CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MOTOR MODULE
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51T40E1214
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
4120	1	BRAKE ASSEMBLY P/N 51T40F688 -1,-3,-5 QTY-6	MODE: BRAKES PERMANENTLY DISENGAGED OR REDUCED BRAKING TORQUE. CAUSE(S): (1) MECHANICAL BINDING. (2) BROKEN SPRING. (3) WORN BRAKE SURFACE.	NO EFFECT IN COMPUTER SUPPORTED MODES. IN DIRECT DRIVE WITH NO COMMAND TO FAILED JOINT JOINT FAILS FREE OR IS ONLY PARTIALLY BRAKED. FOR JOINT RUNAWAY CONSISTENCY CHECK WILL DETECT BUT FAILED JOINT WILL NOT STOP. WORST CASE --- LOSS OF BRAKE ON ONE JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING --- N/A		DESIGN FEATURES --- THE JOINT BRAKE 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.468. THE BRAKE USES FOUR PINS PRESS FITTED INTO THE CORE TO HOLD THE ARMATURE FROM ROTATING AND TO ALLOW AXIAL SLIDING FOR ENGAGEMENT AND DISENGAGEMENT. THE FOLLOWING IS A LIST OF CHARACTERISTICS TO LIMIT THE POSSIBILITY OF THE BRAKE HANGING-UP DUE TO MECHANICAL BINDING BETWEEN THE PINS AND THE HOLES. THE HOLES IN THE ARMATURE AND BRAKE CORE ARE MATCH-BORED (JIG BORED) TO ASSURE GOOD ALIGNMENT. THE ARMATURE HOLES ARE 0.004 TO 0.005 INCH LARGER THAN THE CORE PINS TO ASSURE ADEQUATE CLEARANCE. MEASUREMENTS ARE PERFORMED TO CONFIRM A MINIMUM OF 0.002 INCH RADIAL PLAY BETWEEN THE TWO ASSEMBLED PARTS. THE UNIT IS TESTED A MINIMUM OF SEVEN TIMES DURING ACCEPTANCE TESTING FOR POTENTIAL BINDING. THE TEST CONSISTS OF APPLYING FULL RATED LOAD TORQUE WITH THE UNIT ENGAGED. A VOLTAGE IS THEN APPLIED TO DISENGAGE THE UNIT. THE TIME FROM APPLICATION OF VOLTAGE UNTIL FULL DISENGAGEMENT IS MEASURED. ANY BINDING OF THE ARMATURE WOULD EITHER PREVENT DISENGAGEMENT OR CAUSE AN EXCESSIVE TIME DELAY. THE PINS ARE LUBRICATED WITH MOLYBDENUM DISULFIDE. THE SOLID FILM LUBRICANT SYSTEM USED IS LUBECO 905. THIS COMPRISES A SPRAY AND CURE (400 DEGREES F) APPLICATION OF MOLYDENUM DISULPHIDE, IN AN IN ORGANIC BINDER APPLIED PER PPS:28:11 AND 28:13. BURNISHING AND RUN IN PER SPAR PPS 28:14. THE LUBRICATED BEARING IS TORQUE TRACED TO ENSURE ACCEPTABILITY PER SPAR PPS.28:14.

PREPARED BY: MFWG
SUPERCEDING DATE: 30 SEP 86
APPROVED BY:

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PROJECT: SRMS
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SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140ET214
SHEET: 2

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
4120	1	BRAKE ASSEMBLY P/N 51140F688 -1,-3,-5 QTY-6	MODE: BRAKES PERMANENTLY DISENGAGED OR REDUCED BRAKING TORQUE. CAUSE(S): (1) MECHANICAL BINDING. (2) BROKEN SPRING. (3) WORN BRAKE SURFACE.	NO EFFECT IN COMPUTER SUPPORTED MODES. IN DIRECT DRIVE WITH NO COMMAND TO FAILED JOINT JOINT FAILS FREE OR IS ONLY PARTIALLY BRAKED. FOR JOINT RUNAWAY CONSISTENCY CHECK WILL DETECT BUT FAILED JOINT WILL NOT STOP. WORST CASE --- LOSS OF BRAKE ON ONE JOINT. UNANNUNCIATED. 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/B), RS03, RS04) FLIGHT CHECKOUT --- PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987

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PROJECT: SRMS
ASS'Y NOMENCLATURE: MOTOR MODULE
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1214
SHEET: 3

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
4120	1	BRAKE ASSEMBLY P/N 51140F688 -1,-3,-5 QTY-6	MODE: BRAKES PERMANENTLY DISENGAGED OR REDUCED BRAKING TORQUE. CAUSE(S): (1) MECHANICAL BINDING. (2) BROKEN SPRING. (3) WORN BRAKE SURFACE.	NO EFFECT IN COMPUTER SUPPORTED MODES. IN DIRECT DRIVE WITH NO COMMAND TO FAILED JOINT JOINT FAILS FREE OR IS ONLY PARTIALLY BRAKED. FOR JOINT RUNAWAY CONSISTENCY CHECK WILL DETECT BUT FAILED JOINT WILL NOT STOP. WORST CASE --------- LOSS OF BRAKE ON ONE JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING --------- N/A		QA/INSPECTIONS --------- 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. 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, GEAR INSPECTION, BEFORE GEAR LUBRICATION AND RUN-IN A COMPOSITE ERROR GEAR CHECKER IS USED TO VERIFY THAT INVOLUTE FORM, PITCH CIRCLE CONCENTRICITY AND PITCH DIAMETER ARE TO DRAWING REQUIREMENTS. THIS INSPECTION ALSO INCLUDES TEXTURE EVALUATION. AFTER LUBRICATION, GEARS ARE VISUALLY INSPECTED TO CONFIRM APPROPRIATE LUBRICANT APPLICATION AND GEARS ARE THEN RUN-IN, CLEANED AND VISUALLY INSPECTED. SHAFTS ARE DIMENSIONAL INSPECTED TO DRAWING REQUIREMENTS THROUGHOUT THE MANUFACTURING STAGES. FOLLOWING HEAT TREATMENT THE SHAFTS ARE SUBJECTED TO MAGNETIC PARTICLE INSPECTION FOR CRACKS. BEARINGS RECEIVE DIMENSIONAL INSPECTION AT THE SUPPLIER AND VERIFICATION BY SPAR RECEIVING INSPECTION. PRE-ASSEMBLY INSPECTION VERIFIES CIRCULARITY OF BALL TRACKS AND INNER/OUTER RACE DIAMETERS. AFTER ASSEMBLY PRIOR TO LUBRICATION, RADIAL CLEARANCE MEASUREMENTS ARE TAKEN. FOLLOWING LUBRICATION, RUN-IN/BURNISHING AND CLEANING OF DRY LUBE BEARINGS, SPECIALIZED BEARING INSPECTION EQUIPMENT AT SPAR IS USED TO VERIFY QUALITY AND STICTION LEVELS THROUGH STRIP CHART RECORDING OF TORQUE TRACES. BEARINGS ARE THEN RETURNED TO THE SUPPLIER FOR FINAL RADIAL CLEARANCE MEASUREMENTS. GOVERNMENT SOURCE INSPECTION IS ENVOKED ON ALL BEARING PROCUREMENTS. INSPECTION VERIFIES THAT KITTED PARTS ARE CORRECT PRIOR TO ASSEMBLY AND TRACEABILITY INFORMATION RECORDED. INSPECTION TO DRAWING IS CONDUCTED THROUGHOUT THE ASSEMBLY PROCESS, INCLUDING INSPECTION OF LOCKING, WITNESSING OF TORQUING AND APPLICATION OF TORQUE STRIPING. UNITS ARE INSPECTED TO THE APPLICABLE SPAR INSPECTION TEST PROCURE (ITP). PRIOR TO M/M INTEGRATION, INSPECTIONS INCLUDE CLEANLINESS USING U.V, GENERAL WORKMANSHIP, DIMENSIONAL, SPLINE FOR DRY LUBRICATION, CORRECT INSTALLATION OF BEARING,

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ASS'Y P/N: 51140E1214
SHEET: 4

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
4120	1	BRAKE ASSEMBLY P/N 51140F688 -1,-3,-5 QTY-6	MODE: BRAKES PERMANENTLY DISENGAGED OR REDUCED BRAKING TORQUE. CAUSE(S): (1) MECHANICAL BINDING. (2) BROKEN SPRING. (3) WORN BRAKE SURFACE.	NO EFFECT IN COMPUTER SUPPORTED MODES. IN DIRECT DRIVE WITH NO COMMAND TO FAILED JOINT JOINT FAILS FREE OR IS ONLY PARTIALLY BRAKED. FOR JOINT RUNAWAY CONSISTENCY CHECK WILL DETECT BUT FAILED JOINT WILL NOT STOP. WORST CASE ---------- LOSS OF BRAKE ON ONE JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING ---------- N/A		WIRE LEADS FOR DAMAGE, IDENTIFICATION AND FUNCTIONAL TEST TO VERIFY BRAKE SLIP TORQUE, STICTION, DROPOUT VOLTAGE, PULL-IN VOLTAGE ETC. INTEGRATION OF UNIT TO MOTOR MODULE - INSPECTIONS INCLUDE GROUNDING CHECKS, CONNECTOR FOR BENT PINS, VISUAL, CLEANLINESS, INTERCONNECT WIRING ETC. 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/ 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) 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 AMBINET, 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)

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ASS'Y P/N: 51140E1214

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDW / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
4120	1	BRAKE ASSEMBLY P/N 51140F688 -1, -3, -5 QTY 6	MODE: BRAKES PERMANENTLY DISENGAGED OR REDUCED BRAKING TORQUE. CAUSE(S): (1) MECHANICAL BINDING. (2) BROKEN SPRING. (3) WORN BRAKE SURFACE.	NO EFFECT IN COMPUTER SUPPORTED MODES. IN DIRECT DRIVE WITH NO COMMAND TO FAILED JOINT JOINT FAILS FREE OR IS ONLY PARTIALLY BRAKED. FOR JOINT RUNAWAY CONSISTENCY CHECK WILL DETECT BUT FAILED JOINT WILL NOT STOP. WORST CASE LOSS OF BRAKE ON ONE JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING N/A		FAILURE HISTORY THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT: FAR 1314: S/N 302 OCT 83 DESCRIPTION SJ PITCH MOVED DURING STIFFNESS TEST, BRAKE SLIPPED CORRECTIVE ACTION NONE FAR 2018: S/N 202-9 OCT 78 DESCRIPTION BRAKE SLIP TOO LOW, FRICTION MATERIAL INADEQUATE. CORRECTIVE ACTION NEW FRICTION MATERIAL USED. RELAXED TORQUE REQUIREMENTS ECR-M-188. ALL UNITS REWORKED. FAR 2019: S/N 201-9 OCT 78 DESCRIPTION BRAKE SLIP FAILED AT HIGH (+800C) TEMP FRICTION MATERIAL INADEQUATE CORRECTIVE ACTION REFER TO FAR 2018 FAR 2076: S/N 202-1 JUN 79 DESCRIPTION BRAKE SLIP TOO LOW, BRAKE S/N 204-5, DUE TO MOISTURE APSURPTION CORRECTIVE ACTION NONE REQUIRED FAR 2117: S/N 203-7 SEP 80 DESCRIPTION

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FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	MDUR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
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SHEET: 7

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SHEET: 8

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 1/1 CRITICALITY — RATIONALE FOR ACCEPTANCE
4120	1	BRAKE ASSEMBLY P/N 51140F688 -1,-3,-5 QTY-6	MODE: BRAKES PERMANENTLY DISENGAGED OR REDUCED BRAKING TORQUE. CAUSE(S): (1) MECHANICAL BINDING. (2) BROKEN SPRING. (3) WORN BRAKE SURFACE.	NO EFFECT IN COMPUTER SUPPORTED MODES. IN DIRECT DRIVE WITH NO COMMAND TO FAILED JOINT JOINT FAILS FREE OR IS ONLY PARTIALLY BRAKED. FOR JOINT RUNAWAY CONSISTENCY CHECK WILL DETECT BUT FAILED JOINT WILL NOT STOP. WORST CASE LOSS OF BRAKE ON ONE JOINT. UNANNUNCIATED. REDUNDANT PATHS REMAINING N/A	OPERATIONAL EFFECTS NONE IN COMPUTER SUPPORTED MODES. JOINT WILL FAIL FREE WHEN BRAKE APPLIED AND EXCESSIVE SLIP MAY OCCUR IF PRCS FIRED. ARM WILL NOT STOP AUTOMATICALLY AFTER A JOINT FAILURE. CREW ACTION STOW ARM USING SINGLE. DO NOT USE DIRECT DRIVE OR BACKUP. CREW TRAINING CREW SHOULD BE TRAINED TO RECOGNIZE NOMINAL STOPPING DISTANCE FOR DIRECT DRIVE MISSION CONSTRAINT IF BRAKE FAILURE IS DETECTED, STOW ARM. SCREEN FAILURES N/A OMRSD OFFLINE DRIVE EACH JOINT IN COMPUTER SUPPORTED MODE APPLY BRAKES VERIFY CORRECT STOPPING DISTANCE FOR EACH JOINT. OMRSD ONLINE INSTALLATION NONE OMRSD ONLINE TURNAROUND NONE

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