

**CRITICAL ITEMS LIST**

PROJECT: SRMS  
ASS'Y NOMENCLATURE: END EFFECTOR

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

SHEET: 1

PNEA REF.	REV.	PART, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RISK / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SWARE CABLES P/N 5114001612-1	<p>MODE: CABLES FAIL TO RETURN TO SEATING.</p> <p>CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.</p>	<p>MAY FAIL TO CAPTURE. GRAPPLE MAY SNAG DURING PAYLOAD RELEASE.</p> <p>WORST CASE ----- SNAGGED PAYLOAD.</p> <p>REDUNDANT PATHS REMAINING ----- N/A</p>		<p>DESIGN FEATURES -----</p> <p>MATERIALS SELECTION AND USAGE CONFORMS TO SPAR-SG.360 WHICH IS EQUIVALENT TO THE NASA MATERIALS USAGE REQUIREMENTS.</p> <p>THE STRUCTURAL ANALYSIS CONDUCTED ON THE END EFFECTOR, PER SPAR-TH.1531, CONFIRMED A POSITIVE MARGIN OF SAFETY FOR ALL END EFFECTOR PARTS AND GEARS. THE MARGIN OF SAFETY FOR ULTIMATE STRENGTH M(UTS) INCORPORATES A FACTOR OF SAFETY OF 1.4 AGAINST LIMIT LOAD, AS SPECIFIED IN SPAR-SG. 392.</p> <p>A NEGATIVE MARGIN DOES NOT NECESSARILY IMPLY BREAKAGE OF THE PART, RATHER IT INDICATES THAT A LIMITING STRESS LEVEL, ESTABLISHED BY THE FACTOR OF SAFETY, HAS BEEN EXCEEDED.</p> <p>THE MARGIN OF SAFETY FOR YIELD STRENGTH S(YIELD) EMPLOYS A FACTOR OF SAFETY OF 1.0 AGAINST LIMIT LOAD, AS SPECIFIED IN SPAR-SG.392. TABLE 14 LISTS MARGINS OF SAFETY FOR SRMS STRUCTURAL COMPONENTS.</p> <p>A FATIGUE ANALYSIS WHICH SHOWS INDEFINITE LIFE HAS BEEN PERFORMED ON THE GEARS AND MECHANICAL FASTENERS AND A FRACTURE ANALYSIS WHICH SHOWS LIVES GREATER THAN 424 MISSIONS HAS BEEN DEMONSTRATED ON STRUCTURAL COMPONENTS WITHIN THE END EFFECTOR.</p> <p>NO KINKED CABLES ARE EXPECTED DUE TO NORMAL USAGE. THIS IS CONFIRMED BY GROUND TEST AND FLOWN UNITS.</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 SPHERICAL BEARINGS IN THE CABLE ENDS ARE WET LUBRICATED WITH BRAYCOTE GREASE CONTAINED WITHIN A GREASE CHANNEL ON THE BEARING OUTER RACE. THIS RESERVOIR ENSURES A SUPPLY OF LUBRICANT TO THE BEARING SURFACES DURING OPERATION.</p>

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INHA REF.	REV.	NAME QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SHARE CABLES P/N 5114001612-1	MODE: CABLES FAIL TO RETURN TO SEATING.  CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.	MAY FAIL TO CAPTURE. GRAPPLE MAY SNAG DURING PAYLOAD RELEASE.  WORST CASE ----- SNAGGED PAYLOAD.  REDUNDANT PATHS REMAINING ----- N/A		ACCEPTANCE TESTS ----- THE EE ASSEMBLY IS TESTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTS:  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  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.  QUALIFICATION TESTS ----- THE EE ASSEMBLY QUALIFICATION TESTING CONSISTED OF THE FOLLOWING ENVIRONMENTS:  O VIBRATION: LEVEL AND DURATTION - 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  FLIGHT CHECKOUT ----- PORS OPS CHECKLIST (ALL VEHICLES) JSC 16987

PREPARED BY: MFMG SUPERCEDING DATE: 11 SEP 86 APPROVED BY: \_\_\_\_\_ E: \_\_\_\_\_

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THEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SNARE CABLES P/N 51140D1612-1	<p>MODE: CABLES FAIL TO RETURN TO SEATING.</p> <p>CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.</p>	<p>MAY FAIL TO CAPTURE. GRAPPLE MAY SWAG DURING PAYLOAD RELEASE.</p> <p>WORST CASE</p> <p>SWAGGED PAYLOAD.</p> <p>REDUNDANT PATHS REMAINING</p> <p>W/A</p>	<p>QA/INSPECTIONS</p> <p>SNARE CABLES ARE MANUFACTURED TO SPAR DRAWINGS AND SPECIFICATIONS BY A SPAR APPROVED SUPPLIER. INSPECTIONS ARE PERFORMED TO VERIFY THAT EACH MANUFACTURING, ASSEMBLY AND TEST OPERATION IS SATISFACTORILY COMPLETED. SPAR/GOVERNMENT SOURCE INSPECTION IS INVOKED ON THE PROCUREMENT OF ALL SNARE CABLES.</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>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.</p> <p>SNARE CABLES ARE SUBJECTED TO INSPECTION WITNESS PROOF LOAD TESTING TOGETHER WITH A PRE/POI TEST DIMENSIONAL INSPECTION OF THE CABLE AND SWAGED ENDS.</p> <p>THE SPRING RETURN MECHANISM IS INSPECTED AND MANUALLY OPERATED IN ACCORDANCE WITH THE REQUIREMENTS OF SPAR-TM.1657 TO VERIFY CORRECT OPERATION OF MECHANISM. AFTER INTEGRATION TO THE END EFFECTOR ASSEMBLY, PRIOR TO ACCEPTANCE TESTING THE MECHANISM IS FUNCTIONALLY TESTED TO THE REQUIREMENTS OF SPAR-TM.1727.</p> <p>PRIOR INTEGRATION OF SNARE CABLES TO END EFFECTOR ASSY. CABLE ARE INSPECTED TO DRAWING REQUIREMENTS TO VERIFY CABLES LENGTHS, ANGLE POSITION OF SWAGED END, WORKMANSHIP, CLEANLINESS ETC.</p> <p>AFTER INTEGRATION OF CABLES TO END EFFECTOR ASSEMBLY THEY ARE SUBJECTED TO OPERATIONAL TESTING IN ACCORDANCE WITH SPAR-TM1657 TO VERIFY CABLE OPERATION.</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</p>	

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TREA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HWR / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SHARE CABLES P/N 51140D1612-1	MODE: CABLES FAIL TO RETURN TO SEATING.  CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.	MAY FAIL TO CAPTURE. GRAPPLE MAY SNAG DURING PAYLOAD RELEASE.  WORST CASE ----- SNAGGED PAYLOAD.  REDUNDANT PATHS REMAINING ----- N/A		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)  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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ITEM REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOW / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SNARE CABLES P/N 5114001612-1	<p>MODE: CABLES FAIL TO RETURN TO SEATING.</p> <p>CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.</p>	<p>MAY FAIL TO CAPTURE. GRAPPLE MAY SNAG DURING PAYLOAD RELEASE.</p> <p>WORST CASE ..... SNAGGED PAYLOAD.</p> <p>REDUNDANT PATHS REMAINING ..... N/A</p>		<p>FAILURE HISTORY .....</p> <p>THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT:</p> <p>FAR 1006: S/N 201 JAN 81</p> <p>DESCRIPTION .....</p> <p>KINKED CABLE, DID NOT RETURN TO GROOVE CAUSED BY GRAPPLING LARGE CONTRAINED LOAD AT GREATER THAN PRESCRIBED ANGLE</p> <p>CORRECTIVE ACTION .....</p> <p>REPLACED CABLE. MODIFIED TEST PROCEDURE.</p> <p>FAR 2331: S/N 301 AUG 82</p> <p>DESCRIPTION .....</p> <p>SNARE CABLE OUTSIDE OF GROOVE, ACCEPTABLE</p> <p>CORRECTIVE ACTION .....</p> <p>NONE</p> <p>FAR 2354: S/N 201 APR 83</p> <p>DESCRIPTION .....</p> <p>SNARE CABLE DID NOT RETURN TO GROOVE, DUE TO INSUFFICIENT DRT LUBE ON SPHERICAL BRG.</p> <p>CORRECTIVE ACTION .....</p> <p>ECM 51140C1646-1-01, 02 F1609-1-05, D1612-1 C1776-1-02 CHANGED TO WET LUBRICANT.</p> <p>FAR 5017: S/N 201 DEC 80</p> <p>DESCRIPTION .....</p> <p>SNARE CABLE FAILED TO RETURN TO GROOVE DUE TO INSUFFICIENT ROD END FREE PLAY, DESIGN ERROR</p> <p>CORRECTIVE ACTION .....</p> <p>ECN 51140-2865</p> <p>FAR 6044: S/N 202 FEB 82</p>

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IWEA REF.	REV.	NAME, QTY. & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOUR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SHARE CABLES P/N 51140D1612-1	MODE: CABLES FAIL TO RETURN TO SEATING.  CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.	MAY FAIL TO CAPTURE. GRAPPLE MAY SNAG DURING PAYLOAD RELEASE.  WORST CASE SNAGGED PAYLOAD.  REDUNDANT PATHS REMAINING ----- N/A	1/1 ----- NONE	DESCRIPTION ----- SHARE CABLES NOT RETURN TO GROOVE, SUSPECTED BREAKDOWN OF DRY FILM LUBE.  CORRECTIVE ACTION ----- NONE

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PMA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HWR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
3750	0	E/E SNARE CABLES P/N 5114001612-1	MODE: CABLES FAIL TO RETURN TO SEATING.  CAUSE(S): (1) RETURN SPRING BROKEN. (2) CABLES KINKED FROM USE. (3) BEARING (SPHERICAL) SEIZURE.	MAY FAIL TO CAPTURE. GRAPPLE MAY SWAG DURING PAYLOAD RELEASE.  WORST CASE SNAGGED PAYLOAD.  REDUNDANT PATHS REMAINING ----- N/A	OPERATIONAL EFFECTS ----- WHEN CAPTURE COMMANDED, THE GRAPPLE FIXTURE MAY NOT BE SHARED. IF OPERATOR THEN COMMANDS RELEASE, THE GRAPPLE PIN WILL BE SNAGGED BETWEEN THE SNARE CABLE AND THE CARRIAGE.  CREW ACTION ----- CLOSE THE SNARES AND MANEUVER THE ARM AWAY FROM THE PAYLOAD.  CREW TRAINING ----- NONE  MISSION CONSTRAINT ----- NONE.  SCREEN FAILURES ----- N/A  OMRSD ONLINE ----- PERFORM MANUAL SNARE CLOSE THEN OPEN. INSPECT TO ENSURE SNARE CABLES ARE SEATED CORRECTLY IN GROOVES.  OMRSD OFFLINE INSTALLATION ----- NONE  OMRSD OFFLINE INSTALLATION ----- PERFORM MANUAL SNARE CLOSE THEN OPEN. INSPECT TO ENSURE SNARE CABLES ARE SEATED CORRECTLY IN GROOVES.	