

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: END EFFECTOR

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-1&-3

SHEET: 1

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDMR / FUNC. 2/1R CRITICALITY RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SNARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>	<p>DESIGN FEATURES -----</p> <p>THE END EFFECTOR CLUTCH IS A MAJOR BOUGHT-OUT-PART WHICH IS SUPPLIED BY HONEYWELL SPERRY CORPORATION AND MEETS OR EXCEEDS THE REQUIREMENTS OF SPECIFICATION SPAR-SG.450 FOR P/N 51140D575-1 AND SPAR-SG.1092 FOR P/N51140D575-3.</p> <p>THE FOLLOWING IS A LIST OF DESIGN CHARACTERISTICS THAT LIMIT THE POSSIBILITY OF AN OPEN OR SHORT CIRCUIT IN THE UNIT WINDINGS:</p> <p>THE INSULATION SYSTEM IS CLASS 185 (185 DEGREES C) OR BETTER AND IS PROVEN THROUGH YEARS OF USE.</p> <p>THE WIRE USED IN THE UNITS IS HEAVY ML MAGNET WIRE WHICH HAS AN EXTRA COAT OF INSULATION ON THE MAGNET WIRE.</p> <p>THE WINDINGS ARE PREBAKED AFTER THE WINDINGS ARE FORMED BUT PRIOR TO IMPREGNATION. THIS IS A STRESS RELIEVING OPERATION OF BOTH THE COPPER WIRE AND THE INSULATION, PERFORMED TO MINIMIZE ANY DEGRADATION DURING PROCESSING.</p> <p>KAPTON TAPE IS APPLIED OVER THE BOBBIN AND WINDINGS O.D. TO PROTECT THE MAGNET WIRE DURING PROCESSING AND INSTALLATION.</p> <p>THE UNIT IS IMPREGNATED WITH 100% SOLID EPOXY THAT IMPROVES THE COIL MECHANICAL PROPERTIES ESPECIALLY DURING VIBRATION AND HELPS THE UNIT RUN COOLER BY INCREASING THE EFFECTIVE THERMAL CONDUCTION WITHIN THE WINDING MASS.</p> <p>IT SHOULD BE NOTED THAT THE MAGNET WIRE USED IN THE WINDINGS OF THESE UNITS IS SINGLE STRAND.</p> <p>TO LIMIT THE POSSIBILITY OF A LOSS OF INPUT VOLTAGE DUE TO AN OPEN LEAD WIRE ALL SOLDERING IS ACCOMPLISHED BY OPERATORS WHO ARE TRAINED AND CERTIFIED TO NASA MHB 5300.4 (3A) STANDARD, AS MODIFIED BY JSC 08800A.</p> <p>THE CLUTCH SHAFT AND ARMATURE ARE CONNECTED BY A SPLINE WHICH PROVIDES ROTATION TO THE ARMATURE AND ALLOWS AXIAL SLIDING FOR ENGAGEMENT AND DISENGAGEMENT. THE FOLLOWING IS A LIST OF CHARACTERISTICS TO LIMIT THE POSSIBILITY OF THE CLUTCH HANGING-UP DUE TO MECHANICAL BINDING OF THE SPLINE:</p> <p>THE SPLINES ARE MATCH-MACHINED FOR A PRECISE AND SMOOTH FIT.</p> <p>SERIALIZATION OF THE MATCHED PARTS ASSURES PROPER ASSEMBLY.</p> <p>THE MATCHED SHAFT AND ARMATURE ASSEMBLY IS INSPECTED FOR PROPER CLEARANCE AND SMOOTHNESS OF OPERATION.</p> <p>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.</p>

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PROJECT: SRMS
ASS'Y NOMENCLATURE: END EFFECTOR

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-1E-3

SHEET: 2

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HMWR / FUNC. 2/1R CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SHARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>		<p>THE SPINES ARE LUBRICATED WITH MOLYBDENUM DISULFIDE.</p> <p>THE UNIT LOAD LEVELS ON THE SPLINE ARE LOW.</p> <p>IT SHOULD BE NOTED THAT THESE UNITS DO NOT UTILIZE REDUNDANT SPLINES.</p> <p>THE BEARINGS ARE WET LUBRICATED WITH BRAYCOTE 3L-38RP</p> <p>THE HEAVIEST AMOUNT OF FRICTION MATERIAL DEBRIS IS GENERATED DURING THE CALIBRATION RUN-IN OF THE UNIT. THE RUN-IN CONSISTS OF ROTATING THE UNIT IN ONE DIRECTION AT 50 RPM FOR A TOTAL OF 16 HOURS MINIMUM USING A DUTY CYCLE OF 10 SECONDS ENGAGED AND THEN 10 SECONDS DISENGAGED. THE UNITS RECEIVE A VERY LIMITED AMOUNT OF SLIPPING DURING ON MISSION USAGE. DEBRIS IS PREVENTED FROM ESCAPING FROM THE -3 CLUTCH USED IN THE 51140E1470-3 END EFFECTOR WITH A LABYRINTH NETWORK.</p> <p>THE AIR GAP OF THE UNIT IS VERIFIED TO MEET A MINIMUM VALUE BY THE END PLAY TEST (LARGEST APPLIED LOAD) DURING ACCEPTANCE TESTING.</p> <p>THE STRIPDOWN AND INSPECTION OF FLIGHT HARDWARE RETURNED FOR REPAIR HAS REVEALED THAT A SIGNIFICANT AMOUNT OF FRICTION MATERIAL DEBRIS MAY HAVE ACCUMULATED AT THE UNIT END-OF-LIFE. IT IS VERY UNLIKELY; HOWEVER, THAT SUFFICIENT FRICTION DEBRIS COULD ACCUMULATE BEHIND THE ARMATURE OR BETWEEN THE FRICTION SURFACES, SO AS TO AFFECT THE UNITS PERFORMANCE</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 MSC-SPEC-Q-1A.</p> <p>THE END EFFECTOR BRAKE IS A MAJOR BOUGHT-OUT-PART WHICH IS SUPPLIED BY HONEYWELL SPERRY CORPORATION AND MEETS OR EXCEEDS THE REQUIREMENTS OF SPECIFICATION SPAR-SG.451 FOR P/N 51140D574-1E-3 AND SPAR-SG.1093 FOR P/N 51140D2219-1.</p> <p>THE CALIPER BRAKE INCORPORATES MANY DESIGN FEATURES TO IMPROVE THE BRAKES CAPABILITY AND GIVE HIGHER RELIABILITY AS FOLLOWS:</p> <ul style="list-style-type: none"> - SLIP TORQUE CAPABILITY UP TO 85 OZ-IN. - TOTAL INTERNAL CONTAINMENT OF FRICTION DEBRIS WITH THE USE OF LABYRINTH PATHS AND THE PLACEMENT OF THE FRICTION DISKS ON THE OPPOSITE END OF THE BRAKE SHAFT FROM THE PINION GEAR. - MECHANICALLY REDUNDANT SLIDING SPLINES FOR THE CALIPER DISK. - MECHANICALLY REDUNDANT LOCATING PINS WITH VESPEL SLEEVES FOR DISK LOCATION. - BEARING LOADS ARE REDUCED BY A 5 TO 1 FACTOR OVER THE ORIGINAL E/E SNARE BRAKE P/N 51140D574-3. - SLIDING SURFACES ARE LUBRICATED WITH MOLYBDENUM DISULFIDE. - BEARINGS ARE WET LUBRICATED WITH BRAYCOTE 3L-38RP. - AIR GAP CAN BE ADJUSTED WITHOUT BRAKE DISASSEMBLY.

PREPARED BY: MFVG

SUPERCEDING DATE: 06 OCT 87

APPROVED BY: _____

DATE: 24 JUL 91

CIL REV: 2

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: END EFFECTOR

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-1B-3

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
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/ MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/ MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SNARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>		<p>THE BRAKE DESIGN FEATURES THAT LIMIT THE POSSIBILITY OF AN OPEN OR SHORT CIRCUIT IN THE WINDINGS ARE THE SAME AS THE FEATURES FOR THE CLUTCH DISCUSSED PREVIOUSLY IN THIS CIL ITEM.</p> <p>ALL SRMS GEARS ARE DESIGNATED IN ACCORDANCE WITH AGMA STANDARDS TO GIVE A MINIMUM OF INFINITE LIFE. THE DEFINITION OF INFINITE LIFE IS THE CONDITION WHERE 10**7 MESH CYCLES OR MORE AT THE APPLIED LOAD WILL NOT RESULT IN TOOTH FAILURE.</p> <p>FOR THIS (THESE) GEAR (S) THE CALCULATED LIFE WAS NOT BASED OR CONTROLLED BY CONSIDERATIONS OF STRESS, BUT INSTEAD WERE SIZED TO SATISFY SPECIAL CONSTRAINTS. CONSEQUENTLY, THE MESH IS WELL WITHIN THE DEFINITION OF INFINITE LIFE AND THE FAILURE MODE STATED IN THE FMEA IS REMOTE.</p> <p>THE SOLID FILM LUBRICANT SYSTEM USED IS LUBECO 905. THIS COMPRISES A SPRAY AND CURE (400 DEGREES F) APPLICATION OF MOLYBDENUM 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.</p> <p>THE GREASE LUBRICANT USED IS BRAYCOTE 601 (FORMERLY 3L-38RP) WHICH HAS A PERFLUORINATED POLYETHER OIL BASE WHICH IS VERY STABLE UNDER VACUUM ENVIRONMENT.</p> <p>THE GREASE IS APPLIED IN PRECISE QUANTITY TO EACH BEARING.</p> <p>THE LIFE OF THE BEARING LUBRICATION HAS BEEN ANALYZED USING ULTIMATE LOADS TO EVALUATE HERTZIAN STRESSES. ULTIMATE LOAD = 1.4 X WORKING LOAD. THE LUBRICANT ON ALL BEARINGS IS GOOD FOR OVER 400 MISSIONS USING THE ULTIMATE LOADS.</p> <p>THE END EFFECTOR PRIME AND BACK-UP RELEASE CLUTCH DESIGNS UTILIZE THREE BEARINGS, TWO OF WHICH ARE IDENTICAL. THE BEARINGS ARE PERMANENTLY LUBRICATED WITH WET LUBRICANT. THE TWO IDENTICAL BEARINGS ARE SEALED WITH TEFLON SEALS AND THE OTHER IS SEALED WITH TEFLON COATED FIBREGLASS SEALS, BOTH SIDES, TO PREVENT THE INGRESS OF DEBRIS.</p> <p>BEARINGS ARE LOCATED IN NON-DEBRIS PRODUCING AREA OF ASSEMBLY.</p>

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: END EFFECTOR

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-18-3 SHEET: 4

FMEA REF.	FMEA REV.	NAME, QTY. & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDMR / FUNC. 2/1R CRITICALITY RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/ MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/ MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SNARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>	<p>ACCEPTANCE TESTS ----- THE EE ASSEMBLY IS TESTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTS:</p> <ul style="list-style-type: none"> O VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 7 O THERMAL VACUUM: +70 DEGREES C TO -25 DEGREES C (1 1/2 CYCLES) 1 X 10**6 TORR <p>THE EE ASSEMBLY IS FURTHER TESTED IN THE IN THE RMS SYSTEM TEST (TP518 RMS STRONGBACK AND TP552 FLAT FLOOR TESTS) WHICH VERIFIES THE ABSENCE OF THE FAILURE MODE.</p> <p>QUALIFICATION TESTS ----- THE EE ASSEMBLY QUALIFICATION TESTING CONSISTED OF THE FOLLOWING ENVIRONMENTS:</p> <ul style="list-style-type: none"> O VIBRATION: LEVEL AND DURATION - REFERENCE TABLE 7 O SHOCK: 20G/11 MS - 3 AXES (6 DIRECTIONS) O THERMAL VACUUM: +81 DEGREES C TO -36 DEGREES C (6 CYCLES) 1 X 10**6 TORR O HUMIDITY: 95% RH (65 DEGREES C MAINTAINED FOR 6 HRS) (65 DEGREES C TO 30 DEGREES C IN 16 HRS) 10 CYCLES 240 HRS. O EMC: MIL-STD-461A AS MODIFIED BY SL-E-0002 (TEST CE01, CE03, CS01, CS02, CS06, RE02 (N/B)) O STRUCTURAL STIFFNESS AND LOAD TEST <p>FLIGHT CHECKOUT ----- PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987</p>

PREPARED BY: MFVG SUPERCEDING DATE: 06 OCT 87 APPROVED BY: _____ DATE: 24 JUL 91 CIL REV: 2

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: END EFFECTOR

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-1A-3

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
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SNARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>	<p>QA/INSPECTIONS -----</p>	<p>UNITS ARE MANUFACTURED UNDER DOCUMENTED QUALITY CONTROLS. THESE CONTROLS ARE EXERCISED THROUGHOUT DESIGN PROCUREMENT, PLANNING, RECEIVING, PROCESSING, FABRICATION, ASSEMBLY, TESTING AND SHIPPING OF THE UNITS. MANDATORY INSPECTION POINTS ARE EMPLOYED AT VARIOUS STAGES OF FABRICATION ASSEMBLY AND TEST. GOVERNMENT SOURCE INSPECTION IS INVOKED AT VARIOUS CONTROL LEVELS.</p> <p>WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-81381 AND INSPECTED AND TESTED TO NASA JSCMB080 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-583 AND CHECKED AT INCOMING INSPECTION PER FEDERAL STANDARD J-W-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 MHB5300.4(3A) STANDARD, AS MODIFIED BY JSC 08800A.</p> <p>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 INVOKED ON ALL BEARING PROCUREMENTS.</p> <p>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.</p> <p>CARPENTER 455 STEEL USED FOR THE MANUFACTURE OF (E.G. GEARS) RECEIVES ADDITIONAL LABORATORY INSPECTIONS WHICH INCLUDE CHEMICAL ANALYSIS, INCLUSION RATING, HARDNESS AND TENSILE TESTING TO VERIFY THE PROPERTIES OF THE MATERIAL SUPPLIED.</p>

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SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-1E-3

SHEET: 6

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
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/ MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/ MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SNARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>		<p>SHAFTS ARE DIMENSIONAL INSPECTED TO DRAWING REQUIREMENTS THROUGHOUT THE MANUFACTURING STAGES. FOLLOWING HEAT TREATMENT THE SHAFTS ARE SUBJECTED TO MAGNETIC PARTICLE INSPECTION FOR CRACKS.</p> <p>INSPECTION VERIFIES THAT KITTED PARTS ARE CORRECT PRIOR TO ASSEMBLY AND TRACEABILITY INFORMATION RECORDED.</p> <p>INSPECTION TO DRAWING IS CONDUCTED THROUGHOUT THE ASSEMBLY PROCESS, INCLUDING INSPECTION OF LOCKING, WITNESSING OF TORQUING AND APPLICATION OF TORQUE STRIPING.</p> <p>MOTOR MODULES ARE TESTED TO THE REQUIREMENTS OF SPAR-TM.1624 WHICH INCLUDES, CONTINUITY AND ISOLATION CHECKS, STICTION, COMMUTATOR TIMING, AMBIENT AND THERMAL TESTING. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT).</p> <p>INTEGRATION OF MOTOR MODULE TO END EFFECTOR LRU - INSPECTIONS INCLUDE GROUNDING CHECKS, CONNECTORS FOR BENT OR PUSHBACK CONTACTS, INCONNECT 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> <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>

PREPARED BY: MFVG

SUPERCEDING DATE: 06 OCT 87

APPROVED BY: _____

DATE: 24 JUL 91

CIL REV: 2

CRITICAL ITEMS LIST

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SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-1A-3

SHEET: 7

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOWR / FUNC. 2/1R CRITICALITY RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/ MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/ MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SNARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>	<p>FAILURE HISTORY ----- THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT:</p> <p>FAR 3009: S/N 208 NOV 78</p> <p>DESCRIPTION ----- 1. RATE ERRORS (REFER TO FAR-RMS-3011). 2. RDAI, RATE DEMAND ERROR, DEFECTIVE U15 ON RATE COMPARATOR BD. FOUND SOLDER SHEARS BETWEEN INPUT</p> <p>CORRECTIVE ACTION ----- 1. REFER TO FAR-RMS-3011. 2. REPL. U15, INSTR. OPERATORS ON WORKMANSHIP.</p> <p>FAR 5007: S/N 202 MAY 79</p> <p>DESCRIPTION ----- RIGIDIZE CLUTCH FAILED TO OPERATE DUE TO INCORRECT ALIGNMENT IN HOUSING</p> <p>CORRECTIVE ACTION ----- REPLACED CLUTCH CORRECTLY IN HOUSING</p> <p>FAR 5008: S/N 202 SEP 79</p> <p>DESCRIPTION ----- FAILED TO CAPTURE DUE TO BEARING FAILURES OF MP2 AND MP3 CLUTCHES</p> <p>CORRECTIVE ACTION ----- ECR 214,215,216 CHANGE TO WET LUBE. CHANGE ALL UNITS.</p>

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: END EFFECTOR

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140E1470-18-3

SHEET: 8

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HMWR / FUNC. 2/1R CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: A-PASS, B-PASS, C-PASS
3630	2	MOTOR MODULE ASSEMBLY QTY-1 P/N 51140E1473 OR 51140E2203	<p>MODE: LOSS OF DRIVE TO SNARE MECHANISM.</p> <p>CAUSE(S): (1) RIGIDIZE CLUTCH FAILS TO DISENGAGE DUE TO SHORT/OPEN CIRCUIT WINDINGS OR STRUCTURAL/MECHANICAL FAILURE. (2) SNARE BRAKE FAILS TO DISENGAGE DUE TO WINDING SHORT/OPEN FAILURE OR STRUCTURAL/MECHANICAL FAILURE. (3) DRIVE TRAIN FAILURE BEARINGS, GEAR SHAFT KEYS. (4) SNARE CLUTCH FAILS TO ENGAGE. (5) SEIZURE OF INPUT BEARING ON BACKUP CLUTCH.</p>	<p>END EFFECTOR CANNOT CLOSE OR OPEN SHARES. LOSS OF CAPABILITY TO CAPTURE OR RELEASE PAYLOAD IN PRIME MODES. ARM WILL REMAIN LIMP IF PERFORMING AUTO CAPTURE.</p> <p>WORST CASE ----- UNEXPECTED PAYLOAD MOTION. INCOMPLETE CAPTURE/RELEASE SEQUENCE. UNABLE TO RELEASE PAYLOAD. CREW ACTION REQUIRED.</p> <p>REDUNDANT PATHS REMAINING ----- BACKUP EE RELEASE.</p>	OPERATIONAL EFFECTS -----	<p>EE DOES NOT OPERATE NOMINALLY WHEN COMMANDED. ARM REMAINS LIMP UNTIL EE MODE SWITCH IS TURNED OFF DURING AN AUTO CAPTURE SEQUENCE.</p> <p>CREW ACTION -----</p> <p>FOR ANY OFF NOMINAL OPERATION OF THE EE, THE EE MODE SWITCH SHOULD BE TURNED OFF. ATTEMPT TO CAPTURE IN THE ALTERNATE MODE. IF THE SHARES REMAIN OPEN, MANEUVER ARM AWAY FROM PAYLOAD. IF THE SHARES ARE PARTIALLY CLOSED, ATTEMPT RELEASE USING A PRIMARY EE MODE. IF SHARES OPEN, MANEUVER THE ARM AWAY FROM THE PAYLOAD. IF SHARES DON'T OPEN, ATTEMPT TO RELEASE IN BACKUP MODE. IF SHARES OPEN, MANEUVER ARM AWAY FROM THE PAYLOAD. MANEUVER ORBITER AWAY FROM PAYLOAD. IF SHARES CANNOT BE OPENED, IN ANY MODE, EVA CAN BE USED TO RELEASE THE PAYLOAD OR THE ARM/PAYLOAD COMBINATION CAN BE JETTISONED.</p> <p>CREW TRAINING -----</p> <p>CREW WILL BE TRAINED TO RECOGNIZE OFF NOMINAL EE OPERATIONS AND TO MANEUVER THE ORBITER AWAY FROM A FREE FLYING PAYLOAD AT ANY TIME DURING ARM OPERATIONS.</p> <p>MISSION CONSTRAINT -----</p> <p>WHEN CAPTURING A FREE FLYING PAYLOAD, THE EE MUST BE FAR ENOUGH AWAY FROM STRUCTURE TO PROHIBIT CONTACT REGARDLESS OF PAYLOAD ROTATIONS. THE EE MODE SWITCH SHOULD BE PLACED BACK IN THE OFF POSITION IMMEDIATELY AFTER THE SPEC DRIVE TIME HAS ELAPSED.</p> <p>OMRSD OFFLINE -----</p> <p>VERIFY CORRECT TIME TO CLOSE.</p> <p>OMRSD ONLINE INSTALLATION -----</p> <p>NONE</p> <p>OMRSD ONLINE TURNAROUND -----</p> <p>VERIFY CORRECT TIME TO CLOSE.</p>

PREPARED BY: MFVG

SUPERCEDING DATE: 06 OCT 87

APPROVED BY: _____

DATE: 24 JUL 91

CIL REV: 2