

**CRITICAL ITEMS LIST**

PROJECT: SRMS  
ASS'Y NOMENCLATURE: MOTOR MODULE

SYSTEM: MECHANICAL ARM SUBSYSTEM  
ASS'Y P/N: 51140E1214

SHEET: 1

PWA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HWR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
4060	0	MOTOR DC BRUSHLESS QTY-6 51140C121-1	<p>MODE: REDUCED DRIVE TORQUE.</p> <p>CAUSE(S): (1) MOTOR WINDING OPEN.</p> <p>(2) INPUT LEAD TO MOTOR OPEN CIRCUIT.</p>	<p>CAUSE(1) MOTOR WILL DRIVE WITH REDUCED TORQUE (56X) (SLUGGISH) DYNAMIC BRAKING WILL BE REDUCED. ARM MAY TAKE UNEXPECTED TRAJECTORY.</p> <p>CAUSE(2) MOTOR MAY NOT CONTINUE TO DRIVE (TORQUE 33X). DYNAMIC BRAKING WILL BE REDUCED TO 33X. ARM MAY TAKE UNEXPECTED TRAJECTORY. IF STOPPED JOINT WILL NOT DRIVE.</p> <p>WORST CASE UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING N/A</p>	<p>DESIGN FEATURES</p>	<p>THE JOINT MOTOR IS A MAJOR BOUGHT-OUT PART WHICH IS SUPPLIED BY SPERRY CORPORATION, AEROSPACE AND MARINE GROUP AND MEETS OR EXCEEDS THE REQUIREMENTS OF SPECIFICATION SPAR-SG.388.</p> <p>THE MOTOR COMPRISES:-</p> <p>A MULTIPOLE ROTOR BUILT WITH "RARE EARTH" PERMANENT MAGNETS.</p> <p>A WOUND STATOR, CONSISTING OF 48 COILS WOUND IN GROUPS OF 16. THE 3 GROUPS ARE SYMMETRICALLY ARRANGED AND INSERTED IN 48 RADIAL SLOTS IN A LAMINATED STEEL CORE. THE ENDS OF THE 3 COIL GROUPS ARE JOINED AND CONNECTED TO TEFLON INSULATED LEAD WIRES TO FORM THE CONVENTIONAL "DELTA" CONFIGURATION.</p> <p>THE WINDING FEATURES THAT HELP PREVENT SHORT OR OPEN CIRCUITS ARE:-</p> <ul style="list-style-type: none"> <li>- INSULATION IS TO CLASS 105 (H)</li> <li>- WIRE USED IN HEAVY ML MAGNET WIRE.</li> <li>- COILS ARE BAKED TO STRESS RELIEVE COPPER AND INSULATION.</li> <li>- SLOTS HAVE POLYIMIDE LINER.</li> <li>- END WINDINGS ARE ENCLOSED IN FIBREGLASS COVERS.</li> <li>- WINDING IS VACUUM IMPREGNATED USING 100% SOLID EPOXY, THIS IMPARTS GOOD THERMAL AND MECHANICAL PERFORMANCE.</li> </ul> <p>THE TEFLON INPUT LEADS ARE SOLDERED TO THE WINDING PER MHD5300.4 (3A) REQUIREMENTS. THE CONNECTIONS ARE SUPPORTED WITHIN THE FIBREGLASS END WINDING COVER.</p> <p>CONNECTOR USED ARE TO GSFC SPECIFICATION S.311.P.4/9.</p> <p>CONTACTS USED ARE TO GSF SPEC.S.311.P.4/9.</p> <p>CRIMPING IS CONTROLLED TO SPAR PPS 9:17 WHICH EMBODIES NSC-SPEC-Q-1A.</p>

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P/N REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HORN / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
4060	0	MOTOR DC BRUSHLESS QTY-8 51140C121-1	MODE: REDUCED DRIVE TORQUE.  CAUSE(S): (1) MOTOR WINDING OPEN.  (2) INPUT LEAD TO MOTOR OPEN CIRCUIT.	CAUSE(1) MOTOR WILL DRIVE WITH REDUCED TORQUE (56%) (SLUGGISH) DYNAMIC BRAKING WILL BE REDUCED. ARM MAY TAKE UNEXPECTED TRAJECTORY.  CAUSE(2) MOTOR MAY NOT CONTINUE TO DRIVE (TORQUE 33%). DYNAMIC BRAKING WILL BE REDUCED TO 33%. ARM MAY TAKE UNEXPECTED TRAJECTORY. IF STOPPED JOINT WILL NOT DRIVE.  WORST CASE UNEXPECTED MOTION. SLUGGISH JOINT. UNANNOUNCED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING ..... N/A	ACCEPTANCE TESTS ..... THE JOINTS MOTOR MODULE ASSEMBLY CONSIST OF THE BRAKE ASSEMBLY, MOTOR ASSEMBLY, TACHOMETER, COMM. SCANNER AND SCU ALL OF WHICH ARE EXPOSED TO AN ACCEPTANCE TEST BY THE VENDOR PRIOR TO ACCEPTANCE BY SPAR. THE MOTOR MODULE ASSEMBLY IS SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENT:  O VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 8  O THERMAL VACUUM: +85 DEGREES C TO -25 DEGREES C (1.5 CYCLES) 1 X 10**5 TORR  THE MOTOR MODULE IS INSTALLED IN THE JOINTS ASSEMBLY AND AGAIN IS EXPOSED TO ANOTHER ACCEPTANCE TEST, WHICH INCLUDES VIBRATION AND THERMAL VACUUM OF THE SAME APPROXIMATE LEVEL AND DURATION.  QUALIFICATION TESTS ..... A TYPICAL MOTOR MODULE ASSEMBLY WAS TOTALLY QUALIFIED BY SPAR FOR THE LISTED BELOW ENVIRONMENTS. FURTHER, THE BRAKE ASSEMBLY, MOTOR ASSEMBLY, TACHOMETER AND COMM. SCANNER, ARE SUBJECTED TO SOME DEGREE OF QUALIFICATION TESTING BY THE VENDOR. THE MOTOR MODULE TESTS:  O VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 8  O THERMAL VACUUM: +96 DEGREE C TO -36 DEGREE C (8 CYCLES) 1 X 10**6 TORR  O SHOCK: 20G/11 MS - 3 AXES (6 DIRECTIONS)  O HUMIDITY: TESTED IN SHOULDER JOINT HUMIDITY TEST  O EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CS01, CS02, CS06, CE01, RE02(N/D), RS03, RS04)  FLIGHT CHECKOUT ..... PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987	

PREPARED BY: HWG

SUPERSEDING DATE: 11 SEP 86

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

DATE: \_\_\_\_\_

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ASS'Y P/N: 51140E1214 SHEET: 3

P/N REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. I/I CRITICALITY RATIONALE FOR ACCEPTANCE
4060	0	MOTOR DC BRUSHLESS QTY-6 51140C121-1	<p>MODE: REDUCED DRIVE TORQUE.</p> <p>CAUSE(S): (1) MOTOR WINDING OPEN.</p> <p>(2) INPUT LEAD TO MOTOR OPEN CIRCUIT.</p>	<p>CAUSE(1) MOTOR WILL DRIVE WITH REDUCED TORQUE (56X) (SLUGGISH) DYNAMIC BRAKING WILL BE REDUCED. ARM MAY TAKE UNEXPECTED TRAJECTORY.</p> <p>CAUSE(2) MOTOR MAY NOT CONTINUE TO DRIVE (TORQUE 33X). DYNAMIC BRAKING WILL BE REDUCED TO 33X. ARM MAY TAKE UNEXPECTED TRAJECTORY. IF STOPPED JOINT WILL NOT DRIVE.</p> <p>WORST CASE ----- UNEXPECTED MOTION. SLUGGISH JOINT. UNANNOUNCIATED. CREW ACTION REQ.</p> <p>REDUNDANT PATHS REMAINING ----- N/A</p>	<p>QA/INSPECTIONS -----</p> <p>UNITS ARE MAJOR BOUGHT OUT PARTS, MANUFACTURED, ASSEMBLED AND TESTED TO SPAR DRAWINGS AND SPECIFICATIONS UNDER DOCUMENTED QUALITY CONTROLS. THESE CONTROLS ARE EXERCISED THROUGHOUT DESIGN PROCUREMENT, PLANNING, PROCESSING, FABRICATION, ASSEMBLY QUALIFICATION AND ACCEPTANCE TESTING. MANDATORY INSPECTION POINTS ARE EMPLOYED AS APPROPRIATE AT VARIOUS LEVELS OF ASSEMBLY AND TEST. SPAR/GOVERNMENT SOURCE INSPECTION IS ENVOCKED ON THE SUPPLIER.</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 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>MAGNET WIRE IS PROCURED TO MIL-W-503 AND CHECKED AT INCOMING INSPECTION PER FEDERAL STANDARD J-M-1177 WHICH INCLUDES DIELECTIC, PIN HOLES, BUBBLES, BLISTERS, AND CRACKS IN THE INSULATION.</p> <p>ALL SOLDERING IS ACCOMPLISHED BY OPERATORS, WHO ARE TRAINED AND CERTIFIED TO NASA MMS300.4(3A) STANDARD, AS MODIFIED BY JSC 0000A.</p> <p>UNITS ARE INSPECTED TO THE APPLICABLE SPAR INSPECTION TEST PROCEDURE (ITP). INSPECTIONS INCLUDE CLEANLINESS USING UV, GENERAL WORKMANSHIP, DIMENSIONAL, IDENTIFICATION, LEAD CONFIGURATION, CONTINUITY CHECK ETC.</p> <p>INTEGRATION OF UNIT TO MOTOR MODULE - INSPECTIONS INCLUDE GROUNDING CHECKS, CONNECTOR FOR BENT PINS, VISUAL, CLEANLINESS, INTERCONNECT WIRING ETC.</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> <p>ACCEPTANCE TESTING (ATP) INCLUDES, AMBIENT, VIBRATION AND THERMAL-VAC TESTING, (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</p>

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ITEM REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. 1/1 RATIONALE FOR ACCEPTANCE
4060	0	MOTOR DC BRUSHLESS QTY-6 51140C121-1	MODE: REDUCED DRIVE TORQUE.  CAUSE(S): (1) MOTOR WINDING OPEN.  (2) INPUT LEAD TO MOTOR OPEN CIRCUIT.	CAUSE(1) MOTOR WILL DRIVE WITH REDUCED TORQUE (56%) (SLUGGISH) DYNAMIC BRAKING WILL BE REDUCED. ARM MAY TAKE UNEXPECTED TRAJECTORY.  CAUSE(2) MOTOR MAY NOT CONTINUE TO DRIVE (TORQUE 33%). DYNAMIC BRAKING WILL BE REDUCED TO 33%. ARM MAY TAKE UNEXPECTED TRAJECTORY. IF STOPPED JOINT WILL NOT DRIVE.  WORST CASE ..... UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING ..... N/A	INTEGRATION OF UNIT TO JOINT SRU - INSPECTIONS INCLUDE GROUNDING CHECKS, CONNECTORS FOR BENT OR PUSHBACK CONTACTS, VISUAL, CLEANLINESS, INTERCONNECT WIRING AND POWER UP TEST TO THE APPROPRIATE JOINT INSPECTION TEST PROCEDURE (ITP) ETC.  JOINT LEVEL PRE-ACCEPTANCE TEST INSPECTION, INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC.  JOINT LEVEL 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: MFVG

SUPERCEDING DATE: 11 SEP 86

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

AIC: \_\_\_\_\_

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FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RDRN / FUNC. 1/1 CRITICALITY RATIONALE FOR ACCEPTANCE
4060	0	MOTOR DC BRUSHLESS QTY-6 51140C121-1	MODE: REDUCED DRIVE TORQUE.  CAUSE(S): (1) MOTOR WINDING OPEN.  (2) INPUT LEAD TO MOTOR OPEN CIRCUIT.	CAUSE(1) MOTOR WILL DRIVE WITH REDUCED TORQUE (56%) (SLUGGISH) DYNAMIC BRAKING WILL BE REDUCED. ARM MAY TAKE UNEXPECTED TRAJECTORY.  CAUSE(2) MOTOR MAY NOT CONTINUE TO DRIVE (TORQUE 33%). DYNAMIC BRAKING WILL BE REDUCED TO 33%. ARM MAY TAKE UNEXPECTED TRAJECTORY. IF STOPPED JOINT WILL NOT DRIVE.  WORST CASE UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING N/A	FAILURE HISTORY THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT:  FAR 1300: S/W 301 OCT 82  DESCRIPTION WJ CONN J309A, PIN 47 PUSHED BACK  CORRECTIVE ACTION REPLACED CONN

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PMA REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RISK / FUNC. 1/1 CRITICALITY RATIONALE FOR ACCEPTANCE
4060	0	MOTOR DC BRUSHLESS QTY-6 51140C121-1	MODE: REDUCED DRIVE TORQUE.  CAUSE(S): (1) MOTOR WINDING OPEN.  (2) INPUT LEAD TO MOTOR OPEN CIRCUIT.	CAUSE(1) MOTOR WILL DRIVE WITH REDUCED TORQUE (56%) (SLUGGISH) DYNAMIC BRAKING WILL BE REDUCED. ARM MAY TAKE UNEXPECTED TRAJECTORY.  CAUSE(2) MOTOR MAY NOT CONTINUE TO DRIVE (TORQUE 33%). DYNAMIC BRAKING WILL BE REDUCED TO 33%. ARM MAY TAKE UNEXPECTED TRAJECTORY. IF STOPPED JOINT WILL NOT DRIVE.  WORST CASE UNEXPECTED MOTION. SLUGGISH JOINT. UNANNUNCIATED. CREW ACTION REQ.  REDUNDANT PATHS REMAINING N/A	OPERATIONAL EFFECTS ARM DOES NOT RESPOND PROPERLY TO COMMANDS. FOR 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 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. AUTOTRAJECTORIES MUST BE DESIGNED TO COME NO CLOSER THAN 5 FT FROM STRUCTURE.  SCREEN FAILURES N/A  OMRSD OFFLINE IN DIRECT DRIVE WITH ELBOW DEMATED VERIFY RATES FOR ALL JOINTS  OMRSD ONLINE INSTALLATION NONE  OMRSD ONLINE TURNAROUND NONE

PREPARED BY: HFWG SUPERCEDING DATE: 11 SEP 86 APPROVED BY:

E: