## CRITICAL ITEMS LIST

PROJECT: SRMS (-5 MCIU INSTALLED) SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y NOMENCLATURE: MOTOR MODULE ASS'Y P/N: 51140E1214 SHEET: 1

| FMEA REF. | FMEA REV. | NAME, QTY, & DRAWING REF. DESIGNATION | FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | HDWR / FUNC. 2/1R CRITICALITY — RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS |
|---|---|---|---|---|---|
| 4055 | 0 | MOTOR DC BRUSHLESS QTY-6 51140C121-1 | MODE: LOSS OF DRIVE TORQUE.<br><br>CAUSE(S): (1) MOTOR WINDINGS SHORTED. | LOSS OF ABILITY TO DRIVE JOINT IN PRIME OR BACKUP MODES. SPA FUSE WILL BLOW. AUTOBRAKES ARE APPLIED. ARM COMES TO REST. LOSS OF COMPUTER SUPPORTED MODES. IF BACKUP SELECTED BDA FUSE WILL BLOW. LOSS OF ALL MODES. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>LOSS OF ALL MODES. FREE JOINT. CREW ACTION REQUIRED. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>1) AUTOBRAKES (TO SAFE THE SYSTEM)<br>2) JETTISON (TO SECURE ORBITER). | DESIGN FEATURES<br>---<br><br>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.<br><br>THE MOTOR COMPRISES:-<br><br>A MULTIPOLE ROTOR BUILT WITH "RARE EARTH" PERMANENT MAGNETS.<br><br>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.<br><br>THE WINDING FEATURES THAT HELP PREVENT SHORT OR OPEN CIRCUITS ARE:-<br><br>- INSULATION IS TO CLASS 185 (H)<br>- WIRE USED IN HEAVY ML MAGNET WIRE.<br>- COILS ARE BAKED TO STRESS RELIEVE COPPER AND INSULATION.<br>- SLOTS HAVE POLYMIDE LINER.<br>- END WINDINGS ARE ENCLOSED IN FIBREGLASS COVERS.<br>- WINDING IS VACUUM IMPREGNATED USING 100% SOLID EPOXY, THIS IMPARTS GOOD THERMAL AND MECHANICAL PERFORMANCE. |

PREPARED BY: MFWG SUPERCEDING DATE: NONE DATE: 11 JI



SHEET: 2

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ASS'Y NOMENCLATURE: MOTOR MODULE ASS'Y P/N: 51T40E1214

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| 4055 | 0 | MOTOR DC BRUSHLESS QTY-6 51140C121-1 | MODE: LOSS OF DRIVE TORQUE.<br><br>CAUSE(S): (1) MOTOR WINDINGS SHORTED. | LOSS OF ABILITY TO DRIVE JOINT IN PRIME OR BACKUP MODES. SPA FUSE WILL BLOW. AUTOBRAKES ARE APPLIED. ARM COMES TO REST. LOSS OF COMPUTER SUPPORTED MODES. IF BACKUP SELECTED BDA FUSE WILL BLOW. LOSS OF ALL MODES. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>LOSS OF ALL MODES. FREE JOINT. CREW ACTION REQUIRED. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>1) AUTOBRAKES (TO SAFE THE SYSTEM)<br>2) JETTISON (TO SECURE ORBITER). | ACCEPTANCE TESTS<br>---<br>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:<br><br>O VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 8<br><br>O THERMAL VACUUM: +85 DEGREES C TO -25 DEGREES C (1.5 CYCLES) 1 X 10**5 TORR<br><br>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.<br><br>QUALIFICATION TESTS<br>---<br>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:<br><br>O VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 8<br><br>O THERMAL VACUUM: +96 DEGREE C TO -36 DEGREE C (8 CYCLES) 1 X 10**6 TORR<br><br>O SHOCK: 20G/11 MS - 3 AXES (6 DIRECTIONS)<br><br>O HUMIDITY: TESTED IN SHOULDER JOINT HUMIDITY TEST<br><br>O EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CS01, CS02, CS06, CE01, RE02(N/B), RS03, RS04)<br><br>FLIGHT CHECKOUT<br>---<br>PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987 |

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PROJECT: SRMS (-5 MCIU INSTALLED) SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y NOMENCLATURE: MOTOR MODULE ASS'Y P/N: 51140E1214 SHEET: 3

| FMEA REF. | FMEA REV. | NAME, QTY, & DRAWING REF. DESIGNATION | FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | HDWR / FUNC. 2/1R CRITICALITY — RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS |
|---|---|---|---|---|---|
| 4055 | 0 | MOTOR DC BRUSHLESS QTY-6 51140C121-1 | MODE: LOSS OF DRIVE TORQUE.<br><br>CAUSE(S): (1) MOTOR WINDINGS SHORTED. | LOSS OF ABILITY TO DRIVE JOINT IN PRIME OR BACKUP MODES. SPA FUSE WILL BLOW. AUTOBRAKES ARE APPLIED. ARM COMES TO REST. LOSS OF COMPUTER SUPPORTED MODES. IF BACKUP SELECTED BDA FUSE WILL BLOW. LOSS OF ALL MODES. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>LOSS OF ALL MODES. FREE JOINT. CREW ACTION REQUIRED. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>1) AUTOBRAKES (TO SAFE THE SYSTEM)<br>2) JETTISON (TO SECURE ORBITER). | QA/INSPECTIONS<br>---<br><br>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 ENVOKED ON THE SUPPLIER.<br><br>WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-81381 AND INSPECTED AND TESTED TO NASA JSCM8080 STANDARD NUMBER 95A.<br><br>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.<br><br>PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE,<br><br>MAGNET WIRE IS PROCURED TO MIL-W-583 AND CHECKED AT INCOMING INSPECTION PER FEDERAL STANDARD J-W-1177 WHICH INCLUDES DIELECTIC, PIN HOLES, BUBBLES, BLISTERS, AND CRACKS IN THE INSULATION.<br><br>ALL SOLDERING IS ACCOMPLISHED BY OPERATORS, WHO ARE TRAINED AND CERTIFIED TO NASA NHB5300.4(3A) STANDARD, AS MODIFIED BY JSC 08800A.<br><br>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.<br><br>INTEGRATION OF UNIT TO MOTOR MODULE - INSPECTIONS INCLUDE GROUNDING CHECKS, CONNECTOR FOR BENT PINS, VISUAL, CLEANLINESS, INTERCONNECT WIRING ETC.<br><br>PRE-ACCEPTANCE TEST INSPECTION, WHICH INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC., (MANDATORY INSPECTION POINT).<br><br>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 GOVENMENT REPRESENTATIVE, PRIOR TO THE START OF ANY FORMAL TESTING (ACCEPTANCE OR QUALIFICATION).<br><br>ACCEPTANCE TESTING (ATP) INCLUDES, AMBIENT, VIBRATION AND THERMAL-VAC TESTING, (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT) |

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# CRITICAL ITEMS LIST

PROJECT: SRMS (-5 MCIU INSTALLED) SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y NOMENCLATURE: MOTOR MODULE ASS'Y P/N: S1140E1214 SHEET: 4

| FMEA REF. | FMEA REV. | NAME, QTY, & DRAWING REF. DESIGNATION | FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | HDWR / FUNC. 2/1R CRITICALITY / RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS |
|---|---|---|---|---|---|
| 4055 | D | MOTOR DC BRUSHLESS QTY-6 S1140C121-1 | MODE: LOSS OF DRIVE TORQUE.<br><br>CAUSE(S): (1) MOTOR WINDINGS SHORTED. | LOSS OF ABILITY TO DRIVE JOINT IN PRIME OR BACKUP MODES. SPA FUSE WILL BLOW. AUTOBRAKES ARE APPLIED. ARM COMES TO REST. LOSS OF COMPUTER SUPPORTED MODES. IF BACKUP SELECTED BOA FUSE WILL BLOW. LOSS OF ALL MODES. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>LOSS OF ALL MODES. FREE JOINT. CREW ACTION REQUIRED. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>1) AUTOBRAKES (TO SAFE THE SYSTEM)<br>2) JETTISON (TO SECURE ORBITER). | 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.<br><br>JOINT LEVEL PRE-ACCEPTANCE TEST INSPECTION, INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC.<br><br>JOINT LEVEL ACCEPTANCE TESTING (ATP) INCLUDES AMBINET, VIBRATION AND THERMAL-VAC TESTING. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT).<br><br>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.<br><br>SRMS SYSTEMS TESTING - STRONGBACK AND FLAT FLOOR AMBIENT PERFORMANCE TEST. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT) |

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ASS'Y NOMENCLATURE: MOTOR MODULE ASS'Y P/N: 51T40E1214 SHEET: 5

| FMEA REF. | FMEA REV. | NAME, QTY, & DRAWING REF. DESIGNATION | FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | HDWR / FUNC. 2/1R CRITICALITY — RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS |
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| FMEA REF. | FMEA REV. | NAME, QTY, & DRAWING REF. DESIGNATION | FAILURE MODE AND CAUSE | FAILURE EFFECT ON END ITEM | HDWR / FUNC. 2/1R CRITICALITY<br>RATIONALE FOR ACCEPTANCE<br>SCREENS: A-PASS, B-PASS, C-PASS |
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