS ARE DUPLICATED AND OPERABLE IN STANDBY REDUNDANCY.	

PREPARED BY: MEWG

SUPERCEDING DATE: 11 SEP 86

APPROVED BY: \_\_\_\_\_

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ASS'Y NOMENCLATURE: THERMAL SYSTEM

SYSTEM: MECHANICAL ARM SUBSYSTEM  
ASS'Y P/N: 51140J1657

SHEET: 2

INEA REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. 3/1RAD CRITICALITY	RATIONALE FOR ACCEPTANCE
4350	0	HEATER ELEMENT SPAR-SG.459 QTY-BUNCH	MODE: ONE HEATER ELEMENT FAILS.  CAUSE(S): (1) ELEMENT OPEN CIRCUIT.	NONE - LOSS OF REDUNDANCY "WARM UP" TIME BETWEEN LIMITS MAY INCREASE.  WORST CASE  NO EFFECT ON CREW/VEHICLE OR MISSION.  REDUNDANT PATHS REMAINING  OTHER HEATER ELEMENTS IN FAILED SYSTEM AND ALTERNATE SYSTEM HEATER ELEMENTS		ACCEPTANCE TESTS ----- THE SHOULDER, ELBOW AND WRIST JOINTS ARE SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING.  O VIBRATION: LEVEL AND DURATION - REFERENCE TABLES 9, 10 AND 11.  O THERMAL: +70 DEGREES C TO -25 DEGREES C (2 CYCLES) 1 X 10**6 TORR.  THE JOINTS ARE INTEGRATED INTO THE RMS SYSTEM (PER TP512) WHICH IS FURTHER TESTED IN (TP518 RMS STRONGBACK AND TP552 FLAT FLOOR). THESE TESTS VERIFIES THE ABSENCE OF THE FAILURE MODE.  QUALIFICATION TESTS ----- THE SHOULDER AND WRIST JOINTS WERE SUBJECTED TO THE LISTED BELOW ENVIRONMENTS. THE ELBOW JOINTS WAS NOT EXPOSED THE QUALIFICATION ENVIRONMENTS WAS CERTIFIED BY SIMILARITY TO THE SHOULDER JOINT.  O VIBRATION: LEVEL AND DURATION REFERENCE TABLES 9 AND 10  O SHOCK: 20G/11 MS - 3 AXES ( 6 DIRECTIONS)  O THERMAL VACUUM: +81 DEGREES C TO -36 DEGREES C (6 CYCLES) 1 X 10**6 TORR.  O ENC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CE01, CE03, CS01, CS02, CS06, RE02 (M/B)).  O HUMIDITY: ONLY SHOULDER JOINT WAS TESTED, 95% RH (65 DEGREES C MAINTAINED FOR 6 HRS.) (65 DEGREES C TO 30 DEGREES C IN 16 HRS) 10 CYCLES 240 HRS.  O LOAD TEST: SHOULDER JOINT STRUCTURAL LOAD TEST REFERENCE TABLE 12.  NOTE:  ELBOW JOINT (S/N 302 AND UP) INCORPORATES NON-WELDED TRANSITIONS WHICH WAS LOAD TESTED TO LOAD IN REFERENCE TABLE 18S.  FLIGHT CHECKOUT ----- PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987

PREPARED BY: NFGC

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SYSTEM: MECHANICAL ARM SUBSYSTEM  
ASS'Y P/N: 5116011657

SHEET: 3

THERM REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. 3/18AB CRITICALITY	RATIONALE FOR ACCEPTANCE
4350	0	HEATER ELEMENT SPAR-SG.459 QTY-BUNCH	<p>MODE: ONE HEATER ELEMENT FAILS.</p> <p>CAUSE(S): (1) ELEMENT OPEN CIRCUIT.</p>	<p>NONE - LOSS OF REDUNDANCY "WARM UP" TIME BETWEEN LIMITS MAY INCREASE.</p> <p>WORST CASE</p> <p>NO EFFECT ON CREW/VEHICLE OR MISSION.</p> <p>REDUNDANT PATHS REMAINING</p> <p>OTHER HEATER ELEMENTS IN FAILED SYSTEM AND ALTERNATE SYSTEM HEATER ELEMENTS</p>	<p>QA/INSPECTIONS</p>	<p>ELECTRIC HEATERS ARE PROCURED TO THE REQUIREMENTS OF SPAR SPECIFICATION SG.459/008, WHICH INCORPORATES ROCKWELL INTERNATIONAL SPECIFICATIONS MC363-0024, MC363-0031 AND MC363-0037. QUALIFICATION OF SRMS HEATERS IS BY SIMILARITY WITH QUALIFICATION TESTING PERFORMED FOR THE SHUTTLE ORBITER PROGRAM. ACCEPTANCE TESTING OF HEATERS IS PERFORMED BY THE SUPPLIER AS REQUIRED BY THE PROCUREMENT SPECIFICATIONS. SPAR SOURCE INSPECTION IS ENVOCKED ON THE SUPPLIER FOR ALL HEATER PROCUREMENTS.</p> <p>WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-61381 AND INSPECTED AND TESTED TO NASA JSCM0800 STANDARD NUMBER 95A.</p> <p>RECEIVING INSPECTION VERIFIES THAT THE HARDWARE RECEIVED IS AS IDENTIFIED IN THE PROCUREMENT DOCUMENTS, THAT NO DAMAGE HAS OCCURRED DURING SHIPMENT, AND THAT APPROPRIATE DATA HAS BEEN RECEIVED WHICH PROVIDES ADEQUATE TRACEABILITY INFORMATION AND IDENTIFIES ACCEPTABLE PARTS.</p> <p>PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE,</p> <p>UPON RECEIPT AT SPAR EACH HEATER IS SUBJECTED TO THE FOLLOWING INSPECTIONS PRIOR TO INSTALLATION, WORKMANSHIP, SURFACE FINISH, DIMENSIONAL, IDENTIFICATION, CLEANLINESS AND RESISTANCE MEASUREMENT.</p> <p>COMPONENT MOUNTING INSPECTION FOR CORRECT SOLDERING, WIRE LOOPING, STRAPPING, ETC. OPERATORS AND INSPECTORS ARE TRAINED AND CERTIFIED TO NASA MHD 5300.4(3A) STANDARD, AS MODIFIED BY JSC 08800A.</p> <p>WIRE HARNESSSES ARE INSPECTED DURING ASSEMBLY PROCESSES TO SPAR-JIP.251 AS REQUIRED BY SPECIFICATION SPAR-SG420. INSPECTIONS INCLUDE, CONTINUITY, LEAKAGE RESISTANCE, WIRE ROUTING, STRAIN RELIEF, LACING AND TIEDOWN ETC.</p> <p>AFTER INSTALLATION, HEATERS AND THERMAL SWITCHES ARE VERIFIED AND TESTED TO THE REQUIREMENTS OF THE APPLICABLE JOINT/END EFFECTOR INSPECTION TEST PROCEDURE (ITP) WHICH INCLUDES RESISTANCE. MEASUREMENTS OF EACH HEATER CIRCUIT, PRIME AND BACKUP.</p> <p>PRE-ACCEPTANCE TEST INSPECTION, WHICH INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC., (MANDATORY INSPECTION POINT).</p> <p>A TEST READINESS REVIEW (TRR) WHICH INCLUDES VERIFICATION OF TEST PERSONNEL, TEST DOCUMENTS, TEST EQUIPMENT CALIBRATION/ VALIDATION STATUS AND HARDWARE CONFIGURATION IS CONVENED BY QUALITY ASSURANCE IN CONJUNCTION WITH ENGINEERING RELIABILITY, CONFIGURATION CONTROL, SUPPLIER AS APPLICABLE, AND THE GOVERNMENT REPRESENTATIVE, PRIOR TO THE START OF ANY FORMAL TESTING (ACCEPTANCE OR QUALIFICATION).</p>

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SHEET: 4

P/N REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RISK / CONC. 3/IRAD CRITICALITY	RATIONALE FOR ACCEPTANCE
4350	0	HEATER ELEMENT SPAR-SG.459 QTY-BUNCH	MODE: ONE HEATER ELEMENT FAILS.  CAUSE(S): (1) ELEMENT OPEN CIRCUIT.	NONE - LOSS OF REDUNDANCY "WARM UP" TIME BETWEEN LIMITS MAY INCREASE.  WORST CASE ----- NO EFFECT ON CREW/VEHICLE OR MISSION.  REDUNDANT PATHS REMAINING ----- OTHER HEATER ELEMENTS IN FAILED SYSTEM AND ALTERNATE SYSTEM HEATER ELEMENTS		ACCEPTANCE TESTING (ATP) INCLUDES, AMBIENT, VIBRATION AND THERMAL-VAC TESTING, (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT)  SRMS SYSTEMS INTEGRATION, THE INTEGRATION OF MECHANICAL ARM SUBASSEMBLIES AND THE FLIGHT CABIN EQUIPMENT TO FORM THE SRMS. INSPECTIONS ARE PERFORMED AT EACH PHASE OF INTEGRATION WHICH INCLUDES GROUNDING CHECKS, THRU WIRING CHECKS, WIRING ROUTING, INTERFACE CONNECTORS FOR BENT OR PUSH BACK CONTACTS ETC.  SRMS SYSTEMS TESTING - STRONGBACK AND FLAT FLOOR AMBIENT PERFORMANCE TEST. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT)

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SHEET: 5

P/N REF.	REV.	NAME QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	MODN / FUNC. 3/1RAD CRITICALITY	RATIONALE FOR ACCEPTANCE
4350	0	HEATER ELEMENT SPAR-SG.459 QTY-BUNCH	MODE: ONE HEATER ELEMENT FAILS.  CAUSE(S): (1) ELEMENT OPEN CIRCUIT.	NONE - LOSS OF REDUNDANCY "WARM UP" TIME BETWEEN LIMITS MAY INCREASE.  WORST CASE ----- NO EFFECT ON CREW/VEHICLE OR MISSION.  REDUNDANT PATHS REMAINING ----- OTHER HEATER ELEMENTS IN FAILED SYSTEM AND ALTERNATE SYSTEM HEATER ELEMENTS	FAILURE HISTORY -----  THERE HAVE BEEN NO FAILURES ASSOCIATED WITH THIS FAILURE MODE ON THE SRMS PROGRAM.	

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SHEET: 6

P/N & REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDMR / FUNC. I/IRAB CRITICALITY	RATIONALE FOR ACCEPTANCE
4350	1	HEATER ELEMENT SPAR-SG. 459 QTY-BUNCH	<p>MODE: ONE HEATER ELEMENT FAILS.</p> <p>CAUSE(S): (1) ELEMENT OPEN CIRCUIT.</p>	<p>NONE - LOSS OF REDUNDANCY "WARM UP" TIME BETWEEN LIMITS MAY INCREASE.</p> <p>WORST CASE</p> <p>NO EFFECT ON CREW/VEHICLE OR MISSION.</p> <p>REDUNDANT PATHS REMAINING</p> <p>OTHER HEATER ELEMENTS IN FAILED SYSTEM AND ALTERNATE SYSTEM HEATER ELEMENTS</p>	<p>OPERATIONAL EFFECTS</p> <p>NONE. ONE JOINT MAY MOVE AT A SLOWER THAN COMMANDED RATE IF A PRIOR FAILURE OF THE HEATER CIRCUIT HAS OCCURRED. ARM DOES NOT RESPOND CORRECTLY TO COMMANDS. CREW WILL INHERENTLY COMPENSATE IN MANUAL AUGMENTED MODE.</p> <p>CREW ACTION</p> <p>APPLY BRAKES</p> <p>CREW TRAINING</p> <p>CREW WILL BE TRAINED TO RECOGNIZE IF THE ARM IS RESPONDING CORRECTLY TO COMMANDS.</p> <p>MISSION CONSTRAINT</p> <p>OPERATE UNDER VERNIER RATES WITHIN 10 FT OF STRUCTURE. AUTO TRAJECTORIES MUST BE DESIGNED TO COME NO CLOSER THAN 5 FT FROM STRUCTURE. THE OPERATOR MUST BE ABLE TO DETECT THAT THE ARM IS RESPONDING PROPERLY TO COMMANDS VIA WINDOW AND/OR CCTV VIEWS DURING ALL ARM OPERATIONS. BOTH HEATER POWER BUSES TO BE IN AUTO WHEN OPERATING ARM.</p> <p>SCREEN FAILURES</p> <p>A: INDEPENDENT THERMOSTATS ARE NOT ACCESSIBLE, ARE NOT INSTRUMENTED AND THE REDUNDANT ELEMENTS ARE STILL OPERABLE.</p> <p>B: REDUNDANT ELEMENTS ARE STILL OPERABLE.</p> <p>OMRSD OFFLINE</p> <p>VERIFY HEATERS WHERE POSSIBLE.</p> <p>OMRSD ONLINE INSTALLATION</p> <p>NONE</p> <p>OMRSD ONLINE TURNAROUND</p> <p>VERIFY HEATERS WHERE POSSIBLE.</p>	

PREPARED BY: W/MG

SUPERSEDING DATE: 06 OCT 97

APPROVED BY: \_\_\_\_\_