

**EXPEDITE  
 PROCESSING**

**INTRODUCTION TO APPENDIX G**

08/19/88

ITEM 1 - EVENT INDICATOR . . . . . MC432-0222-XXXX  
 ITEM 2 - METER TAPE . . . . . MC432-0232-XXXX

THE FOLLOWING TABLE LISTS FAILURE MODES AND CAUSES WHICH WERE CONSIDERED IN DERIVING THE FAILURE MODES AND EFFECTS ANALYSIS (FMEA'S) FOR THE ITEMS LISTED ABOVE:

FAILURE MODE / Failure Cause	ITEM 1 EVENT INDICATOR	ITEM 2 METER TAPE
LOSS OF INDICATION, FALLS TO CHANGE STATE (a) Piece Part Failure (b) Contamination (c) Vibration (d) Mechanical Shock (e) Processing Anomaly (f) Thermal Stress	X X X X X X	X X X X X X
INADEQUATE INDICATION, INADEQUATE CHANGE OF STATE (a) Piece Part Failure (b) Contamination (c) Vibration (d) Mechanical Shock (e) Processing Anomaly (f) Thermal Stress	X X X X X X	X X X X X X

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APPENDIX G ITEM 2 - METER TAPE  
(MC432-0232-XXXX)

DISPOSITION & RATIONALE

(A) DESIGN, (B) TEST, (C) INSPECTION, (D) FAILURE HISTORY:

(A) DESIGN

PHYSICAL/FUNCTIONAL DESCRIPTION

TAPE METERS PROVIDE INDICATION OF PRESSURE, QUANTITY, AND TEMPERATURE PARAMETERS WITHIN THE MAIN PROPULSION, HYDRAULIC, AND AUXILIARY POWER SUBSYSTEMS. THEY PRESENT VISUAL INFORMATION ON SELECTED PARAMETERS USING SERVO DRIVEN TAPES. THE ELECTRONIC/MECHANICAL ASSEMBLY IS ENCLOSED IN A SEALED, PANEL MOUNTED ENVELOPE. TAPE METER CONFIGURATIONS DIFFER IN METER MOVEMENT RANGE, SCALE INDICATION, AND NUMBER OF DISPLAYS. EACH CONSISTS OF A SINGLE OR MULTIPLE-FIXED VERTICAL SCALE METER FACE WITH DUAL, TRIPLE, OR QUADRUPLE TAPE MOVEMENTS. THE METERS CONTAIN INTEGRAL LIGHTING, OPERATE FROM A 28 VDC POWER SOURCE, AND PROVIDE INDICATION FROM A 0 TO 5 VDC ANALOG INPUT SIGNAL.

DESIGN EVOLUTION

DURING ACCEPTANCE VIBRATION TEST, THE TAPE METER BECAME ERRATIC (CAR A3367). THE FAILURE WAS ATTRIBUTED TO INSUFFICIENT BRUSH PRESSURE (POTENTIOMETER) AND EXCESSIVE END PLAY OF MOTOR/POTENTIOMETER SHAFT. THE CORRECTIVE ACTION CONSISTED OF ASSURING PROPER BRUSH PRESSURE AND ALIGNMENT IN THE POTENTIOMETERS, INCREASING THE GAP BETWEEN WIPER ARM AND RESISTIVE ELEMENT AND ADDING SHIMS.

DURING ACCEPTANCE VIBRATION TEST, THE READOUT CHANGED FROM CALIBRATION POSITION (CAR A3680). FAILURE ANALYSIS REVEALED BROKEN SPOT WELDS BETWEEN THE ARMATURE PLATE AND SHAFT. THE SUPPLIER REVISED HIS PLATE AND SHAFT ASSEMBLY DRAWING TO PROVIDE SUITABLE SPOT WELDS WHICH WERE SUBJECTED TO SHEAR AND PULL TEST FOLLOWED BY INSPECTION FOR SURFACE FLATNESS AND SHAFT PERPENDICULARITY.

DURING ACCEPTANCE TEST, THE TAPE METER LIGHTING DID NOT MATCH THE LIGHTING STANDARD, APPEARING DIMMER WITH A SLIGHT YELLOWISH TINT (CAR A4014). ANALYSIS REVEALED THE UNIT TO HAVE A SHIFT IN LIGHT INTENSITY AND COLOR DUE TO DARKENING OF THE DIAL FACE COATING EXPERIENCED DURING BURN-IN. THE LIGHTING BLOCK ASSEMBLY AND LIGHTING EVALUATION WERE MODIFIED TO ELIMINATE THE PROBLEM.

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DESIGN (CONTINUED)

DURING QUALIFICATION VIBRATION TEST, CHANNEL 2 BECAME ERRATIC AND CHANNEL 3 TAPE SHIFTED CALIBRATION (CAR A4282). THE CHANNEL 3 MOTOR ASSEMBLY FEEDBACK POTENTIOMETER WIPER WAS NOT PARALLEL TO THE POTENTIOMETER SURFACE RESULTING IN DECREASED CLEARANCE AND SHORTING DURING VIBRATION. THE CAUSE OF THE CHANNEL 2 CONDITION WAS ATTRIBUTED TO EXTENSIVE REWORK PERFORMED PRIOR TO QUALIFICATION TEST. THE CHANNEL 3 PROBLEM WAS CAUSED BY AN IMPROPER FIT OF THE TORQUE MOTOR BETWEEN THE SIDE PLATE AND END PLATE. VIBRATION THEN CAUSED THE SIDE PLATE TO FLEX AND THE MOTOR TO SHIFT. THE END PLATES WERE MODIFIED TO CORRECT THIS PROBLEM.

DURING QUALIFICATION VIBRATION TEST, CHANNEL 2 LOST SIGNAL (CAR A4327). ANALYSIS DISCLOSED A BROKEN WIRE CAUSED BY INSUFFICIENT RESTRAINT OF WIRE BUNDLES. CORRECTIVE ACTION INCLUDED THE SEPARATION AND REROUTING OF WIRE BUNDLES. PRINTED CIRCUIT BOARDS WERE REARRANGED TO ACCOMMODATE THE IMPROVED WIRE ROUTING.

DURING ACCEPTANCE THERMAL TEST, CHANNEL 2 FLAG APPEARED AT AN INCORRECT VOLTAGE LEVEL (CAR A4782). ANALYSIS REVEALED NO FAILED COMPONENTS. HOWEVER, THE COMPONENT THAT ESTABLISHED THE THRESHOLD VOLTAGE FOR THE MICROCIRCUIT WAS FOUND TO BE RESPONSIBLE FOR THE FAILURE. RESISTIVE VALUE WAS CHANGED TO BIAS THE INPUT VOLTAGE OF THE MICROCIRCUIT.

DURING QUALIFICATION VIBRATION TEST, THE CHANNEL NO. 3 OFF FLAG DID NOT COMPLETELY COME INTO VIEW (CAR A6402). ANALYSIS DISCLOSED THAT THE TAPE HAD MOVED Laterally SLIPPING OFF THE EDGE OF THE DRUM INTERFERING WITH FLAG MOVEMENT. THE DRUM WAS REDESIGNED BY ADDING A LIP TO THE OUTER EDGES THUS CREATING A GROOVE IN WHICH THE INDICATOR TAPE WOULD RIDE.

DURING THE QUALIFICATION LIFE TEST, THE CHANNEL 4 INDICATING TAPE WAS OBSERVED TO BE OSCILLATING (CAR AD3288). ANALYSIS REVEALED THAT THE FAILURE WAS THE RESULT OF VOLTAGE POTENTIAL VARIATIONS BETWEEN ADJACENT MOTOR COIL SEGMENTS, FRICTION AND SERVO LOOP SENSITIVITY. CORRECTIVE ACTION INCLUDED AN ADDITION TO THE FTP TO LOOK FOR OSCILLATION TENDENCIES.

THE ABOVE DESIGN CHANGES WERE INCORPORATED INTO THE FLIGHT CONFIGURATION TAPE METERS.

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(B) TESTS

CERTIFICATION

THE TAPE METER MOVEMENT RANGE AND SCALE INDICATIONS DIFFER. THE TEST SPECIMENS SELECTED REPRESENTED ALL CONFIGURATIONS AS CLOSELY AS POSSIBLE AND ARE CONSIDERED SIMILAR.

CERTIFICATION WAS BASED ON QUALIFICATION AND ANALYSIS TESTS.

CERTIFICATION

<u>CERTIFICATION &amp; QUALIFICATION</u> TEST SAMPLE DASH NO. See Note	<u>FLIGHT CERTIFIED</u> SIMILAR DASH NO.
-0013 TRIPLE METER MOVEMENT	-0008 -0009 -0015 -0017 -0018
-0014 QUADRUPL METER MOVEMENT	-0010
-0016 DUAL METER MOVEMENT	-0012

Note: Dash number indicates dial face configuration.

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TESTS (CONTINUED)

QUALIFICATION TESTS

TEST
ACCEPTANCE TEST
VIBRATION
QAVT - (0.067G <sup>2</sup> /HZ)
FLIGHT - (0.09G <sup>2</sup> /HZ)
ACCELERATION
SHOCK
BENCH HANDLING
BASIC DESIGN
CRASH SAFETY
WINDOW IMPACT
BONDING
ELECTROMAGNETIC COMPATIBILITY (EMC)
THERMAL CYCLE
OPERATING LIFE
POWER TEST
CABIN ATMOSPHERE
PACKAGE QUALIFICATION TEST
LIGHTNING TEST
LIGHTING

ACCEPTANCE TESTS

ALL PRODUCTION METERS ARE SUBJECTED THE FOLLOWING ACCEPTANCE TESTS.

INSPECTION AND TESTS
EXAMINATION OF PRODUCT
FUNCTIONAL TESTS
ACCEPTANCE VIBRATION TESTS (0.04G <sup>2</sup> HZ)
ACCURACY
ACCEPTANCE THERMAL TESTS
INSULATION RESISTANCE
PRESSURE/VACUUM/LEAK RATE
LIGHTING

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(C) INSPECTION

RECEIVING INSPECTION -

RECEIVING INSPECTION VERIFIES PURCHASED MATERIALS TO THE EXTENT NECESSARY TO ASSURE CONFORMANCE TO THE APPLICABLE TECHNICAL REQUIREMENTS OF THE PURCHASE ORDER AND DRAWING, PER DOCUMENTED POLICY.

ENGINEERING SPECIFIES CRITICAL AND MAJOR PARAMETERS OF PURCHASED PARTS AND MATERIALS TO BE VERIFIED BY RECEIVING INSPECTION, PER DOCUMENTED REQUIREMENTS.

ALL CERTIFICATION RECORDS AND TEST REPORTS ARE MAINTAINED WITH THE ORIGINAL RECEIVING REPORT AND PACKING SLIP.

COMPLETED RECEIVING REPORTS ARE MAINTAINED IN THE CLOSED PURCHASE ORDER FILE PER DOCUMENTED PROCEDURES.

CONTAMINATION CONTROL -

QUALITY ASSURANCE (QA) MONITORS AND AUDITS SHOP AREAS TO ENSURE THAT THE RESPONSIBLE PARTIES ARE IN COMPLIANCE WITH ALL SPECIFIED CONTAMINATION CONTROLS, PER DOCUMENTED INSTRUCTIONS.

ASSEMBLY/INSTALLATION -

IN-PROCESS INSPECTION POINTS ARE ESTABLISHED BY QA TO ENSURE ACCEPTABILITY OF ITEMS PRIOR TO SUBSEQUENT PROCESSING OR STOCKING, WHEN SUCH PROCESSING WOULD MAKE VERIFICATION OF ACCEPTABILITY OF PREVIOUS OPERATIONS IMPOSSIBLE, PER DOCUMENTED INSTRUCTIONS.

A CRIMP LOG IS MAINTAINED, AND CRIMP TOOL CALIBRATION VERIFICATION COMPLIES WITH MSC-SPEC-Q-1A.

ALL BRAZED JOINTS AND CRIMPS ARE VISUALLY INSPECTED.

CRITICAL PROCESSES -

PROCESSING OPERATIONS ARE MONITORED FOR COMPLIANCE WITH QUALITY REQUIREMENTS, AND QA PERFORMS AUDITS TO VERIFY THAT PROCESSING REQUIREMENTS ARE MET.

CRITICAL PROCESSES ARE BRAZING, CRIMPING, SPOT WELDING, SOLDERING, SWAGING, COMPONENT BONDING, CONFORMAL COATING, SEALING, AND ETCHING.

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INSPECTION (CONTINUED)

CERTIFICATION OF OPERATORS IS VERIFIED FOR CRIMPING, SOLDERING, COMPONENT BONDING, CONFORMAL COATING, AND HARNESS/CABLE FABRICATION.

TESTING -

QA REGULARLY CONDUCTS SURVEILLANCE OF PRODUCT TESTING IN ACCORDANCE WITH DOCUMENTED INSTRUCTIONS.

A FULL TEST IS PERFORMED FOR EVERY ONE HUNDRED SPOT WELDS.

HANDLING/PACKAGING -

PARTS PACKAGED AND PROTECTED ARE VERIFIED BY INSPECTION TO APPLICABLE REQUIREMENTS.

SPECIAL HANDLING PER DOCUMENTED INSTRUCTIONS IS VERIFIED, TO PRECLUDE DAMAGE, SHOCK, AND CONTAMINATION DURING COMPONENT HANDLING/TRANSPORTING/PACKAGING BETWEEN WORK STATIONS.

CONTROLS ARE IMPLEMENTED TO PREVENT ELECTROSTATIC DISCHARGE, AND THE MAINTENANCE OF CONTROLS IS AUDITED BY QA.

(D) FAILURE HISTORY

CAR AB6906 PRIME. CAR AB7315. CAR AC1172-REFERENCE

DURING SAIL SYSTEMS CHECKOUT TESTS, METER-M4 MOVEMENT WAS ERRATIC. THE METER EXHIBITED EVIDENCE OF OVERHEATING, COMPONENT OVER-STRESS AND APPARENT EXCESSIVE CURRENT DRAW THROUGH THE MOTOR CIRCUITS. THE METER HAD OPERATED SATISFACTORY FOR OVER 2000 HOURS BEFORE FAILURE DETECTION. THE FAILURES WERE ATTRIBUTED TO DEFECTIVE MOTOR ARMATURE WINDING. ALL SHUTTLE ARMATURES WILL BE 100% TESTED FOR INSULATION BREAKDOWN. ARMATURE THERMAL TEST WAS REVISED FOR 25 CYCLES BETWEEN -50 DEGREES C TO +120 DEGREES.

CAR AD0080

MPS ENGINE NO. 1 HELIUM PRESSURE METER EXHIBITED STICKY MOVEMENT AND BLEW ASSOCIATED FUSE. ANALYSIS ISOLATED THE PROBLEM AS AN OVERCURRENT STRESS TO THE TORQUE MOTOR COIL ASSEMBLY. THE ANOMALY IS CONSIDERED AN ISOLATED INCIDENT. SINCE THE TAPE METER HAS OPERATED FOR OVER 17,000 HOURS AT SAIL WITHOUT A PROBLEM AND SINCE THE METER DATA CAN BE READ ON THE CRT DISPLAY AND ON THE GROUND, AND STICKY METER OPERATION IS SCREENABLE BY SUBSYSTEM CHECKOUT PRIOR TO LAUNCH, NO FURTHER ACTION WAS TAKEN.

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FAILURE HISTORY (CONTINUED)

CAR AD1731

TAPE METER DISPLAYED ERRATIC MOVEMENT. FAILURE ANALYSIS REVEALED THAT FAILURE WAS CAUSED BY IMPROPER POSITIONING OF THE MOTOR/DRUM ASSEMBLY WHICH RESULTED IN EXCESSIVE ANGULAR PLAY AND A DEFORMED ZEE CLIP WHICH RESULTED IN TAPE BINDING. FOR CORRECTIVE ACTION, THE MANUFACTURING PROCESS WAS CHANGED TO PREVENT THIS PROBLEM. THE EXPERIENCED FAILURE IS CONSIDERED TO BE ACCEPTANCE TEST SCREENABLE.

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