CRITICAL 1

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1565
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 |
|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 511400231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK, DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION.<br>INCORRECT POSITION DATA.<br>AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | DESIGN FEATURES<br>---<br><br>THE JOINT AND WRIST ROLL OPTICAL POSITION ENCODERS ARE MAJOR BOUGHT-OUT-PARTS WHICH ARE SUPPLIED BY BEI MOTION SYSTEMS AND MEET OR EXCEED THE REQUIREMENTS OF SPECIFICATIONS SPAR-SG.466 AND SPAR-SG.421, RESPECTIVELY.<br><br>ALL EEE PARTS ARE PROCURED TO MILITARY SPECIFICATIONS OR EQUIVALENT. THE CIRCUITS EMBODY THE USE OF NHB5300.4(3A) SOLDERING, M38510 LEVEL B IC'S 2-SIDED PRINTED CIRCUIT BOARDS WITH NO PLATED-THU HOLES (Z WIRES USED WHERE NECESSARY) AND ALL LAP SOLDER JOINTS. THE EMI FILTER IS PURCHASED TO AN SCD (905-15181), WHICH INCORPORATES RESCREENING INCLUDING THERMAL SHOCK, BURN-IN, AND HERMITICITY TESTING, AS WELL AS X-RAY OF ALL UNITS.<br><br>THE LED IS A CUSTOM DEVICE MANUFACTURED BY MA/COMLASER DIODE LABORATORIES TO A BEI SCD (905-17137). THIS DEVICE IS SCREENED AND QUALIFIED TO A JANTXV-EQUIVALENT LEVEL SPECIFICATION, THEN RESCREENDED AGAIN TO INSURE THAT INFANT FAILURES ARE REMOVED. THE LED IS OPERATED AT A VERY LOW AVERAGE CURRENT LEVEL SO LITTLE HEAT GENERATED. THIS MINIMIZES DEGRADATION OF THE LIGHT OUTPUT WITH TIME. THIS TYPE OF DEVICE HAS BEEN CHARACTERIZED WITH RESPECT TO RADIATION, AND THE EXPECTED DEGRADATION IS VERY NORMAL (2-5% FOR 7 YEARS IN GEOSYNCHRONOUS ORBIT).<br><br>THE LED IS ASSEMBLED INTO AN OPTIC BLOCK WHICH PROVIDES GOOD THERMAL CONDUCTIVITY AND SIGNIFICANT RADIATION SHIELDING.<br><br>CONNECTOR USED ARE TO GSFC SPECIFICATION S.311.P.4/9.<br><br>CONTACTS USED ARE TO GSF SPEC.S.311.P.4/9.<br><br>CRIMPING IS CONTROLLED TO SPAR PPS 9:17 WHICH EMBODIES MSC-SPEC-Q-1A.<br><br>ALL RESISTORS AND CAPACITORS USED IN THE DESIGN ARE SELECTED FROM ESTABLISHED RELIABILITY (ER) TYPES. LIFE EXPECTANCY IS INCREASED BY ENSURING THAT ALL ALLOWABLE STRESS LEVELS ARE DERATED IN ACCORDANCE WITH SPAR-RMS-PA.003. ALL CERAMIC AND ELECTROLYTIC CAPACITORS ARE ROUTINELY SUBJECTED TO RADIOGRAPHIC INSPECTION.<br><br>DISCRETE SEMICONDUCTOR DEVICES SPECIFIED TO AT LEAST THE TX LEVEL OF MIL-S-19500. ALL DEVICES ARE SUBJECTED TO RE-SCREENING BY AN INDEPENDANT TEST HOUSE. SAMPLES OF ALL PROCURED LOTS/DATE CODES ARE SUBJECTED TO DESTRUCTIVE PHYSICAL ANALYSIS (DPA) TO VERIFY THE INTEGRITY OF THE MANUFACTURING PROCESSES. DEVICE STRESS LEVELS ARE, DERATED IN ACCORDANCE WITH SPAR-RMS-PA.003 AND VERIFIED BY DESIGN REVIEW.<br><br>COMPARATORS AND OPERATIONAL AMPLIFIERS ARE STANDARD LINEAR INTEGRATED CIRCUITS WITH MATURE MANUFACTURING TECHNOLOGY. APPLICATION CONSTRAINTS ARE IN ACCORDANCE WITH SPAR-RMS-PA.003.<br><br>THE OPTICAL REFLECTIVE SURFACES ARE DEPOSITED ON AN ANNEALED SODA LIME GLASS. THE UNDER COATING IS 200 ANGSTROMS OF CHROME |

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

# CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51T40J1565
SHEET: 2

| 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 |
|---|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 51140D231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LEO.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION. INCORRECT POSITION DATA. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | | TO ENSURE ADHESION WITH 800 ANGSTROMS OF GOLD AS THE REFLECTIVE SURFACE. THE SUFACE IS PROTECTED BY A 1/2 WAVE DIELECTRIC OVERCOAT. THE PEAK REFLECTIVITY IS GREATER THAN 95%. |

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## CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1565
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 |
|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 511400231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION.<br>INCORRECT POSITION DATA.<br>AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | ACCEPTANCE TESTS<br>---<br>THE SHOULDER, ELBOW AND WRIST JOINTS ARE SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING.<br><br>O VIBRATION: LEVEL AND DURATION - REFERENCE TABLES 9, 10 AND 11.<br><br>O THERMAL: +70 DEGREES C TO -25 DEGREES C (2 CYCLES) 1 X 10**6 TORR.<br><br>THE JOINTS ARE INTEGRATED INTO THE RMS SYSTEM (PER TP532) WHICH IS FURTHER TESTED IN (TP518 RMS STRONGBACK AND TP552 FLAT FLOOR). THESE TESTS VERIFIES THE ABSENCE OF THE FAILURE MODE.<br><br>QUALIFICATION TESTS<br>---<br>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.<br><br>O VIBRATION: LEVEL AND DURATION REFERENCE TABLES 9 AND 10<br><br>O SHOCK: 20G/11 MS - 3 AXES ( 6 DIRECTIONS)<br><br>O THERMAL VACUUM: +81 DEGREES C TO -36 DEGREES C (6 CYCLES) 1 X 10**6 TORR.<br><br>O EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CE01, CE03, CS01, CS02, CS06, RE02 (N/B).<br><br>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.<br><br>O LOAD TEST: SHOULDER JOINT STRUCTURAL LOAD TEST REFERENCE TABLE 12.<br><br>NOTE:<br><br>ELBOW JOINT (S/N 302 AND UP) INCORPORATES NON-WELDED TRANSITIONS WHICH WAS LOAD TESTED TO LOAD IN REFERENCE TABLE TBS.<br><br>FLIGHT CHECKOUT<br>---<br>PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987 |

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# CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1565
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 |
|---|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 51140M431-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION. INCORRECT POSITION DATA. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | 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>EEE PARTS INSPECTION IS PERFORMED AS REQUIRED BY SPAR-RMS-PA.003. EACH EEE PART IS QUALIFIED AT THE PART LEVEL TO THE REQUIREMENTS OF THE APPLICABLE SPECIFICATION. ALL EEE PARTS ARE 100% SCREENED AND BURNED IN, AS A MINIMUM, AS REQUIRED BY SPAR-RMS-PA.003, BY THE SUPPLIER. ADDITIONALLY, EEE PARTS ARE 100% RE-SCREENED IN ACCORDANCE WITH REQUIREMENTS, BY AN INDEPENDENT SPAR APPROVED TESTING FACILITY. DPA IS PERFORMED AS REQUIRED BY PA.003 ON A RANDOMLY SELECTED 5% OF PARTS, MAXIMUM 5 PIECES, MINIMUM 3 PIECES FOR EACH LOT NUMBER/DATE CODE OF PARTS RECEIVED.<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 ALL PARTS RECEIVED ARE AS IDENTIFIED IN THE PROCUREMENT DOCUMENTS, THAT NO PHYSICAL DAMAGE HAS OCCURRED TO PARTS DURING SHIPMENT, THAT THE RECEIVING DOCUMENTS PROVIDE ADEQUATE TRACEABILITY INFORMATION AND SCREENING DATA CLEARLY IDENTIFIES ACCEPTABLE PARTS.<br><br>PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE,<br><br>PRINTED CIRCUIT BOARD INSPECTION FOR TRACK SEPARATION, DAMAGED OR LIFTING CIRCUIT PADS, CLEANLINESS ETC.<br><br>COMPONENT MOUNTING INSPECTION FOR CORRECT SOLDERING, WIRE LOOPING, STRAPPING, ETC. OPERATORS AND INSPECTORS ARE TRAINED AND CERTIFIED TO NASA NHB 5300.4(3A) STANDARD, AS MODIFIED BY JSC 08800A.<br><br>CONFORMAL COATING INSPECTION FOR ADEQUATE PROCESSING IS PERFORMED USING ULTRAVIOLET LIGHT TECHNIQUES.<br><br>P.C. BD. INSTALLATION INSPECTION, CHECK FOR CORRECT BOARD INSTALLATION, ALIGNMENT OF BOARDS, PROPER CONNECTOR CONTACT MATING, WIRE ROUTING, STRAPPING OF WIRES ETC.,<br><br>PRE-CLOSURE INSPECTION, WORKMANSHIP AND CLEANLINESS (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT)<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 |

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## CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1585
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 |
|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 51140D231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION. INCORRECT POSITION DATA. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | 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 GOVENNMENT 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)<br><br>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>WIRE HARNESSES ARE INSPECTED DURING ASSEMBLY PROCESSES TO SPAR-ITP.251 AS REQUIRED BY SPECIFICATION SPAR-SG420. INSPECTIONS INCLUDE, CONTINUITY, LEAKAGE RESISTANCE, WIRE ROUTING, STRAIN RELIEF, LACING AND TIEDOWN 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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SUPERCEDING DATE: 06 OCT 87
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CIL REV: 2

# CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 5114031565
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<br>RATIONALE FOR ACCEPTANCE<br>SCREENS: A-PASS, B-PASS, C-PASS |
|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140f680-3 AND QTY-1 P/N 511400231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION. INCORRECT POSITION DATA. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | FAILURE HISTORY<br>---<br>THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT:<br><br>FAR 2073:<br>S/N 203 JUN 79<br><br>DESCRIPTION<br>---<br>NO OUT/PUT AFTER VIB. TEST, FOUND BROKEN WIRE AND GENERAL POOR WORKMANSHIP<br><br>CORRECTIVE ACTION<br>---<br>REWORKED BROKEN WIRE. INSPECTED ALL QUAL UNITS (INCLUDING CSA'S.)<br><br>FAR 2103:<br>S/N 203 FEB 80<br><br>DESCRIPTION<br>---<br>OUTPUT DID NOT CHANGE DUE TO CRACKED SOLDER JOINTS DUE TO QUAL VIBRATION. REFER TO FAR 2073<br><br>CORRECTIVE ACTION<br>---<br>NONE REQUIRED, UNIT QUAL TEST ACCEPTABLE.<br><br>FAR 2303:<br>S/N 301 SEP 81<br><br>DESCRIPTION<br>---<br>INPUT CURRENT TOO HIGH, CAUSE UNKNOWN<br><br>CORRECTIVE ACTION<br>---<br>PCB SCRAPPED AND REPLACED<br><br>FAR 2356:<br>S/N 316 APR 83<br><br>DESCRIPTION<br>---<br>SERIAL DATA FAILED, CLK SIGNAL SHORTED, POOR WORKMANSHIP.<br><br>CORRECTIVE ACTION<br>---<br>REPAIRED DAMAGED INSULATION.<br><br>FAR 2383:<br>S/N 215 MAY 85<br><br>DESCRIPTION<br>--- |

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## CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1565
SHEET: 7

| 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 |
|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 511400231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>---<br>UNEXPECTED MOTION. INCORRECT POSITION DATA. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>---<br>AUTOBRAKES | +5V RAIL CURRENT TOO HIGH. SHRINK TUBING CUT AFTER ASSEMBLY, POOR WORKMANSHIP.<br><br>CORRECTIVE ACTION<br>---<br>SOLDER TERMINAL SHORTENED, UNIT REPAIRED. |

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# CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: MECHANICAL ARM
SYSTEM: MECHANICAL ARM SUBSYSTEM
ASS'Y P/N: 51140J1565
SHEET: 8

| 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 |
|---|---|---|---|---|---|
| 4030 | 2 | OPTICAL POSITION ENCODER QTY-5 P/N 51140F680-3 AND QTY-1 P/N 511400231-3 | MODE:<br>NO OUTPUT.<br><br>CAUSE(S):<br>(1) FAILURE OF EEE PARTS.<br>(2) LOSS OF LED.<br>(3) LOSS OF 5V. OR 10V. SUPPLY.<br>(4) FAILURE OF OPTICAL REFLECTIVE SURFACE. | THE POSITION INFORMATION TO COMPUTER IS UNRELIABLE AND NOT REPRESENTATIVE OF JOINT POSITION. AUTO MODE WILL BE INOPERATIVE. CONSISTENCY CHECK WILL INITIATE AUTO BRAKES. IN AUTO ARM WILL STOP, 0 RATE COMMAND TO ALL JOINTS. ENCODER CHECK. DIRECT, BACKUP AND SINGLE MODES OPERATIVE. LOSS OF LIMPING DURING END EFFECTOR CAPTURE.<br><br>WORST CASE<br>----------<br>UNEXPECTED MOTION. INCORRECT POSITION DATA. AUTO BRAKES.<br><br>REDUNDANT PATHS REMAINING<br>----------<br>AUTOBRAKES | OPERATIONAL EFFECTS<br>----------<br>JOINT RUNAWAY. AUTOBRAKES. CANNOT USE COMPUTER SUPPORTED MODES. DIRECT DRIVE AND BACKUP AVAILABLE. ARM WILL NOT STOP AUTOMATICALLY IF AN UNDETECTED FAILURE OF THE AUTO BRAKES SYSTEM HAS PREVIOUSLY OCCURRED.BRAKES CAN BE APPLIED MANUALLY.<br><br>CREW ACTION<br>----------<br>APPLY BRAKES. USE DIRECT DRIVE.<br><br>CREW TRAINING<br>----------<br>THE CREW WILL BE TRAINED TO ALWAYS OBSERVE WHETHER THE ARM IS RESPONDING PROPERLY TO COMMANDS. IF IT ISN'T, APPLY BRAKES.<br><br>MISSION CONSTRAINT<br>----------<br>OPERATE UNDER VERNIER RATES WITHIN 10 FT OF STRUCTURE. THE OPERATOR MUST BE ABLE TO DETECT THAT THE ARM/PAYLOAD IS RESPONDING PROPERLY TO COMMANDS VIA WINDOW AND/OR CCTV VIEWS DURING ALL ARM OPERATIONS.<br><br>OMRSD OFFLINE<br>----------<br>DRIVE EACH JOINT IN COMPUTER SUPPORTED MODE AND VERIFY ENCODER MOVEMENT.<br><br>OMRSD ONLINE INSTALLATION<br>----------<br>NONE<br><br>OMRSD ONLINE TURNAROUND<br>----------<br>VERIFY JOINT BIASES. |

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