CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: TRANSLATIONAL HAND CONTROLLER
SYSTEM: D&C CONTROLS SUBSYSTEM
ASS'Y P/N: 5115SE118
SHEET: 1

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
1630	0	TRANS-LATIONAL HAND CONTROLLER QTY-1 SPAR P/N 5115SE118	MODE: LOSS OF/OR, ERRATIC OUTPUT FROM ONE OR ALL THREE AXES. CAUSE(S): (1) MECHANICAL FAILURE OF GIMBAL.	THC COMMANDS ERRATIC. ARM MAY MOVE IN UNEXPECTED TRAJECTORY. WORST CASE --------- UNEXPECTED MOTION. 6 JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQUIRED. REDUNDANT PATHS REMAINING --------- N/A		DESIGN FEATURES --------- THE MOVING-PARTS COUNT IS LOW. ALL MOVING PARTS ARE SUPPORTED BY PRECISION BEARINGS WHICH ARE DRY LUBRICATED. BEARING STRESSES AND ROTATIONAL SPEEDS ARE LOW. THE SPUR GEAR SEGMENTS ARE PRECISION GROUND AND DRY LUBRICATED. STRESS ANALYSIS FOR GIMBAL TRUNNIONS, BEARINGS, LINKAGES, AND GEARS HAS CONFIRMED ADEQUATE SAFETY MARGINS UNDER WORST CASE INPUT LOADING - 300 POUNDS INTO/OUT OF HANDGRIP, 150 POUND SIDE LOAD APPLIED TO HAND GRIP IN ANY LATERAL DIRECTION. REFER TO TABLE 14.6 FOR MARGINS OF SAFETY. STRENGTHS OF THE MECHNICAL LINKAGE SYSTEMS HAVE BEEN DEMONSTRATED BY DESIGN PROOF-TESTS. THE STAINLESS STEEL INDEX RING AFFORDS ADDITIONAL PROTECTION AGAINST DAMAGE DUE TO EXTERNALLY APPLIED LOADS. THE BASIC TRANSDUCER DESIGN IS IDENTICAL IN FORM, MATERIALS AND PROCESSES, TO THE ORBITER RHC TRANSDUCER. THE WINDINGS ARE IMPREGNATED AND POTTED IN THE FORM OF STATOR WINDINGS, HENCE THERE ARE NO MOVING CONTACTS AND HEAT TRANSFER TO THE TRANSDUCER CASE ENSURES LOW TEMPERATURE STRESS. EACH TRANSDUCER ASSEMBLY COMPRISES AN INPUT SHAFT, CENTERING SPRING AND THE BASIC TRANSDUCER, MOUNTED IN THE HOUSING WITH THREE BEARINGS. EACH TRANSDUCER ASSEMBLY IS SUBJECTED TO AN ACCEPTANCE TEST PRIOR TO ASSEMBLY TO THE HAND CONTROLLER MECHANISMS. SPRING LIFE HAS BEEN DEMONSTRATED TO 1000000 CYCLES. THE TWO HALVES OF THE CASE HOUSING HAVE THE MATING EDGES MACHINED TO FORM AN OVERLAPPING SEAL. THESE EDGES ARE COATED WITH AN EPOXY SEALANT ON ASSEMBLY. INGRESS OF PARTICULATES THROUGH THE INPUT SHAFT BEARING IS PRECLUDED BY A FLEXIBLE SEALING BOOT. ALL THREADED FASTENERS ENGAGE IN SELF LOCKING THREADS.

PREPARED BY: MFWG SUPERCEDING DATE: 11 SEP 86 APPROVED BY: _____ DATE: _____

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: TRANSLATIONAL HAND CONTROLLER
SYSTEM: D&C CONTROLS SUBSYSTEM
ASS'Y P/N: 51155E118
SHEET: 2

THEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 1/1 CRITICALITY	RATIONALE FOR ACCEPTANCE
1630	0	TRANS-LATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E118	MODE: LOSS OF/OR ERRATIC OUTPUT FROM ONE OR ALL THREE AXES. CAUSE(S): (1) MECHANICAL FAILURE OF GIMBAL.	THC COMMANDS ERRATIC. ARM MAY MOVE IN UNEXPECTED TRAJECTORY. WORST CASE UNEXPECTED MOTION. 6 JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQUIRED. REDUNDANT PATHS REMAINING N/A		ACCEPTANCE TESTS THE THC IS SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING AS AN SRU. O VIBRATION: LEVEL AND DURATION REFERENCE TABLE 1 O THERMAL: +100 DEGREES F TO 0 DEGREES F (12 HRS PER CYCLE) 2 CYCLES TOTAL. THE THC IS TESTED AS PART OF THE D&C SUBSYSTEM WHICH CONSISTS OF D&C PANEL, THC, AND RHC; PER TP347. THE THC IS FURTHER TESTED AS PART OF THE RMS SYSTEM TESTS (TP518 RMS STRONGBACK TEST AND TP552 FLAT FLOOR TEST), WHICH VERIFIES THE ABSENCE OF THE FAILURE MODE. QUALIFICATIONS TESTS THE THC HAS BEEN SUBJECTED TO THE FOLLOWING QUALIFICATION TEST ENVIRONMENTS. O VIBRATION: LEVEL AND DURATION REFERENCE TABLE 1 O SHOCK: 20G/11MS - 3 AXES (6 DIRECTIONS) O THERMAL: +140 DEGREES F TO -23 DEGREES F (6 CYCLES) 12 HRS PER CYCLE O HUMIDITY: 95% RH MAINTAIN AT 120 DEGREES F FOR 6 HRS AND DECREASE FROM 120 DEGREES F TO 82 DEGREES F IN 16 HRS.) 10 CYCLES TOTAL. O EMC: MIL-STD-461 AS MODIFIED BY SL-E-0002 (TESTS CE01, CE03, CS01 (DC/AC), CS02, CS06, RE02 (B/N) RS02, RS03, RS04. FLIGHT CHECKOUT PORS OPS CHECKLIST (ALL VEHICLES) JSC 16987

PREPARED BY: MFWG
SUPERCEDING DATE: 11 SEP 86
APP

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CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: TRANSLATIONAL HAND CONTROLLER
SYSTEM: D&C CONTROLS SUBSYSTEM
ASS'Y P/N: 51155E118
SHEET: 3

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
1630	0	TRANS-LATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E118	MODE: LOSS OF/OR ERRATIC OUTPUT FROM ONE OR ALL THREE AXES. CAUSE(S): (1) MECHANICAL FAILURE OF GIMBAL.	THC COMMANDS ERRATIC. ARM MAY MOVE IN UNEXPECTED TRAJECTORY. WORST CASE --------- UNEXPECTED MOTION. 6 JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQUIRED. REDUNDANT PATHS REMAINING --------- N/A		QA/INSPECTIONS --------- 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. THE TRANSDUCER ASSY CONSISTING OF A TRANSDUCER, DRY LUBE BEARINGS AND SPRINGS ETC. ARE BOUGHT OUT PARTS AS REQUIRED BY CAE SPEC PSD7786. INSPECTIONS ARE PERFORMED BY THE SUPPLIER CLIFTON PRECISION TO VERIFY THAT EACH MANUFACTURING, ASSEMBLY AND TEST OPERATION IS SATISAFCTORILY COMPLETED. THE TRANSDUCER ASSEMBLY IS ACCEPTANCE TESTED BY CLIFTON, WHICH INCLUDES INSULATION RESISTANCE CHECKS, AMBIENT PERFORMANCE, VIBRATION, THERMAL CYCLING AND POST THERMAL PERFORMANCE. THE ASSEMBLIES ARE SOURCE INSPECTED BY CAE QUALITY ASSURANCE PRIOR TO SHIPMENT TO CAE, QUALIFICATION OF ASSEMBLY IS PERFORMED AT THE THC ASSEMBLY LEVEL. 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. THE THC ASSY IS INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THE MECHANICAL LINKAGE, GEAR TRAINS, TRANSDUCER MECHANISM AND GIMBAL STRUCTURES ARE DIMENSIONALLY CHECKED USING STANDARD INSPECTION TECHNIQUES, AND LUBRICATION APPLICATION VERIFIED WHERE APPROPRIATE. DRY LUBE BEARINGS RECEIVE DIMENSIONAL INSPECTION AT THE SUPPLIER AND VERIFICATION BY RECEIVING INSPECTION PRE-ASSEMBLY INSPECTION VERIFIES CIRCULARITY OF BALL TRACKS AND INNER/OUTER RACE DIMETERS. 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. PRECLOSURE INSPECTION IS PERFORMED TO CHECK FOR FREEDOM OF MOVING PARTS ADEQUATE RETENTION OF WIRING, GENERAL WORKMANSHIP AND CLEANLINESS. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT). PRE-TEST INSPECTION OF THC ASSY. INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT).

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CRITICAL ITEMS LIST

PROJECT: SRMS
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SYSTEM: D&C CONTROLS SUBSYSTEM
ASS'Y P/N: 51155E118
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
1630	D	TRANS-LATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E118	MODE: LOSS OF/OR ERRATIC OUTPUT FROM ONE OR ALL THREE AXES. CAUSE(S): (1) MECHANICAL FAILURE OF GIMBAL.	THC COMMANDS ERRATIC, ARM MAY MOVE IN UNEXPECTED TRAJECTORY. WORST CASE ---------- UNEXPECTED MOTION, & JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQUIRED. REDUNDANT PATHS REMAINING ---------- N/A		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 PERFORMANCE, THERMAL AND VIBRATION TESTING, (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT). INTEGRATION OF D&C PANEL, RHC, THC AND MCIU, INSPECTIONS ARE PERFORMED AT EACH STAGE OF INTEGRATION, WHICH INCLUDES GROUNDING CHECKS, INTER CONNECT CABLE VERIFICATION, CONNECTOR INSPECTION FOR BENT OR PUSHBACK CONTACTS ETC. SUB-SYSTEM PERFORMANCE TESTING (ATP), INCLUDES AN AMBIENT PERFORMANCE TEST. (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)

PREPARED BY: MFWG
SUPERCEDING DATE: 11 SEP 86
AP

DATE:

CRITICAL ITEMS LIST

PROJECT: SRMS
SYSTEM: D&C CONTROLS SUBSYSTEM
ASS'Y NOMENCLATURE: TRANSLATIONAL HAND CONTROLLER
ASS'Y P/N: 5115SE118
SHEET: 5

FMEA REF.	REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
1630	1	TRANS-LATIONAL HAND CONTROLLER QTY-1 SPAR P/N 5115SE118	MODE: LOSS OF/OR ERRATIC OUTPUT FROM ONE OR ALL THREE AXES. CAUSE(S): (1) MECHANICAL FAILURE OF GIMBAL.	THC COMMANDS ERRATIC. ARM MAY MOVE IN UNEXPECTED TRAJECTORY. WORST CASE --- UNEXPECTED MOTION. 6 JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQUIRED. REDUNDANT PATHS REMAINING --- N/A		FAILURE HISTORY --- THE FOLLOWING FAILURE ANALYSIS REPORT(S) ARE RELEVANT: FAR 4007: S/N 202 JAN 80 DESCRIPTION --- AFTER VIBRATION FORCE/DISPLACEMENT O.O.S. NO APPARENT CAUSE. CORRECTIVE ACTION --- NONE FAR 4009: S/N 202 JAN 80 DESCRIPTION --- FORCE DISPLACEMENT O.O.S. CORRECTIVE ACTION --- REFER TO 4007

PREPARED BY: MEHG
SUPERCEDING DATE: 06 OCT 87
APPROVED BY: _____
DATE: _____

CRITICAL ITEMS LIST

PROJECT: SRMS
ASS'Y NOMENCLATURE: TRANSLATIONAL HAND CONTROLLER
SYSTEM: D&C CONTROLS SUBSYSTEM
ASS'Y P/N: 51155E110
SHEET: 12

FMEA REF.	REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. I/I CRITICALITY	RATIONALE FOR ACCEPTANCE
1630	1	TRANS-LATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E110	MODE: LOSS OF/OR ERRATIC OUTPUT FROM ONE OR ALL THREE AXES. CAUSE(S): (1) MECHANICAL FAILURE OF GIMBAL.	THC COMMANDS ERRATIC. ARM MAY MOVE IN UNEXPECTED TRAJECTORY. WORST CASE UNEXPECTED MOTION, 6 JOINT RUNAWAY. UNANNUNCIATED. CREW ACTION REQUIRED. REDUNDANT PATHS REMAINING N/A		OPERATIONAL EFFECTS ARM DOES NOT RESPOND PROPERLY TO COMMANDS OR DRIVES WITHOUT COMMAND. WHEN THE COMMAND IS REMOVED, THE ARM CONTINUES TO DRIVE. CREW ACTION APPLY BRAKES. CREW TRAINING THE CREW WILL BE TRAINED TO ALWAYS OBSERVE WHETHER THE ARM IS RESPONDING PROPERLY TO COMMANDS. IF IT ISN'T, APPLY BRAKES. MISSION CONSTRAINTS OPERATE UNDER VERNIER RATES WITHIN 10 FT OF STRUCTURE. THE OPERATOR MUST BE ABLE TO DETECT THAT THE ARM IS RESPONDING PROPERLY TO COMMANDS VIA WINDOW AND/OR CCTV VIEWS DURING ALL ARM OPERATIONS. SCREEN FAILURES N/A ONRSD OFFLINE EXERCISE THC THROUGH FULL OPERATING RANGE IN EACH AXIS VERIFY OUTPUT VOLTAGE CHANGE SMOOTH AND CONTINUOUS AT THC OUTPUT ONRSD ONLINE INSTALLATION NONE ONRSD ONLINE TURNAROUND EXERCISE THC THROUGH FULL OPERATING RANGE IN EACH AXIS VERIFY BIT COUNT CHANGES MONOTONICALLY

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