

11/03/87

INTRODUCTION TO APPENDIX E

- ITEM 1 - RESISTOR - FILM - RLR42
- ITEM 2 - RESISTOR - FILM - RLR07
- ITEM 3 - RESISTOR - FILM - RLR07
- ITEM 4 - RESISTOR - WIRE WOUND - RWR80
- ITEM 5 - RESISTOR - FILM, POWER WIRE WOUND - RWR77
- ITEM 6 - RESISTOR - FILM - RLR20

THE FOLLOWING TABLE LISTS FAILURE MODES AND CAUSES WHICH WERE CONSIDERED IN DESCRIBING THE FAILURE MODES AND EFFECTS ANALYSIS (MEA'S).

FAILURE MODE / Failure Cause	RLR42	RLR07	RWR80	RWR77	RWR65	RLR20
OPEN (a) Structural Failure Mechanical Stress Vibration (c) Electrical Stress (d) Thermal Stress (e) Processing Anomaly	X	X	X	X	X	X
SHORT (END TO END) (a) Structural Failure Mechanical Stress Vibration (b) Contamination (c) Electrical Stress (d) Thermal Stress (e) Processing Anomaly			X	X	X	
SHORT TO STRUCTURE (GROUND) (a) Structural Failure Mechanical Stress Vibration (b) Contamination (c) Electrical Stress (d) Thermal Stress (e) Processing Anomaly				X	X	

11/03/87

APPENDIX E ITEM 2 - RESISTOR -FIXED FILM AXIAL LEAD  
RLR07CXXGR

RETENTION RATIONALE:

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

(A) DESIGN

THE PART IS AN INSULATED FILM, 1/4 WATT FIXED RESISTOR IN A MOLDED PACKAGE WITH AXIAL LEADS. THE PACKAGE IS RESISTANT TO HUMIDITY EXPOSURE. THE RESISTOR IS CAPABLE OF FULL LOAD OPERATION AT AN AMBIENT TEMPERATURE OF 70 °C AND HAS RESISTANCE-TEMPERATURE CHARACTERISTICS OF ±100 PART PER MILLION PER °C. THE RESISTOR LIFE FAILURE RATE IS .01 PERCENT FOR 1000 HR. THIS FAILURE RATE LEVEL IS ESTABLISHED AT A 60 PERCENT CONFIDENCE LEVEL ON THE BASIS OF LIFE TESTS. THIS FAILURE RATE LEVEL IS REFERRED TO OPERATION AT FULL RATED WATTAGE AT 70 °C, WITH A PERMISSIBLE CHANGE IN RESISTANCE OF ±4 PERCENT IN 10,000 HOURS. THE PART IS DESIGNED TO MEET THE REQUIREMENTS OF MIL-R-39017/1. THE PART APPLICATION IS ALSO ANALYZED TO ASSURE COMPLIANCE WITH THE 25% DERATING CRITERIA OF THE ORBITER PROJECT PARTS LIST.

(B) TEST

THE PART AS SCREENED AND QUALIFIED TO THE REQUIREMENTS OF MIL-R-39017/1. TESTS AND INSPECTIONS PERFORMED ON A SAMPLE OF PARTS FROM EACH PRODUCTION LOT ARE:

TEST / INSPECTION	CAUSE CONTROL				
	a	b	c	d	e
VISUAL AND MECHANICAL INSPECTION	X				X
RESISTANCE-TEMPERATURE CHARACTERISTIC		X		X	X
DIELECTRIC WITHSTANDING VOLTAGE		X	X		X
THERMAL CYCLING		X		X	X
SHORT TIME OVERLOAD (1250 VOLTS, 5 SEC)			X		X
SOLDERABILITY		X			X

QUALIFICATION TESTS (LOT SAMPLE)

11/03/87

APPENDIX E ITEM 2 CONT'D

TESTS AND INSPECTIONS PERFORMED ON A PERIODIC BASIS AS A PART OF QUALIFICATION ARE:

TEST / INSPECTION	CAUSE CONTROL				
	a	b	c	d	e
LIFE (70 °C, 2000 HOURS)		X	X	X	X
SOLDERABILITY		X			X
DIELECTRIC WITHSTANDING VOLTAGE		X	X		X
INSULATION RESISTANCE		X	X		X
THERMAL CYCLE (150 TO -65 °C)				X	X
RESISTANCE TO SOLDERING HEAT				X	X
MOISTURE RESISTANCE	X				X
SHOCK (1000G)	X				X
VIBRATION	X				X
RESISTANCE TO SOLVENTS					X
LOW TEMPERATURE STORAGE (-65 °C, 24 HR)				X	X
LOW TEMPERATURE OPERATION (-55 °C, 45 MIN)				X	X
TERMINAL STRENGTH	X				X
HIGH TEMP EXPOSURE (150 °C, 2000 HR)		X		X	X

QUALIFICATION TESTS (PERIODIC)

TESTS AND INSPECTIONS PERFORMED ON 100% OF THE PRODUCT ARE:

TEST / INSPECTION	CAUSE CONTROL				
	a	b	c	d	e
POWER CONDITIONING (3/8 WATTS, 24 HOURS)		X	X	X	X
DC RESISTANCE		X	X		X

QUALITY CONFORMANCE TESTS (ALL DEVICES)

(C) INSPECTION

THE PART HAS REQUIRED INSPECTION DURING MANUFACTURING PROCESS IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-R-39017/1. IN ADDITION, THE PART SUPPLIER IS REQUIRED TO HAVE QUALITY CONTROL (QC) PRACTICES IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-R-39017 AND

11/03/87

APPENDIX E ITEM 2 CONT'D

IN ADDITION, THE PART SUPPLIER IS REQUIRED TO HAVE QUALITY CONTROL (QC) PRACTICES IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-STD-790. THE REQUIREMENTS ARE TO ASSURE ADEQUATE PROCESS CONTROLS ARE IMPOSED BY THE PART SUPPLIER ON THE PARTS MANUFACTURING PROCESS. THE PROCESSES AND CONTROLS ARE ROUTINELY REVIEWED AND APPROVED BY THE QUALIFYING AGENCY (DEFENSE ELECTRONIC SUPPLY CENTER)..

RECEIVING INSPECTION (FAILURE CAUSE a,b,e)

INSPECTION OF INCOMING MATERIALS, UTILITIES AND WORK-IN PROCESSES (PACKAGES, WIRE, WATER PURIFICATION) IS REQUIRED OF THE PART SUPPLIER.

CLEANLINESS CONTROL (FAILURE CAUSE b)

THE PART SUPPLIER IS REQUIRED TO HAVE CLEANLINESS AND ATMOSPHERE CONTROL IN CRITICAL WORK AREAS TO THE REQUIREMENTS OF FED-STD-209.

ASSEMBLY/INSTALLATION (FAILURE CAUSE a,b,e)

THE PART SUPPLIER IS REQUIRED TO HAVE INSPECTION CRITERIA, FINAL LOT DISPOSITION AND RECORDS RETENTION. THE MANUFACTURER IS ALSO REQUIRED TO SUBMIT A PROGRAM PLAN ESTABLISHING A MANUFACTURING FLOW CHART, INTERNAL AUDIT ACTIVITIES AND EXAMPLES OF DESIGN, MATERIAL EQUIPMENT STANDARDS AND PROCESS INSTRUCTIONS FOR APPROVAL BY THE QUALIFYING AGENCY.

CRITICAL PROCESSES (FAILURE CAUSE a,e)

THE PART SUPPLIER MUST HAVE REQUIREMENTS AND CONTROLS ON MATERIALS PREPARATION; BONDING CRITERIA; REWORK CRITERIA; DESIGN, PROCESSING, MANUFACTURING, TESTING, AND INSPECTION DOCUMENTATION AND CHANGE CONTROL; PERSONNEL TRAINING; FAILURE/DEFECT ANALYSIS AND CORRECTIVE ACTION; AND INVENTORY CONTROL.

TESTING (FAILURE CAUSE a,b,c,d,e)

THE PART SUPPLIER MUST HAVE TEST EQUIPMENT MAINTENANCE AND CALIBRATION CONTROLS WHICH COMPLY WITH THE REQUIREMENTS OF MIL-STD-45662 AND HAVE BEEN APPROVED BY THE QUALIFYING AGENCY.

11/03/87

APPENDIX E ITEM 2 CONT'D

HANDLING/PACKAGING (FAILURE CAUSE a)

HANDLING PROCEDURES MUST PROVIDE PHYSICAL PROTECTION OF MATERIAL DURING ALL SEQUENCES OF PRODUCTION AND INSPECTION. ASSEMBLED PARTS ARE PHYSICALLY PROTECTED DURING TESTING AND QUALITY CONFORMANCE INSPECTIONS. STORAGE OF PARTS IS IN A CONTROLLED AREA, REQUIRING AUTHORIZATION FOR REMOVAL FROM THE AREA AND PREPARATION FOR SHIPMENT.

(D) FAILURE HISTORY

FAILURE MODE: FAIL OPEN

CAR AD6582

REPORTS THAT THE RESISTOR RLR07C1801 MANUFACTURED BY DALE WAS FOUND TO EXHIBIT A RESISTANCE OF APPROXIMATELY 8 MEGOHMS WHICH WOULD DECREASE WITH INCREASED TEMPERATURE. VISUAL EXAMINATION REVEALED THAT THE LEADS HAD BEEN BENT EXTREMELY CLOSE TO THE BODY OF THE RESISTOR RESULTING IN A CHIP CRACKING OUT OF THE BODY MATERIAL. RADIOGRAPHIC EXAMINATION AND SECTIONING FAILED TO LOCATE THE MARGINAL OR OPEN CONNECTION. BASED UPON THE AVAILABLE DATA, IT APPEARS THAT THE BENDING OF THE RESISTOR LEAD CAUSED STRESS BETWEEN THE RESISTOR AND END-CAP AND RESISTOR METAL FILM ELEMENT WHICH RESULTED IN AN "OPEN." MANUFACTURING AND INSPECTION PERSONNEL WERE BRIEFED. A REVIEW OF THE COMPONENT LEAD FORMING PROCESS REFLECTS THE PARTICULAR RESISTOR LEADS WERE NOT FORMED OR BENT TO THE ESTABLISHED CRITERIA. COMPONENT CIRCUIT BOARDS IN THE MANUFACTURING AREA WERE EXAMINED. THESE BOARDS CONTAINED COMPONENTS WHOSE LEADS WERE BENT OUT AWAY FROM THE BODY OF THE DEVICE. BASED UPON THE RESULTS OF THE REVIEW AND INTERVIEWS WITH THE MANUFACTURING PERSONNEL, THIS FAILURE IS CONSIDERED AN ISOLATED ESCAPE AND NOT A GENERIC MANUFACTURING ISSUE. ALL ROCKWELL SPACE DIVISION FABRICATION AREAS, HAVE BEEN REVIEWED AND PROPER COMPONENT LEAD FORMING PROCESS VERIFIED.

CAR AC9186-010

GIDEP ALERT ZW-A-84-01 REPORTED A CHANGE IN RESISTANCE OF RLR07 RESISTORS MANUFACTURED BY CORNING. CHANGE OCCURRED DURING MOISTURE AND THERMAL SHOCK TEST. SEVENTEEN SUBCONTRACTOR IDENTIFIED HAVE REPORTED USE OF THE ALERTED PARTS. BUT HAVE NOT EXPERIENCE AND FAILURES OR ANOMALIES IN USING THE RESISTORS. ANY RESIDUAL RESISTORS IN INVENTORY WILL BE RETURNED TO CORNING GLASS FOR REPLACEMENT. ELEVEN SUBCONTRACTORS REPORT NO USAGE OF THE ALERTED RESISTOR AND HAVE NO INTENT TO PURCHASE CORNING RLR07 RESISTORS FOR SPARES. THERE HAVE BEEN NO REPORTED FAILURES OF THESE DEVICES DESPITE EXTENSIVE USAGE THROUGHOUT THE VEHICLE IN MULTIPLE APPLICATIONS. NO FURTHER ACTION IS WARRANTED.

11/02/87 (5:57pm)

APPENDIX E ITEM 2 CONT'D

PREPARED BY:

APPROVED BY:

APPROVED BY (NASA):

DESIGN

RELIABILITY

QUALITY

M. HOVE

J. COURSEN

DES

REL

QE

J. K. Chase

Melvin D. [unclear] 11-3-87

[unclear] R. [unclear]

SSM

REL

QE

N. C. [unclear] 11/3/87

[unclear] 11/3/87

[unclear] 11/3/87