

CRITICAL ITEMS LIST

PROJECT: SRMS
 ASS'Y NOMENCLATURE: SHOULDER

SYSTEM: MECHANICAL ARM SUBSYSTEM
 ASS'Y P/N: 5114011219

SHEET: 1

P/N REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	NOM / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE
4100	0	SHOULDER BRACE QTY-1 P/N 5114001107	MODE: FAILURE TO RELEASE. CAUSE(S): (1) SEIZURE OF ACTUATOR. (2) LOSS OF POWER.	SHOULDER BRACE CANNOT BE RELEASED. ARM CANNOT BE DEPLOYED. WORST CASE ----- LOSS OF MISSION. LOSS OF SHOULDER BRACE RELEASE. REDUNDANT PATHS REMAINING ----- N/A	DESIGN FEATURES -----	<p>THE LINEAR ACTUATOR 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.515.</p> <p>MATERIALS SELECTION AND USAGE CONFORMS TO SPAR-SG.368 WHICH IS EQUIVALENT TO THE NASA MATERIALS USAGE REQUIREMENTS.</p> <p>THE BEARING ANALYSIS USES ULTIMATE LOADS TO DETERMINE THE MARGINS OF SAFETY OF THE LUBRICANT. THE FACTOR BETWEEN WORKING LOADS AND ULTIMATE IS 1.4. THE LUBRICANT FAILURE STRESSES ARE LOWER THAN THE BRINELLING STRESS. LIFE FOR ALL BEARINGS IS GREATER THAN 400 MISSIONS BASED UPON THE ABOVE CRITERIA.</p> <p>THE ALLOWABLE CONTACT STRESS FOR THE LUBRICANT IS ABOUT 1/5TH THE ALLOWABLE CONTACT STRESS FOR THE BEARING, THEREFORE THE LUBRICANT PROPERTIES DICTATE THE DESIGN, THE BEARINGS AS A RESULT ARE LIGHTLY LOADED AND SURFACE FATIGUE IN THE BEARING MATERIAL IS NOT A VIABLE FAILURE MODE.</p> <p>BEARINGS ARE LOCATED IN NON-DEBRIS PRODUCING AREA OF ASSEMBLY.</p> <p>THE BEARINGS ARE PROCURED AND SUPPLIED TO SPERRY BY SPAR, AND MEET OR EXCEED THE REQUIREMENTS OF SPECIFICATION SPAR-SG.393.</p> <p>THE LINEAR ACTUATOR DESIGN UTILIZES THREE DIFFERENT BEARINGS, FOUR OF ONE DESIGN AND TWO EACH OF THE OTHER TWO DESIGNS. ALL OF THE BEARINGS ARE OF THE DEEP GROOVE BALL TYPE AND ARE PERMANENTLY LUBRICATED WITH DRY LUBRICANT. THEY ARE SEALED ON BOTH SIDES WITH CRES. 300 SERIES CORROSION RESISTANT SEALS TO PREVENT THE INGRESS OF DEBRIS.</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 ORGANIC BINDER APPLIED PER PPS:28:11 AND 28:13. BURNISHING AND RUM IN PER SPAR PPS 28:14. THE LUBRICATED BEARING IS TORQUE TRACED TO ENSURE ACCEPTABILITY PER SPAR PPS.28:14.</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>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 10⁶ MESH CYCLES OR MORE AT THE APPLIED LOAD WILL NOT RESULT IN TOOTH FAILURE.</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>

PREPARED BY: HWG

SUPERSEDING DATE: 11 SEP 86

APPROVED BY: _____

DATE: _____

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: SHOULDER

SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1219 SHEET: 2

TIMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOWR / FUNC. CRITICALITY	RATIONALE FOR ACCEPTANCE
4190	0	SHOULDER BRACE QTY: 1 P/N 51140D1107	MODE: FAILURE TO RELEASE. CAUSE(S): (1) SEIZURE OF ACTUATOR. (2) LOSS OF POWER.	SHOULDER BRACE CANNOT BE RELEASED. ARM CANNOT BE DEPLOYED. WORST CASE ----- LOSS OF MISSION. LOSS OF SHOULDER BRACE RELEASE. REDUNDANT PATHS REMAINING ----- N/A	2/2	<p>ACCEPTANCE TESTS ----- THE SHOULDER, ELBOW AND WRIST JOINTS ARE SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING.</p> <ul style="list-style-type: none"> O VIBRATION: LEVEL AND DURATION - REFERENCE TABLES 9, 10 AND 11. O THERMAL: +70 DEGREES C TO -25 DEGREES C (2 CYCLES) 1 X 10**6 TORR. <p>THE JOINTS ARE INTEGRATED INTO THE RMS SYSTEM (PER TP532) WHICH IS FURTHER TESTED IN (TP510 RMS STRONGBACK AND TP552 FLAT FLOOR). THESE TESTS VERIFIES THE ABSENCE OF THE FAILURE MODE.</p> <p>QUALIFICATION TESTS ----- THE SHOULDER AND WRIST JOINTS WERE SUBJECTED TO THE LISTED BELOW ENVIRONMENTS. THE ELBOW JOINTS WAS NOT EXPOSED THE QUALIFICATION ENVIRONMENTS WAS CERTIFIED BY SIMILARITY TO THE SHOULDER JOINT.</p> <ul style="list-style-type: none"> O VIBRATION: LEVEL AND DURATION REFERENCE TABLES 9 AND 10 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 EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CE01, CE03, CS01, CS02, CS06, RE02 (N/B)). O HUMIDITY: ONLY SHOULDER JOINT WAS TESTED, 95% RH (65 DEGREES C MAINTAINED FOR 6 HRS.) (65 DEGREES C TO 30 DEGREES C IN 16 HRS) 10 CYCLES 240 HRS. O LOAD TEST: SHOULDER JOINT STRUCTURAL LOAD TEST REFERENCE TABLE 12. <p>NOTE: ELBOW JOINT (S/N 302 AND UP) INCORPORATES NON-WELDED TRANSITIONS WHICH WAS LOAD TESTED TO LOAD IN REFERENCE TABLE 12S.</p> <p>FLIGHT CHECKOUT ----- PDWS OPS CHECKLIST (ALL VEHICLES) JSC 16987</p>

PREPARED BY: MFUG

SUPERCEDING DATE: 11 SEP 86

APPROVED BY: _____

RMS/MECH - 324

CRITICAL ITEMS LIST

PROJECT: SRMS
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SYSTEM: MECHANICAL ARM SUBSYSTEM
 ASS'Y P/N: 51140J1219 SHEET: 3

P/N REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDM / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE
4190	0	SHOULDER BRACE QTY-1 P/N 51140D1107	MODE: FAILURE TO RELEASE. CAUSE(S): (1) SEIZURE OF ACTUATOR. (2) LOSS OF POWER.	SHOULDER BRACE CANNOT BE RELEASED. ARM CANNOT BE DEPLOYED. WORST CASE ----- LOSS OF MISSION. LOSS OF SHOULDER BRACE RELEASE. REDUNDANT PATHS REMAINING ----- N/A	QA/INSPECTIONS	<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-81301 AND INSPECTED AND TESTED TO NASA JSCN8080 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-W-1177 WHICH INCLUDES DIELECTIC, PIN HOLES, RIBBIFS, BLISTERS, AND CRACKS IN THE INSULATION.</p> <p>ALL SOLDERING IS ACCOMPLISHED BY OPERATORS, WHO ARE TRAINED AND CERTIFIED TO NASA NHB5300.4(3A) STANDARD, AS MODIFIED BY JSC 0800A.</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 ENVOCKED ON ALL BEARING PROCUREMENTS.</p> <p>UNITS ARE INSPECTED TO THE APPLICABLE SPAR INSPECTION TEST PROCEDURE (ITP) PRIOR TO MOTOR MODULE INTEGRATION. INSPECTIONS INCLUDE WORKMANSHIP, CLEANLINESS, DIMENSIONAL ETC.</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</p>

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 ASS'Y P/N: 5114011219

SHEET: 4

P/N REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RISK / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE
4190	0	SHOULDER BRACE QTY-1 P/N 5114001107	MODE: FAILURE TO RELEASE. CAUSE(S): (1) SEIZURE OF ACTUATOR. (2) LOSS OF POWER.	SHOULDER BRACE CANNOT BE RELEASED. ARM CANNOT BE DEPLOYED. WORST CASE ----- LOSS OF MISSION. LOSS OF SHOULDER BRACE RELEASE. REDUNDANT PATHS REMAINING ----- N/A		<p>RUN-IN, CLEANED AND VISUALLY INSPECTED.</p> <p>LINEAR ACTUATOR UNITS ARE FUNCTIONAL TESTED AFTER INTEGRATION TO SHOULDER JOINT PRIOR TO ACCEPTANCE TESTING IN ACCORDANCE WITH INSPECTION TEST PROCEDURE ITP251A (SHOULDER JOINT POWER-UP TESTS).</p> <p>JOINT LEVEL PRE-ACCEPTANCE TEST INSPECTION, INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC.</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>JOINT LEVEL 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>

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FMEA REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOUR / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE
4190	0	SHOULDER BRACE QTY-1 P/N 51140D1107	NODE: FAILURE TO RELEASE. CAUSE(S): (1) SEIZURE OF ACTUATOR. (2) LOSS OF POWER.	SHOULDER BRACE CANNOT BE RELEASED. ARM CANNOT BE DEPLOYED. WORST CASE ----- LOSS OF MISSION. LOSS OF SHOULDER BRACE RELEASE. REDUNDANT PATHS REMAINING ----- N/A	FAILURE HISTORY ----- THERE HAVE BEEN NO FAILURES ASSOCIATED WITH THIS FAILURE MODE ON THE SRMS PROGRAM.	

PREPARED BY: MEWG

SUPERCEDING DATE: 11 SEP 86

APPROVED BY:

TE: _____

CRITICAL ITEMS LIST

PROJECT: SRMS
 ASS'Y NOMENCLATURE: SHOULDER

SYSTEM: MECHANICAL ARM SUBSYSTEM
 ASS'Y P/N: 51140JT219

SHEET: 6

ITEM REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	DOWN / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE
4190	0	SHOULDER BRACE QTY: 1 P/N 5114001107	MODE: FAILURE TO RELEASE. CAUSE(S): (1) SEIZURE OF ACTUATOR. (2) LOSS OF POWER.	SHOULDER BRACE CANNOT BE RELEASED. ARM CANNOT BE DEPLOYED. WORST CASE ----- LOSS OF MISSION. LOSS OF SHOULDER BRACE RELEASE. REDUNDANT PATHS REMAINING ----- N/A		<p>OPERATIONAL EFFECTS -----</p> <p>CANNOT RELEASE SHOULDER BRACE. CANNOT UNCRADLE ARM TO PERFORM MISSION.</p> <p>CREW ACTION -----</p> <p>PERFORM EVA TO RELEASE SHOULDER BRACE.</p> <p>CREW TRAINING -----</p> <p>NONE</p> <p>MISSION CONSTRAINTS -----</p> <p>RELEASE THE SHOULDER BRACE AS EARLY IN THE MISSION AS POSSIBLE TO AVOID ANY THERMALLY INDUCED FAILURES TO RELEASE.</p> <p>SCREEN FAILURES -----</p> <p>N/A</p> <p>OMRSD OFFLINE -----</p> <p>OPERATE SHOULDER BRACE TO LATCH, UNLATCH. VERIFY FLAG STATUS.</p> <p>OMRSD ONLINE INSTALLATION -----</p> <p>NONE</p> <p>OMRSD ONLINE TURNAROUND -----</p> <p>OPERATE SHOULDER BRACE TO UNLATCH. VERIFY FLAG STATUS.</p>