

**CRITICAL ITEMS LIST**

PROJECT: SRMS

ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM

ASS'Y P/N: 51155E117

SHEET: 1

THEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. I/I CRITICALITY	RAISONNE FOR ACCEPTANCE
1470	0	ROTATIONAL HAND CONTROLLER QTY: 1 SPAR P/N 51155E117	<p>MODE: UNCOMMANDED OUTPUT IN ALL AXES.</p> <p>CAUSE(S): (1) LOSS OF +12V OR -12V DUE TO INPUT FILTER PARTS.</p>	<p>UNEXPECTED ARM MOTION. PERMANENT BIAS OF 35% IN ALL AXES IN ONE DIRECTION AND ZERO OUTPUT IN OTHER DIRECTION INABILITY TO ENTER MANUAL AUGMENTED MODES.</p> <p>WORST CASE</p> <p>UNEXPECTED MOTION, &amp; JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING</p> <p>N/A</p>		<p>DESIGN FEATURES</p> <p>EACH 12 VOLT SUPPLY IS FILTERED BY A SIMPLE R-C CIRCUIT COMPRISING A 22 OHM, ALR07 RESISTOR AND A 0.1UF, M39014/02 CAPACITOR. MAXIMUM STRESS RATIO FOR THE RESISTORS IS 10 PERCENT; AND FOR THE CAPACITORS, 25 PER CENT. THESE EEE PARTS ARE MOUNTED ON A PCB WHICH IS CONFIGURED AS A POTTED ASSEMBLY WITH THE INPUT CONNECTOR.</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-5G.340 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-STD-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> <p>BOARD ASSEMBLY DRAWINGS INCLUDE THE REQUIREMENT FOR SOLDERING STANDARDS IN ACCORDANCE WITH NHB 5300.4(3A) AND JSC 08600A.</p> <p>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.</p>

PREPARED BY: MFUG

SUPERSEDING DATE: 11 SEP 86

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SHEET: 2

THEA REF.	REV.	NAME DTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RDOR / YUNC. I/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1470	0	ROTATIONAL HAND CONTROLLER Q1Y-1 SPAR P/N 51155E117	<p>MODE: UNCOMMANDED OUTPUT IN ALL AXES.</p> <p>CAUSE(S):                      (1) LOSS OF +12V OR -12V DUE TO INPUT FILTER PARTS.</p>	<p>UNEXPECTED ARM MOTION.                      PERMANENT BIAS OF 35% IN ALL AXES IN ONE DIRECTION AND ZERO OUTPUT IN OTHER DIRECTION                      INABILITY TO ENTER MANUAL AUGMENTED MODES:</p> <p>WORST CASE                      -----                      UNEXPECTED MOTION, 6 JOINT RUNAWAY.                      UNANNUNCIATED.                      CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING                      -----                      N/A</p>		<p>ACCEPTANCE TESTS                      -----                      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, TNC 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                      -----                      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                      -----                      PDORS OPS CHECKLIST (ALL VEHICLES) JSC 16987</p>

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SHEET: 3

TMEA REF.	REV.	NAME QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT OR END ITEM	HDLR / YUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
1470	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	<p>MODE: UNCOMMANDED OUTPUT IN ALL AXES.</p> <p>CAUSE(S): (1) LOSS OF +12V OR -12V DUE TO INPUT FILTER PARTS.</p>	<p>UNEXPECTED ARM MOTION. PERMANENT BIAS OF 35X IN ALL AXES IN ONE DIRECTION AND ZERO OUTPUT IN OTHER DIRECTION INABILITY TO ENTER MANUAL AUGMENTED MODES.</p> <p>WORST CASE</p> <p>UNEXPECTED MOTION, &amp; JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING</p> <p>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 JSCM0000 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 0000A.</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 INSTRUMENTS, 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>

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SHEET: 4

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT OR END ITEM	HDLR / FUNC. 1/1 CRITICALITY RATIONALE FOR ACCEPTANCE
1470	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	<p>MODE: UNCOMMANDED OUTPUT IN ALL AXES.</p> <p>CAUSE(S): (1) LOSS OF +12V OR -12V DUE TO INPUT FILTER PARTS.</p>	<p>UNEXPECTED ARM MOTION. PERMANENT BIAS OF 35% IN ALL AXES IN ONE DIRECTION AND ZERO OUTPUT IN OTHER DIRECTION INABILITY TO ENTER MANUAL ALIGNED MODES.</p> <p>WORST CASE ..... UNEXPECTED MOTION, &amp; JOINT RUNAWAY. UNANNUNCIATED. 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, RHC, THC 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 (ASP), 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: 5

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDMR / FDMC, 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1470	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	MODE: UNCOMMANDED OUTPUT IN ALL AXES.  CAUSE(S): (1) LOSS OF +12V OR -12V DUE TO INPUT FILTER PARTS.	UNEXPECTED ARM MOTION. PERMANENT BIAS OF 35% IN ALL AXES IN ONE DIRECTION AND ZERO OUTPUT IN OTHER DIRECTION INABILITY TO ENTER MANUAL AUGMENTED MODES.  WORST CASE ----- UNEXPECTED MOTION, 6 JOINT RUNAWAY. 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.  DURING INITIAL EMI TESTING, THE RHC WAS FOUND TO BE SUSCEPTIBLE TO RADIATED EMISSIONS RESULTING IN UNCOMMANDED OUTPUTS IN EACH AXIS. THE PROBLEM WAS RESOLVED BY REDESIGN OF THE ROCKWELL SUPPLIED INTERCONNECT CABLE BETWEEN RHC AND THE D&C PANEL. THIS CABLE, P95B4(P) TO P471(S), HAS A DOUBLE SHIELD SYSTEM, WITH 360 DEGREE SHIELD CONTACT AT EACH CONNECTOR.

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SHEET: 6

P/N & REF.	REV.	NAME QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. I/F CRITICALITY	RATIONALE FOR ACCEPTANCE
1470	1	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	<p>MODE: UNCOMMANDED OUTPUT IN ALL AXES.</p> <p>CAUSE(S): (1) LOSS OF +12V OR -12V DUE TO INPUT FILTER PARTS.</p>	<p>UNEXPECTED ARM MOTION. PERMANENT BIAS OF 35K IN ALL AXES IN ONE DIRECTION AND ZERO OUTPUT IN OTHER DIRECTION INABILITY TO ENTER MANUAL AUGMENTED MODES.</p> <p>WORST CASE</p> <p>UNEXPECTED MOTION. 6 JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING</p> <p>N/A</p>		<p>OPERATIONAL EFFECTS</p> <p>ARM DOES NOT RESPOND PROPERLY TO COMMANDS OR DRIVES WITHOUT COMMAND. WHEN THE COMMAND IS REMOVED, THE ARM CONTINUES TO DRIVE.</p> <p>CREW ACTION</p> <p>APPLY BRAKES.</p> <p>CREW TRAINING</p> <p>THE CREW WILL BE TRAINED TO ALWAYS OBSERVE WHETHER THE ARM IS RESPONDING PROPERLY TO COMMANDS. IF IT ISN'T, APPLY BRAKES.</p> <p>MISSION CONSTRAINT</p> <p>OPERATE UNDER VERNIER 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.</p> <p>SCREEN FAILURES</p> <p>N/A</p> <p>ORRSO OFFLINE</p> <p>EXERCISE RHC IN ALL AXES VERIFY VOLTAGES AT OUTPUT OF RHC VERIFY CURRENT DRAW</p> <p>ORRSO ONLINE INSTALLATION</p> <p>NONE</p> <p>ORRSO ONLINE TURNAROUND</p> <p>EXERCISE RHC IN ALL AXES VERIFY BIT COUNT IN EACH AXIS</p>

PREPARED BY: HEMG

SUPERSEDING DATE: 06 OCT 07

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