CRITICAL ITEMS LIST

PROJECT: SRMS | ASS'Y NOMENCLATURE: THERMAL SYSTEM | SYSTEM: MECHANICAL ARM SUBSYSTEM | ASS'Y P/N: 51140F1657 | SHEET: 1

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/1R CRITICALITY — RATIONALE FOR ACCEPTANCE
4331	2	HEATER BUS/ FUSES. QTY-2 FOR E/E 51140B1470-1	MODE: LOSS OF POWER TO ONE OF HEATER GROUPS. CAUSE(S). (1) OPEN WIRE. (2) SHORT CIRCUIT TO GROUND. (3) SHORT CIRCUIT HEATER OR HEATER CONNECTIONS. (4) BLOWN FUSE.	IF FAILED SYSTEM SELECTED. HEATER POWER LOST. ARM WILL COOL DOWN. JOINT BEARING MAY BIND. (SLUGGISH JOINT) WORST CASE ---------- LOSS OF MISSION. SUBSEQUENT FAILURE MAY RESULT IN UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING --------------- OTHER SYSTEM HEATING GROUP	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. FUSES USED IN THE SHOULDER FUSE PLUG ASSEMBLIES ARE OF THE DESIGN DEFINED BY MSFC SPECIFICATION 40M38259. FOR SRMS APPLICATION, DESIGN AND PROCESS IMPROVEMENTS HAVE BEEN NEGOTIATED WITH, AND IMPLEMENTED BY, THE MANUFACTURER. THESE INCLUDE: - IMPROVED ATTACHMENT OF END CAPS. - CONTROL OF FUSE ELEMENT LENGTH AND DISPOSITION WITHIN THE FUSE BODY TUBE. - CONTROL SOLDERING BETWEEN FUSE ELEMENT AND THE END CAPS. PRIOR TO ASSEMBLY IN THE FUSE PLUG ASSEMBLY, A CONNECT PIN IS SOLDERED TO EACH OF THE FUSE LEAD WIRES. THIS PROCESS IS CONTROLLED BY ESTABLISHED PROCEDURES WHICH INCLUDE THE REQUIREMENT OF A "METCAL" QUALITY OF SOLDER FOR EACH SOLDER JOINT. THE FUSE BODY AND LEAD WIRES ARE SLEEVED TO PRECLUDE SHORT CIRCUITS. EACH FUSE AND ALL SOLDERED JOINTS ARE SUBJECTED TO RADIOGRAPHIC INSPECTION. THE FUSE PLUG ASSEMBLY INCLUDES AN ALUMINUM POTTING SHELL. FOLLOWING INTEGRATION OF THE FUSES, THE CONNECTOR ASSEMBLY IS POTTED USING A SEMI RESILIENT (RTV) COMPOUND. THE POTTING MEDIUM PROVIDES GOOD HEAT TRANSFER AND ENSURES MECHANICAL STABILITY OF THE INDIVIDUAL FUSES.

PREPARED BY: RFWG   SUPERCEDING DATE: 21 SEP 87   APPROVED BY:

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: THERMAL SYSTEM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: S114001EST

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/IRB CRITICALITY	RATIONALE FOR ACCEPTANCE
4331	2	HEATER BUS/ FUSES. QTY-2 FOR E/C S114002147B-3	MODE: LOSS OF POWER TO ONE OF HEATER GROUPS. CAUSE(S): (1) OPEN WIRE. (2) SHORT CIRCUIT TO GROUND. (3) SHORT CIRCUIT HEATER OR HEATER CONNECTIONS. (4) BLOWN FUSE.	IF FAILED SYSTEM SELECTED, HEATER POWER LOST. ARM WILL COOL DOWN. JOINT BEARING MAY BIND. (SLUGGISH JOINT) WORST CASE --- LOSS OF MISSION. SUBSEQUENT FAILURE MAY RESULT IN UNEXPECTED MOTION. SLUGGISH JOINT. UNAMBIGUIATED. REDUNDANT PATHS REMAINING --- OTHER SYSTEM HEATING GROUP		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 TP532) 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 -16 DEGREES C (6 CYCLES) 1 X 10**-6 TORR. O EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CE01, CE03, CS01, CS02, CS06, RE02 (N/B). O HUMIDITY: ONLY SHOULDER JOINT WAS TESTED, 95% RH (55 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 10S. FLIGHT CHECKOUT --- PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987

PREPARED BY: MEWE
SUPERCEDING DATE: 28 SEP 87
APPROVED BY:

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: THERMAL SYSTEM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1K57
SHEET 1

FMEA REF.	REV	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. Z/IAB CRITICALITY	RATIONALE FOR ACCEPTANCE
4331	2	HEATER BUS/ FUSES. QTY-2 FOR E/E 51140D1470 3	MODE: LOSS OF POWER TO ONE OF HEATER GROUPS. CAUSE(S): (1) OPEN WIRE. (2) SHORT CIRCUIT TO GROUND. (3) SHORT CIRCUIT HEATER OR HEATER CONNECTIONS. (4) BLOWN FUSE.	IF FAILED SYSTEM SELECTED, HEATER POWER LOST. ARM WILL COOL DOWN. JOINT BEARING MAY BIND. (SLUGGISH JOINT) WORST CASE --- LOSS OF MISSION. SUBSEQUENT FAILURE MAY RESULT IN UNEXPECTED MOTION SLUGGISH JOINT UNANNUNCIATED. REDUNDANT PATHS REMAINING --- OTHER SYSTEM HEATING GROUP		QA/INSPECTIONS --- ELECTRIC HEATERS ARE PROCURED TO THE REQUIREMENTS OF SPAR SPECIFICATION SG.659/BDB, WHICH INCORPORATES ROCKWELL INTERNATIONAL SPECIFICATIONS MC363-0020, MC363-0031 AND MC361-0037. 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 INVOKED ON THE SUPPLIER FOR ALL HEATER PROCUREMENTS. FUSES ARE PROCURED AS A EEE PART TO SPAR SPECIFICATION SPAR-SG459/023, WHICH INCORPORATES SPECIFICATION MSFC40M38259 AS REQUIRED BY SPAR-RMS-PA.003. QUALIFICATION, ACCEPTANCE TESTING AND RELIABILITY LIFE TESTING OF FUSE PLUG ASSEMBLIES WAS PERFORMED TO THE REQUIREMENTS OF THE SPAR-RMS-TP.952. WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL W-81381 AND INSPECTED AND TESTED TO NASA JSCN0080 STANDARD NUMBER 95A 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. PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE. UPON RECEIPT AT SPAR EACH HEATER IS SUBJECTED TO THE FOLLOWING INSPECTIONS PRIOR TO INSTALLATION, WORKMANSHIP, SURFACE FINISH, DIMENSIONAL, IDENTIFICATION, CLEANLINESS AND RESISTANCE MEASUREMENT. COMPONENT MOUNTING INSPECTION FOR CORRECT SOLDERING, WIRE LOOPING, STRAPPING, ETC. OPERATORS AND INSPECTORS ARE TRAINED AND CERTIFIED TO NASA NHB 5300 4(3A) STANDARD, AS MODIFIED BY JSC 08800A. WIRE HARNESSES ARE INSPECTED DURING ASSEMBLY PROCESSES TO SPAR-ITP.251 AS REQUIRED BY SPECIFICATION SPAR-SG420 INSPECTIONS INCLUDE CONTINUITY, LEAKAGE RESISTANCE, WIRE ROUTING, STRAIN RELIEF [illegible] AND TIEDOWN ETC. 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 CIRUCIT, PRIME AND BACKUP. PRE-ACCEPTANCE TEST INSPECTION, WHICH INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC., (MANDATORY INSPECTION POINT). A TEST READINESS REVIEW (TRR) WHICH INCLUDES VERIFICATION OF TEST PERSONNEL, TEST DOCUMENTS, TEST EQUIPMENT CALIBRATION/

PREPARED BY: RFHD SUPERCEDING DATE: 28 SEP 87 APPROVED BY: _____ DATE: _____

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: THERMAL SYSTEM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: SI140J1657
SHEET 4

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/INB CRITICALITY	RATIONALE FOR ACCEPTANCE
4331	2	HEATER BUS/ FUSES. QTY-2 FOR E/E SI140D1470-3	MODE: LOSS OF POWER TO ONE OF HEATER GROUPS. CAUSE(S): (1) OPEN WIRE. (2) SHORT CIRCUIT TO GROUND. (3) SHORT CIRCUIT HEATER OR HEATER CONNECTIONS. (4) BLOWN FUSE.	IF FAILED SYSTEM SELECTED, HEATER POWER LOST, ARM WILL COOL DOWN, JOINT BEARING MAY BIND. (SLUGGISH JOINT) WORST CASE --- LOSS OF MISSION. SUBSEQUENT FAILURE MAY RESULT IN UNEXPECTED MOTION, SLUGGISH JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING --- OTHER SYSTEM HEATING GROUP		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). 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)

PREPARED BY: MEMG SUPERCEDING DATE: 28 SEP 87 APPROVED BY:

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: THERMAL SYSTEM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: [illegible]
SHEET: 5

AREA REF.	REV.	NAME QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/1RB CRITICALITY	RATIONALE FOR ACCEPTANCE
4331	2	HEATER BUS/ FUSES. QTY-2 FOR E/E 51140B1070-3	MODE: LOSS OF POWER TO ONE OF HEATER GROUPS. CAUSE(S): (1) OPEN WIRE. (2) SHORT CIRCUIT TO GROUND. (3) SHORT CIRCUIT HEATER OR HEATER CONNECTIONS. (4) BLOWN FUSE.	SF FAILED SYSTEM SELECTED. HEATER POWER LOST. ARM WILL COOL DOWN. JOINT BEARING MAY BIND. (SLUGGISH JOINT) WORST CASE --- LOSS OF MISSION. SUBSEQUENT FAILURE MAY RESULT IN UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING --- OTHER SYSTEM HEATING GROUP		FAILURE HISTORY --- THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT FAR 2174 S/N 303 FEB 84 DESCRIPTION --- B.U. HTR CURRENT LIMITED TO 10 AMPS SHORTED EZ SPLICE BLOCK DUE TO MIS-ASSEMBLY. CORRECTIVE ACTION --- ECN 51140J1219-11 S1217,S1218 TO CARRY BUILD AND TEST.

PREPARED BY: [illegible] SUPERCEDING DATE: 28 SEP 87 APPROVED BY

E: _____

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: THERMAL SYSTEM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: ST140J1657
SHEET: 6

FMEA REF.	REV.	NAME, QTY. & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/IRB CRITICALITY	RATIONALE FOR ACCEPTANCE
4331	2	HEATER BUS/ FUSES. QTY-2 FOR E/E ST140D1470-3	MODE: LOSS OF POWER TO ONE OF HEATER GROUPS. CAUSE(S): (1) OPEN WIRE. (2) SHORT CIRCUIT TO GROUND. (3) SHORT CIRCUIT HEATER OR HEATER CONNECTIONS. (4) BLOWN FUSE.	IF FAILED SYSTEM SELECTED, HEATER POWER LOST. ARM WILL COOL DOWN. JOINT BEARING MAY BIND. (SLUGGISH JOINT) WORST CASE LOSS OF MISSION. SUBSEQUENT FAILURE MAY RESULT IN UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING OTHER SYSTEM HEATING GROUP		OPERATIONAL EFFECTS 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. CREW ACTION APPLY BRAKES CREW TRAINING CREW WILL BE TRAINED TO RECOGNIZE IF THE ARM IS RESPONDING CORRECTLY TO COMMANDS. MISSION CONTRAINT 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 BUSSES TO BE IN AUTO WHEN OPERATING ARM. SCREEN FAILURES B: REDUNDANT ELEMENTS ARE STILL OPERABLE. ORBSD OFFLINE PARTIAL CHECK WITH ELBOW DEMATED. ORBSD ONLINE INSTALLATION NONE ORBSD ONLINE TURNAROUND E/E TEST SET TO MONITOR HEATER BUSES.

PREPARED BY: MMG SUPERCEDING DATE: 28 SEP 87 APPROVED BY: