

**CRITICAL ITEMS LIST**

PROJECT: SRMS

ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM

ASS'Y P/N: 51155E117

SHEET: 1

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOUR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	<p>MODE: LOSS OF ALL RHC CHANNELS.</p> <p>CAUSE(S): (1) LOSS OF 20V AC VOLTAGE. (2) LOSS OF +/-12 VOLT D.C. VOLTAGE. (3) ELECTRONIC PARTS FAILURE.</p>	<p>LOSS OF OUTPUT SIGNAL FROM THE RHC. ARM CANNOT BE COMMANDED FROM RHC. ARM MAY TAKE UNEXPECTED TRAJECTORY.</p> <p>WORST CASE ..... UNEXPECTED MOTION. INCORRECT H/C COMMANDS. UNANNUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING ..... N/A</p>	DESIGN FEATURES	<p>THE 20 VAC AND THE +/- 12 VDC SUPPLIES ARE ROUTED THROUGH THE D&amp;C PANEL CABLE HARNESS AND THE ELECTRONICS PACKAGE TO D&amp;C INTERFACE CONNECTOR ABA1J3. INTERCONNECTION, BETWEEN ABA1J3 AND THE RHC, IS VIA ORBITER CABLE P9584(P) TO P471(S). WITHIN THE RHC, 20 VAC AND +/- 12 VDC SUPPLIES ARE ROUTED TO THE DEMODULATOR PCB VIA A MOLDED CABLE FORM, TERMINATED AT EACH END WITH A CONNECTOR. 20 VAC IS ALSO ROUTED TO EACH TRANSDUCER VIA ULTRA-FLEXIBLE (CI-COIL) CABLE FORMS. BOTH WIRING FORMS ARE SIMILAR TO THE ORBITER RHC DESIGN CONFIGURATION. HOWEVER, THE CABLE FORM FOR THE 20 VAC CARRIES FEWER WIRES THAN THE ORBITER RHC, AND IS LESS SUSCEPTIBLE TO FLEXURE DAMAGE. SINCE THE ANGULAR EXCURSIONS FOR WIRE FLEXURE ARE APPROX. 30 PER CENT LESS FOR THE SRMS RHC. A LIFE OF 50000 FULL SCALE COMMAND CYCLES IS PREDICTED. ASSEMBLY PROCESS DOCUMENTATION INCLUDES CAUTIONARY NOTES RE-HANDLING OF THESE CABLE FORMS. QUALITY REQUIREMENTS FOR RHC WIRE AND CONNECTORS ARE CONTROLLED BY HONEYWELL PROCUREMENT DOCUMENTS. THE DESIGN, MATERIALS, AND PROCESSES FOR THESE ITEMS HAVE BEEN REVIEWED BY SPAR AND NASA PARTS BRANCH, IN THE COURSE OF NON-STANDARD PARTS REVIEW.</p> <p>EEE PARTS HAVE BEEN SELECTED AND CONTROLLED IN ACCORDANCE WITH SPAR-RMS-PA.003. THIS DOCUMENT DEFINES THE PROGRAM REQUIREMENTS FOR MONITORING AND CONTROLLING EEE PARTS. THE REQUIREMENTS INCLUDE PARTS SELECTION TO AT LEAST "ESTABLISHED RELIABILITY" LEVELS, AND ADEQUATE DERATING OF PART STRESS LEVELS. PROCEDURES AND ACTIVITIES ARE SPECIFIED TO ENSURE AT LEAST EQUIVALENT QUALITY FOR NONSTANDARD AND IRREGULAR PARTS. RELIABILITY ANALYSIS HAS CONFIRMED NO PARTS WITH GENERICALLY HIGH FAILURE RATES. AEROSPACE DESIGN STANDARDS FOR DETAILING ELECTRONIC PARTS PACKAGING, MOUNTING AND STRUCTURAL/MECHANICAL/INTEGRITY OF ASSEMBLIES ARE APPLIED. SUCH DESIGN HAS BEEN REVIEWED AND FOUND SATISFACTORY THROUGH THE DESIGN AUDIT PROCESS, INCLUDING THE USE OF RELIABILITY, MAINTAINABILITY AND SAFETY CHECKLISTS. MATERIAL SELECTION AND USAGE CONFORMS TO SPAR-SG.368 WHICH IS EQUIVALENT TO THE NASA MATERIALS USAGE REQUIREMENTS. WORST CASE ANALYSIS HAS BEEN CONDUCTED TO ENSURE THAT PERFORMANCE CAN BE MET UNDER WORST CASE TEMPERATURE AND AGING EFFECTS. EEE PARTS STRESS ANALYSIS HAS BEEN COMPLETED AND CONFIRMS THAT THE PARTS MEET THE DERATING REQUIREMENTS.</p> <p>PRINTED CIRCUIT BOARD DESIGNS HAVE BEEN REVIEWED TO ENSURE ADEQUATE CIRCUIT PATH WIDTH AND SEPARATION AND TO CONFIRM APPROPRIATE DIMENSIONS OF CIRCUIT SOLDER PADS AND OF COMPONENT HOLE PROVISIONS.</p> <p>PARTS MOUNTING METHODS ARE CONTROLLED IN ACCORDANCE WITH NSFC-SID-136 AND CAE PD93489. THESE DOCUMENTS REQUIRE APPROVED MOUNTING METHODS, STRESS RELIEF, AND COMPONENT SECURITY.</p> <p>WHERE APPLICABLE, DESIGN DRAWINGS AND DOCUMENTATION GIVE CLEAR IDENTIFICATION OF HANDLING PRECAUTIONS FOR ESD SENSITIVE PARTS.</p>

PREPARED BY: MFUG

SUPERCEDING DATE: 11 SEP 86

APPROVED BY:

DATE:

**CRITICAL ITEMS LIST**

PROJECT: SRMS  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: DEC SUBSYSTEM  
 ASS'Y P/N: 51155E117

SHEET: 2

PMA REF.	REV.	PART, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	0	ROTATIONAL HAND CONTROLLER QTY 1 SPAR P/N 51155E117	MODE: LOSS OF ALL RHC CHANNELS.  CAUSE(S): (1) LOSS OF 20V AC VOLTAGE.  (2) LOSS OF +/-12 VOLT D.C. VOLTAGE.  (3) ELECTRONIC PARTS FAILURE.	LOSS OF OUTPUT SIGNAL FROM THE RHC. ARM CANNOT BE COMMANDED FROM RHC. ARM MAY TAKE UNEXPECTED TRAJECTORY.  WORST CASE ..... UNEXPECTED MOTION: INCORRECT N/C COMMANDS. UNANNUNCIATED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING ..... N/A		BOARD ASSEMBLY DRAWINGS INCLUDE THE REQUIREMENT FOR SOLDERING STANDARDS IN ACCORDANCE WITH MHB 5300.4(3A) AND JSC 08800A.  PROCESSING OF ADDRESS DECODING IS PERFORMED USING 'A' TYPE CMOS LOGIC DEVICES. INPUT DATA IS BUFFERED BY A COMPLEMENTARY TRANSISTOR STAGE. THE CMOS LOGIC CIRCUITS ARE OF THE GENERIC TYPE SERIES "4000A". THE COMPLEMENTARY TRANSISTORS ARE 2N2222A AND 2N2907A.

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PROJECT: SRMS

ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM

ASS'Y P/N: 51155E117

SHEET: 3

FMEA REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	DOWN / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	<p>MODE: LOSS OF ALL RHC CHANNELS.</p> <p>CAUSE(S):</p> <p>(1) LOSS OF 20V AC VOLTAGE.</p> <p>(2) LOSS OF +/-12 VOLT D.C. VOLTAGE.</p> <p>(3) ELECTRONIC PARTS FAILURE.</p>	<p>LOSS OF OUTPUT SIGNAL FROM THE RHC. ARM CANNOT BE COMMANDED FROM RHC. ARM MAY TAKE UNEXPECTED TRAJECTORY.</p> <p>WORST CASE</p> <p>UNEXPECTED MOTION.</p> <p>INCORRECT W/C COMMANDS. UNANNOUNCED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING</p> <p>N/A</p>	1/1	<p>ACCEPTANCE TESTS</p> <p>THE RHC IS SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING AS AN SRU.</p> <p>O VIBRATION: LEVEL AND DURATION REFERENCE TABLE 1</p> <p>O THERMAL: +120 DEGREES F TO 20 DEGREES F (12 HRS PER CYCLE) 2 CYCLES TOTAL.</p> <p>THE RHC IS TESTED AS PART OF THE D&amp;C SUBSYSTEM; WHICH CONSIST OF D&amp;C PANEL, IHC AND RHC; PER TP 347.</p> <p>THE TOTAL D&amp;C SUBSYSTEM UNDERGOES RMS SYSTEM TESTING, (TP 510 RMS STRONGBACK, AND TP552 FLAT FLOOR TESTS) WHICH VERIFIES THE ABSENCE OF THE FAILURE MODE.</p> <p>QUALIFICATIONS TESTS</p> <p>THE RHC IS CERTIFIED BY SIMILARITY TO THE ORBITER USED RHC EXCEPT FOR FINGER OPERATED SWITCHES. THE BASIC DIFFERENCES IS THAT THE ORBITER RHC IS TRIPLE REDUNDANT AND THE RMS RHC IS SINGLE STRING.</p> <p>FLIGHT CHECKOUT</p> <p>PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987</p>

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PROJECT: SRMS

SYSTEM: D&C SUBSYSTEM

ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

ASS'Y P/N: 51155E117

SHEET: 4

FMEA REF.	REV.	NAME, QTY. & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOUR / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	0	ROTATIONAL HAND CONTROLLER QTY: 1 SPAR P/N 51155E117	<p>MODE: LOSS OF ALL RHC CHANNELS.</p> <p>CAUSE(S): (1) LOSS OF 20V AC VOLTAGE. (2) LOSS OF +/-12 VOLT D.C. VOLTAGE. (3) ELECTRONIC PARTS FAILURE.</p>	<p>LOSS OF OUTPUT SIGNAL FROM THE RHC. ARM CANNOT BE COMMANDED FROM RHC. ARM MAY TAKE UNEXPECTED TRAJECTORY.</p> <p>WORST CASE ..... UNEXPECTED MOTION. INCORRECT H/C COMMANDS. UNANNUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING ..... N/A</p>	<p>QA/INSPECTIONS .....</p>	<p>EEE PARTS INSPECTION IS PERFORMED AS REQUIRED BY SPAR-RMS-PA.003. EACH EEE PART IS QUALIFIED AT THE PART LEVEL TO THE REQUIREMENTS OF THE APPLICABLE SPECIFICATION. ALL EEE PARTS ARE 100% SCREENED AND BURNED IN, AS A MINIMUM, AS REQUIRED BY SPAR-RMS-PA.003, BY THE SUPPLIER. ADDITIONALLY, EEE PARTS ARE 100% RE-SCREENED IN ACCORDANCE WITH REQUIREMENTS, BY AN INDEPENDENT SPAR APPROVED TESTING FACILITY. DPA IS PERFORMED AS REQUIRED BY PA.003 ON A RANDOMLY SELECTED 5% OF PARTS, MAXIMUM 5 PIECES, MINIMUM 3 PIECES FOR EACH LOT NUMBER/DATE CODE OF PARTS RECEIVED.</p> <p>WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-81381 AND INSPECTED AND TESTED TO NASA JSCN0080 STANDARD NUMBER 95A.</p> <p>RECEIVING INSPECTION VERIFIES THAT ALL PARTS RECEIVED ARE AS IDENTIFIED IN THE PROCUREMENT DOCUMENTS, THAT NO PHYSICAL DAMAGE HAS OCCURRED TO PARTS DURING SHIPMENT, THAT THE RECEIVING DOCUMENTS PROVIDE ADEQUATE TRACEABILITY INFORMATION AND SCREENING DATA CLEARLY IDENTIFIES ACCEPTABLE PARTS.</p> <p>PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE,</p> <p>PRINTED CIRCUIT BOARD INSPECTION FOR TRACK SEPARATION, DAMAGE AND ADEQUACY OF PLATED THROUGH HOLES,</p> <p>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.</p> <p>CONFORMAL COATING INSPECTION FOR ADEQUATE PROCESSING IS PERFORMED USING ULTRAVIOLET LIGHT TECHNIQUES.</p> <p>POST P.C. BD. INSTALLATION INSPECTION, WORKMANSHIP &amp; CLEANLINESS (HONEYWELL/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</p> <p>P.C. BD. INSTALLATION INSPECTION, CHECK FOR CORRECT BOARD INSTALLATION, ALIGNMENT OF BOARDS, PROPER CONNECTOR CONTACT MATING, WIRE ROUTING, STRAPPING OF WIRES ETC.,</p> <p>PRE-CLOSURE INSPECTION, WORKMANSHIP AND CLEANLINESS (CAE/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</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</p>

PREPARED BY: MFMG

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**CRITICAL ITEMS LIST**

PROJECT: SRMS

ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
ASS'Y P/N: 51155E117

SHEET: 5

THEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOWR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	<p>MODE: LOSS OF ALL RMC CHANNELS.</p> <p>CAUSE(S): (1) LOSS OF 20V AC VOLTAGE. (2) LOSS OF +/-12 VOLT D.C. VOLTAGE. (3) ELECTRONIC PARTS FAILURE.</p>	<p>LOSS OF OUTPUT SIGNAL FROM THE RMC. ARM CANNOT BE COMMANDED FROM RMC. ARM MAY TAKE UNEXPECTED TRAJECTORY.</p> <p>WORST CASE ----- UNEXPECTED MOTION. INCORRECT H/C COMMANDS. UNANNOUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING ----- N/A</p>		<p>FORMAL TESTING (ACCEPTANCE OR QUALIFICATION).</p> <p>ACCEPTANCE TESTING (ATP) INCLUDES, AMBIENT, VIBRATION AND THERMAL TESTING (CAE/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</p> <p>INTEGRATION OF D&amp;C PANEL, RMC, IHC AND MCIU, INSPECTIONS ARE PERFORMED AT EACH STAGE OF INTEGRATION, WHICH INCLUDES GROUNDING CHECKS, INTER CONNECT CABLE VERIFICATION, CONNECTOR INSPECTION FOR BENT OR PUSHBACK CONTACTS ETC.</p> <p>SUB-SYSTEM PERFORMANCE TESTING (AIP), INCLUDES AN AMBIENT PERFORMANCE TEST. (MANDATORY INSPECTION POINT).</p> <p>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.</p> <p>SRMS SYSTEMS TESTING - STRONGBACK AND FLAT FLOOR AMBIENT PERFORMANCE TEST. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</p>

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SHEET: 6

P/N REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RISK / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	MODE: LOSS OF ALL RHC CHANNELS.  CAUSE(S): (1) LOSS OF 20V AC VOLTAGE.  (2) LOSS OF +/-12 VOLT D.C. VOLTAGE.  (3) ELECTRONIC PARTS FAILURE.	LOSS OF OUTPUT SIGNAL FROM THE RHC. ARM CANNOT BE COMMANDED FROM RHC. ARM MAY TAKE UNEXPECTED TRAJECTORY.  WORST CASE UNEXPECTED MOTION. INCORRECT H/C COMMANDS. UNANNUNCIATED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING ----- N/A	FAILURE HISTORY ----- THERE HAVE BEEN NO FAILURES ASSOCIATED WITH THIS FAILURE MODE ON THE SRMS PROGRAM.  NO EEE PARTS FAILURES HAVE OCCURRED SUBSEQUENT TO ASSEMBLY OF PARTS.	

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**CRITICAL ITEMS LIST**

PROJECT: SRMS  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: ORC SUBSYSTEM  
 ASS'Y P/N: 5155E117

SHEET: 7

PRA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOWR / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
1450	1	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 5155E117	MODE: LOSS OF ALL RHC CHANNELS.  CAUSE(S): (1) LOSS OF 20V AC VOLTAGE.  (2) LOSS OF +/-12 VOLT D.C. VOLTAGE.  (3) ELECTRONIC PARTS FAILURE.	LOSS OF OUTPUT SIGNAL FROM THE RHC. ARM CANNOT BE COMMANDED FROM RHC. ARM MAY TAKE UNEXPECTED TRAJECTORY.  WORST CASE UNEXPECTED MOTION. INCORRECT H/C COMMANDS. UNANNUNCIATED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING ----- N/A		OPERATIONAL EFFECTS ----- ARM DOES NOT RESPOND PROPERLY TO HAND CONTROLLER COMMANDS. CREW INHERENTLY COMPENSATES FOR ANY UNDESIRED ARM TRAJECTORY.  CREW ACTION ----- APPLY BRAKES.  CREW TRAINING ----- THE CREW WILL BE TRAINED TO OBSERVE WHETHER THE ARM IS RESPONDING PROPERLY TO COMMANDS. IF IT ISN'T, APPLY BRAKES.  MISSION CONSTRAINT ----- OPERATE UNDER VERMIER RATES WITHIN 10 FT OF 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.  SCREEN FAILURES ----- N/A  OMRSD OFFLINE ----- EXERCISE RHC IN ONE AXIS VERIFY VOLTAGE AT RHC OUTPUT  OMRSD ONLINE INSTALLATION ----- NONE  OMRSD ONLINE TURNAROUND ----- EXERCISE RHC IN ONE AXIS VERIFY BIT COUNT

PREPARED BY: HEMC

SUPERCEDING DATE: 06 OCT 87

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

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