INTRODUCTION TO APPENDIX F

THE FOLLOWING CHART SHOWS THE DIODE TYPE VERSUS FAILURE MODES AND CAUSES WHICH WERE CONSIDERED IN DERIVING THE FAILURE MODES AND EFFECTS ANALYSIS (FMEA'S).

APPENDIX F ITEM NUMBER	#1	#2	#3	#4	#5	#6
FAILURE MODE / Failure Cause	JANTX 1N1188R	JANTX 1N1204RA	JANTXV 1N4246	JANTXV 1N5551	JANTXV 1N4148-1	JANTXV 1N4247
OPEN, FAILS TO CONDUCT (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	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				

TABLE 1

NOTE: RATIONALE IS PROVIDED FOR THE JANTXV1N4148-1, A METALLURGICAL BOND DIODE, WHICH HAS DEMONSTRATED ITSELF TO BE A RELIABLE PART ON THE ORBITER PROGRAM. THIS RATIONALE SHOULD NOT BE APPLIED TO THE JANTXV1N4148 (NO DASH ONE) WHICH HAS HAD A FAILURE HISTORY OF THERMAL COMPRESSION BOND FAILURES.

APPENDIX F ITEM 1 - DIODE, POWER - STUD MOUNT
JANTX1N1188R (35 AMPERE)

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

(A) DESIGN

THE PART IS A 35 AMPERE SILICON SEMICONDUCTOR DIODE. THE SILICON SEMICONDUCTOR CHIP IS INSTALLED IN A STUD MOUNT CASE WHICH IS MADE OF CORROSION RESISTANT METAL, HERMETICALLY SEALED BY WELDING. THE ANODE OF THE SILICON CHIP IS ELECTRICALLY CONNECTED TO THE CASE. THE CATHODE IS ELECTRICALLY CONNECTED TO THE INSULATED TERMINAL. THIS TERMINAL / CASE ARRANGEMENT RESULTS IN LOSS OF ONLY ONE POWER OR CONTROL SIGNAL PATH, SHOULD THE CASE BE SHORTED TO GROUND, REDUNDANT POWER OR CONTROL SIGNALS WILL NOT BE AFFECTED. THE DEVICE IS DESIGNED, QUALIFIED, TESTED AND INSPECTED TO THE REQUIREMENTS OF MIL-S-19500/297. THE PART APPLICATION IS ANALYZED TO ASSURE COMPLIANCE WITH THE 25% DERATING CRITERIA OF THE ORBITER PROJECTS PARTS LIST. THIS ANALYSIS ASSURES PROPER ELECTRICAL AND THERMAL APPLICATION.

(B) TEST

THE PART IS SCREENED AND QUALIFIED TO THE REQUIREMENTS OF MIL-S-19500/297. THE FOLLOWING TESTS ARE PERFORMED ON SAMPLE DEVICES REMOVED FROM EACH MANUFACTURING LOT TO DEMONSTRATE QUALIFICATION OF THE LOT:

TEST / INSPECTION	CAUSE CONTROL				
	a	b	c	d	e
SOLDERABILITY		X			X
THERMAL CYCLING (175 TO -65°C, 10 CYCLES)	X			X	X
THERMAL SHOCK (175 TO 0°C, 25 CYCLES)	X			X	X
TERMINAL STRENGTH (15 LBS)	X				X
HERMETIC SEAL ($5x10^{-8}$ CC/SEC)	X	X			X
MOISTURE RESISTANCE	X	X			X
ELECTRICAL FUNCTIONAL TESTS	X	X		X	X
SHOCK (500-G)	X				X
VIBRATION (20-G, 48 MIN)	X				X
ACCELERATION (10,000-G)	X				X
SURGE CURRENT (500 AMPERES)	X				X
HIGH TEMPERATURE LIFE (175°C, 24 HR)	X			X	X
OPERATIONAL LIFE (150°C, 340 HR)	X	X	X	X	X
FINAL ELECTRICAL FUNCTIONAL TESTS		X	X		X

QUALIFICATION TESTS (LOT SAMPLE)

APPENDIX F ITEM 1 CONT'D

TESTS AND INSPECTIONS PERFORMED ON A PERIODIC BASIS TO DEMONSTRATE QUALIFICATION ARE:

TEST / INSPECTION	CAUSE CONTROL				
	a	b	c	d	e
REDUCED BAROMETRIC PRESSURE	X				X
THERMAL CYCLE	X			X	X
FINAL ELECTRICAL FUNCTIONAL		X	X	X	X
SALT ATMOSPHERE (CORROSION)	X				X

QUALIFICATION TESTS (PERIODIC)

TESTS AND INSPECTIONS PERFORMED ON ALL PARTS TO DEMONSTRATE PROCESSES AND CONTROLS ARE ADEQUATELY PROVIDING A RELIABLE PRODUCT ARE:

TEST / INSPECTION	CAUSE CONTROL				
	a	b	c	d	e
THERMAL CYCLING	X			X	X
ACCELERATION	X				X
HERMETIC SEAL	X	X			X
BURN-IN (150 $^{\circ}$C, 96 HR)		X	X	X	X
ELECTRICAL FUNCTIONAL		X	X	X	X

QUALITY CONFORMANCE TESTS (ALL DEVICES)

(C) INSPECTION

THE PART HAS REQUIRED INSPECTIONS DURING MANUFACTURING PROCESS IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-S-19500/297. IN ADDITION, THE PART SUPPLIER IS REQUIRED TO HAVE QUALITY CONTROL (QC) PRACTICES IN ACCORDANCE WITH THE REQUIREMENTS OF MIL-S-19500 APPENDIX D. 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).

APPENDIX F ITEM 1 CONT'D

RECEIVING INSPECTION (FAILURE CAUSE a,b)

INSPECTION OF INCOMING MATERIALS, UTILITIES AND WORK-IN PROCESSES (WAFERS, 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 b,e)

THE PART SUPPLIER IS REQUIRED TO HAVE INSPECTION CRITERIA 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 (LAPPING, POLISHING, ETCHING, AND CLEANING); BONDING CRITERIA; REWORK CRITERIA; DIE ATTACHMENT AND SUPPORT; DESIGN, PROCESSING, MANUFACTURING, TESTING, AND INSPECTION DOCUMENTATION AND CHANGE CONTROL; PERSONNEL TRAINING; MASKING; PHOTORESIST REGISTRATION; OXIDATION OR PASSIVATION; METALLIZATION AND FILM DEPOSITION; SEALING PROCESSES FAILURE/DEFECT ANALYSIS AND CORRECTIVE ACTION; AND INVENTORY CONTROL.

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

THE PART SUPPLIER MUST HAVE TEST EQUIPMENT MAINTENANCE AND CALIBRATION CONTROLS WHICH HAVE BEEN APPROVED BY THE QUALIFYING AGENCY. SUPPLIER MUST ALSO MAINTAIN QUALITY CONTROL INSPECTION TEST DOCUMENTATION AND FINAL LOT DISPOSITION.

HANDLING/PACKAGING (FAILURE CAUSE a)

THE DEVICES ARE PACKAGE AND HANDLED TO THE REQUIREMENTS OF MIL-S-19491. THE PART SUPPLIER IS REQUIRED TO INCLUDE TRACEABILITY (PRODUCT LOT IDENTIFICATION).

APPENDIX F ITEM 1 CONT'D

(D) FAILURE HISTORY

SHUTTLE PROGRAM HISTORY INDICATES THREE REPORTED FAILURES:

FAILURE MODE: OPEN

CAR AC1165-010
IDENTIFIES A REDUNDANCY TEST FAILURE DURING CHECKOUT OF OV-102 THERE WAS APPROXIMATELY A ONE SECOND DELAY IN POWER APPLICATION TO A LOAD. SUBSEQUENTLY POWER WAS NOT AVAILABLE AT THE LOAD, INDICATING AN OPEN CIRCUIT. THE PROBLEM WAS TRACED TO A JANTX1N1188R DIODE MANUFACTURED BY NAE IN 1975. THE MOST PROBABLE CAUSE OF THE DIODE FAILURE IS A CRACK IN THE SILICON CHIP. THE PROBLEM IS AN ISOLATED INCIDENT FOR NO OTHER FAILURES OF THIS TYPE DIODE FROM THIS MANUFACTURER HAVE OCCURRED. THE DIODES ARE ALL SCREENED AT THE PART LEVEL AND AT THE NEXT LEVEL ASSEMBLY ACCEPTANCE TEST PROCEDURE.

CAR AC4773-010
IDENTIFIES AN INTERMITTENT OPEN OF ONE JANTX1N1188R DIODE MANUFACTURED BY SEMICON 1978. THE FAILURE CAUSE WAS A MARGINAL SOLDER JOINT BETWEEN THE CHIP AND SANDWICHING DISKS. THIS FAILURE WAS CONSIDERED TO BE AN ISOLATED INCIDENT FOR NO OTHER OCCURRENCES OF THIS FAILURE MODE HAVE OCCURRED. THE DIODES ARE ALL SCREENED AT THE PART LEVEL AND AT THE NEXT LEVEL ASSEMBLY ACCEPTANCE TEST PROCEDURE.

THE TWO FAILURES DO NOT INDICATE A DEFECTIVE DIODE MANUFACTURING TREND. THE FAILURES WERE FROM TWO SEPARATE MANUFACTURERS AND THE DIODES WERE MANUFACTURED THREE YEARS APART. NO COMMON FAILURE CAUSE OR PROCESSING AREA CAN BE IDENTIFIED.

FAILURE MODE: SHORT

SHUTTLE PROGRAM HISTORY INDICATES NO REPORTED SHORTS FOR THIS DEVICE TYPE. A REVIEW OF GIDEP PRIOR MILITARY PART FAILURE HISTORY REVEALS NO UNCORRECTED GENERIC ISSUES EXIST.

FAILURE MODE: SHORT TO CASE

DR AC4954-000
IDENTIFIES A PROBLEM WITH THE STUD CASE SHORTED TO THE MOUNTING SURFACE. THIS PROBLEM OCCURRED BECAUSE OF A BURR IN THE MOUNTING HOLE THAT MADE CONTACT WITH THE DIODE STUD. ROCKWELL ASSEMBLY PROCEDURE SPECIFICATION NUMBER ML0303-0029 REQUIRES THE MOUNTING HOLE BE INSPECTED FOR BURRS. ANY BURRS FOUND ARE REMOVED. THE NEXT ASSEMBLY ACCEPTANCE DIELECTRIC STRENGTH TEST WILL DETECT FAILURES OF THIS NATURE.

APPENDIX F ITEM 1 CONT'D

PREPARED BY:		APPROVED BY:	APPROVED BY (NASA):
DESIGN	I. CHASE	DES [signature]	SSM [signature] 11/2/87
RELIABILITY	M. HOVE	REL [signature] 11-2-87	REL [signature]
QUALITY	J. COURSEN	QE [signature]	QE [signature]