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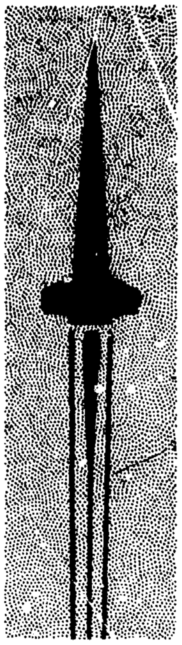

U.S. ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND

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STORAGE RELIABILITY OF MISSILE MATERIEL PROGRAM

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MISSILE MATERIEL RELIABILITY PREDICTION HANDBOOK

PARTS COUNT PREDICTION

LC-78-1

FEBRUARY 1978

PRODUCT ASSURANCE DIRECTORATE

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This handbook contains data for predicting the reliability of missile systems based on a "parts count" approach. The handbook is part of a research program being conducted by the U. S. Army Missile R&D Command, Redstone Arsenal, Alabama. Included is data on electronic, electrical, electromechanical, hydraulic, pneumatic ordnance, and electro optical devices.

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STORAGE RELIABILITY
OF
MISSILE MATERIEL PROGRAM

MISSILE MATERIEL RELIABILITY
PREDICTION HANDBOOK
PARTS COUNT PREDICTION

LC-78-1 FEBRUARY 1978

Prepared by: Dennis F. Malik
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EQUIPMENT DIVISION

LIFE CYCLE ANALYSIS DEPARTMENT
HUNTSVILLE, ALABAMA

ABSTRACT

This handbook contains data for predicting the reliability of missile systems based on a "parts count" approach. The handbook is a result of a program whose objective is the development of non-operating (storage) reliability prediction and assurance techniques for missile materiel. The analysis results will be used by U. S. Army personnel and contractors in evaluating current missile programs and in the design of future missile systems.

The storage reliability research program consists of a country wide data survey and collection effort, accelerated testing, special test programs and development of a non-operating reliability data bank at the U. S. Army Missile R&D Command, Redstone Arsenal, Alabama. The Army plans a continuing effort to maintain the data bank and analysis reports.

Storage or non-operating prediction data contained herein has been developed under the program described above. Operating data has been extracted from existing reliability prediction sources.

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1.0 INTRODUCTION

1.1 Missile Reliability Considerations

Materiel in the Army inventory must withstand long periods of storage and "launch ready" non-activated or dormant time as well as perform operationally in severe launch and flight environments. In addition to the stress of temperature soaks and aging, they must often endure the abuse of frequent transportation and handling and the climatic extremes of the forward area battlefield environment.

Missiles spend the majority of the time in this non-operating environment. In newer missile systems, complexity is increasing significantly, longer service lives are being required, and periodic maintenance and checkouts are being reduced. The combination of these factors places great importance on selecting missile materiels which are capable of performing reliably in each of the environments.

The inclusion of storage reliability requirements in the initial system specifications has also placed an importance on maintaining non-operating reliability prediction data for evaluating the design and mechanization of new systems.

1.2 Storage Reliability Research Program

An extensive effort is being conducted by the U. S. Army Missile Command to provide detailed analyses of missile materiel and to generate reliability prediction data. This handbook updates LC-76-1 dated May 1976 and provides the current prediction data resulting from this effort.

Non-operating data has been extracted from Report LC-78-2, Storage Reliability Analysis Summary, dated February 1978. LC-78-2 provides a summary of the analyses performed under the storage reliability research program and background information for the predictions in this handbook. Detailed models from which the "parts count" predictions were extracted are presented. Included are summaries of real time and test data, failure modes and mechanisms, and conclusions and recommendations resulting from analysis of the data. These recommendations include special design, packaging and product assurance data and information on specific part types and part construction.

For a number of the part types, detailed analysis reports are also available. These reports present details on part construction, failure modes and mechanisms, parameter drift and aging trends, applications, and other considerations for the selection of materiel and reliability prediction of missile systems.

The U. S. Army Missile Command also maintains a Storage Reliability Data Bank. This data bank consists of a computerized data base with generic part storage reliability data and a storage reliability report library containing available research and test reports of non-operating reliability research efforts.

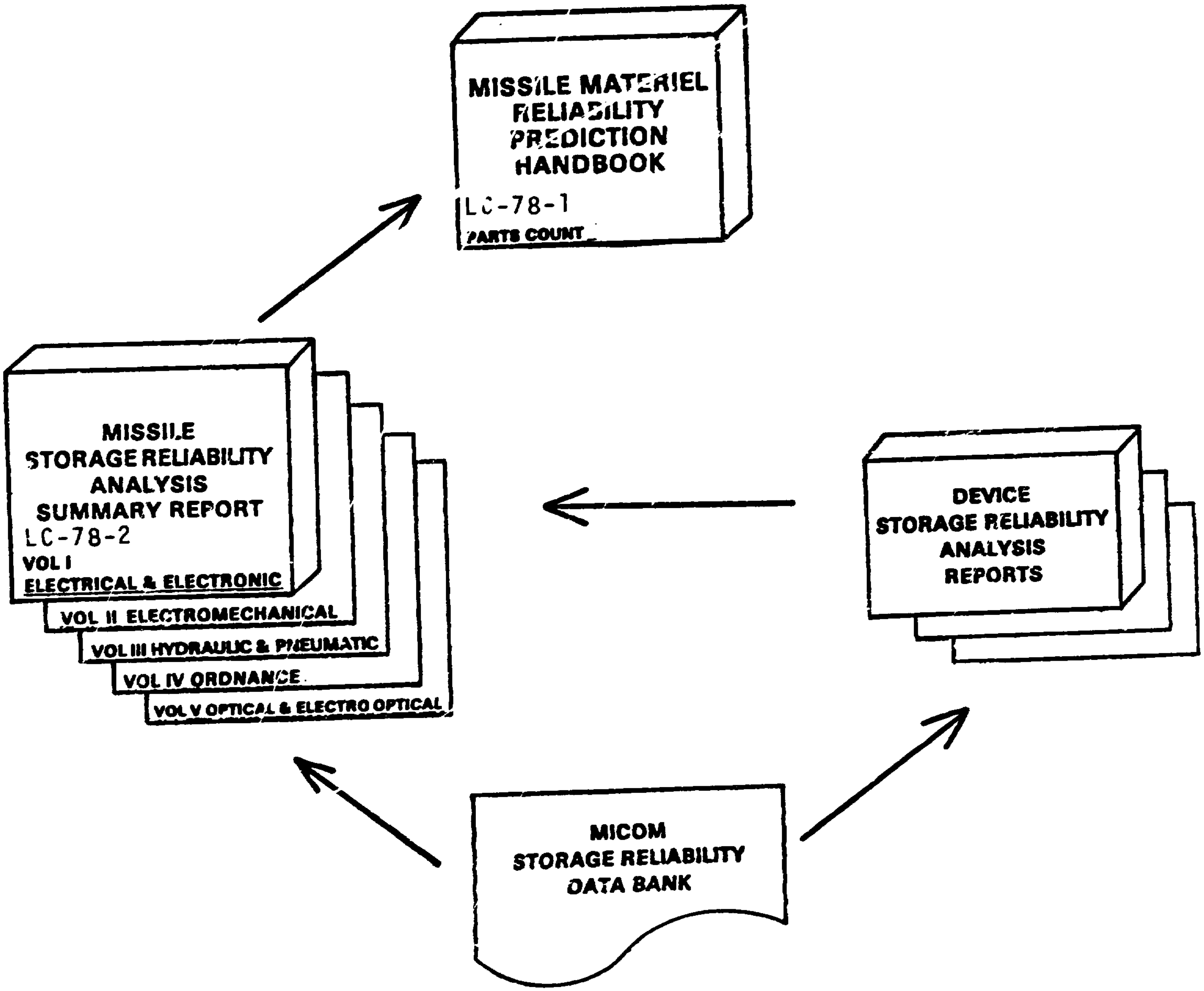
For the operational data contained in this handbook, the user should refer to the following sources: MIL-HDBK-217B, Military Standardization Handbook, Reliability Prediction of Electronic Equipment; Reliability Analysis Center (RAC) Microcircuit Generic Failure Rates; RADC-TR-74-268, Revision to the Nonelectronic Reliability Handbook; and the Government-Industry Data Exchange Program (GIDEP) Summaries of Failure Rate Data.

1.3 Non-Operating Environments

A missile system may be subjected to various modes of transportation and handling, temperature soaks, climatic extremes, and activated test time and "launch ready" time in addition to a controlled storage environment. Some studies have been performed on missile systems to measure these environments. A summary of several studies is presented in Report BR-7811, "The Environmental Conditions Experienced by Rockets and Missiles in Storage, Transit and Operations" prepared by the Raytheon Company, dated December 1973.

In this report, skin temperatures of missiles in containers were recorded in dump (or open) storage at a maximum of 165°F (74°C) and a minimum of -44°F (-42°C). In non-earth

FIGURE 1-1. STORAGE RELIABILITY OF MISSILE MATERIEL PROGRAM DOCUMENTATION



covered bunkers temperatures have been measured at a maximum of 116°F (47°C) to a minimum of -31°F (-35°C). In earth covered bunkers, temperatures have been measured at a maximum of 103°F (39°C) to a minimum of 23°F (-5°C).

Acceleration extremes during transportation have been measured for track, rail, aircraft and ship transportation. Up to 7 G's at 300 hertz have been measured on trucks; 1 G at 300 hertz by rail; 7 G's at 1100 hertz on aircraft; and 1 G at 70 hertz on shipboard.

Maximum shock stresses for truck transportation have been measured at 10 G's and by rail at 300 G's.

Although field data does not record these levels, where available, the type and approximate character of storage and transportation conditions are identified and used to classify the devices in LC-78-2.

The ground, fixed non-operating environment represents the bulk of the non-operating data and is reported in this handbook. A continuing effort is planned to attempt to differentiate between other non-operating environments. Appendix E presents the MIL-HDBK-217B Environmental Factors.

1.4 Operating Environments

The operational data contains two sets of environments. The first set has been extracted from MIL-HDBK-217B and each environment is described in Table 1-1.

The second set has been extracted from document RADC-TR-74-268, Section 2, "Revision to RADC Nonelectronic Reliability Notebook," dated October 1974. This set is only slightly different from the MIL-HDBK-217B environments.

1.5 Limitations of Reliability Prediction

Practical limitations are placed in any reliability analysis effort in gathering and analyzing data. Field data is generated at various levels of detail and reported in varying manners. Often data on environments, applications, part classes and part construction are not available. Even more often, failure analyses are non-existant. Data on low use devices and new technology devices is also difficult to

TABLE 1-1.

ENVIRONMENTAL DESCRIPTION

Environment	Nominal Environmental Conditions
Ground, Benign	Nearly zero environmental stress with optimum engineering operation and maintenance.
Space, Flight	Earth orbital. Approaches Ground, Benign conditions without access for maintenance. Vehicle neither under powered flight nor in atmospheric reentry.
Ground, Fixed	Conditions less than ideal to include installation in permanent racks with adequate cooling air, maintenance by military personnel and possible installation in unheated buildings.
Ground, Mobile (and Portable)	Conditions more severe than those for Ground, Fixed, mostly for vibration and shock. Cooling air supply may also be more limited, and maintenance less uniform.
Naval, Sheltered	Surface ship conditions similar to Ground, Fixed, subject to occasional high shock and vibration.
Naval, Unsheltered	Nominal surface shipborne conditions but with repetitive high levels of shock and vibration.
Airborne, Inhabited	Typical cockpit conditions without environmental extremes of pressure, temperature, shock and vibration.
Airborne, Uninhabited	Bomb-bay, tail, or wing installations where extreme pressure, temperature, and vibration cycling may be aggravated by contamination from oil, hydraulic fluid, and engine exhaust. Classes I and Ia equipment of MIL-E-5400 should not be used in this environment.
Missile, Launch	Severe conditions of noise, vibration, and other environments related to missile launch, and space vehicle boost into orbit, vehicle re-entry and landing by parachute. Conditions may also apply to installation near main rocket engines during launch operations.

obtain. Finally in the storage environment, the very low occurrence of failures in many devices requires extensive storage time to generate any meaningful statistics.

These difficulties sometimes lead to prediction of conservative or pessimistic failure rates. The user may review the existing data in the backup analyses reports in any case where design or program decision is necessary.

1.6 Life Cycle Reliability Prediction Modeling

Developing missile reliability predictions requires several tasks. The first tasks include defining the system, its mission, environments and life cycle operation or deployment scenario.

The system and mission definitions provide the basis for constructing reliability success models. The modeling can incorporate reliability block diagrams, truth tables and logic diagrams. Descriptions of these methods are not included here but are discussed in detail in MIL-HDBK-217B or other texts listed in the bibliography.

After the reliability success modeling is completed, reliability life cycle prediction modeling for each block or unit in the success model is performed based on the definitions of the system environment and deployment scenario. This reliability life cycle modeling is based on a "wooden round" concept in order to assess the missile's capability of performing in a no-maintenance environment. The general equation for this modeling is:

$$R_{LC} = R_{T/H} \times R_{STOR} \times R_{TEST} \times R_{LR/D} \times R_{LR/O} \times R_{L} \times R_{F}$$

where:

R_{LC} is the unit's life cycle reliability

$R_{T/H}$ is the unit's reliability during handling and transportation

R_{STOR} is the reliability during storage

R_{TEST} is the unit's reliability during check out and test

$R_{LR/D}$ is the unit's reliability during dormant launch ready time

$R_{LR/O}$ is the unit's reliability during operational (>10% electronic stress) launch ready time

R_L is the unit's reliability during powered launch and flight

R_F is the unit's reliability during unpowered flight

The extent of the data to date does not provide a capability of separately estimating the reliability of transportation and storage for missile materiel. Also data has indicated no difference between dormant (>0 and <10% electrical stress) and non-operating time. Therefore, the general equation can be simplified as follows:

$$R_{LC}(t) = R_{NO}(t_{NO}) \times R_O(t_O) \times R_L(t_L) \times R_F(T_F)$$

where:

R_{NO} is the unit's reliability during transportation and handling, storage and dormant time (non-operating time)

t_{NO} is the sum of all non-operating and dormant time

R_O is the unit's reliability during checkout, test or system exercise during which components have electrical power applied (operating)

t_O is the sum of all operating time excluding launch and flight

R_L is the unit's reliability during powered launch and flight (Propulsion System Active)

t_L is the powered launch and flight time

R_F is the unit's reliability during unpowered flight

t_F is the unpowered flight time

t is the sum of t_{NO}, t_O, t_L and t_F

The values R_{NO}, R_O, R_L, and R_F are calculated using several methods. The primary method is to assume exponential distributions as follows:

$$
\begin{aligned}
R_{NO}(t_{NO}) &= e^{-\lambda_{NO} t_{NO}} \\
R_O(t_O) &= e^{-\lambda_O t_O} \\
R_L(t_L) &= e^{-\lambda_L t_L} \\
R_F(t_F) &= e^{-\lambda_F t_F}
\end{aligned}
$$

The failure rates λ_{NO}, λ_O, λ_L and λ_F are calculated from the information in the following sections. Failures rates are given for various environments and quality levels and are based on part stress factors which may include complexity, construction, derating, and other characteristics of the device.

Other methods for calculating the reliability include wearout or aging reliability models and cyclic or one shot reliability models. For each of these cases, the device section will specify the method for calculating the reliability.

1.7 Data Presentation

The data is presented in two formats. Section 2.0 lists failure rates for individual part types. Failure rates are given for the non-operating environment and a number of operating environments.

Section 3.0 provides backup information on these failure rates. It includes part hours and number of failures (where available) used to generate the failure rates; 90% one-sided confidence limits; failure rate ranges where available; and environment and quality adjustment factors.

Finally Section 4.0 provides an example reliability prediction of a missile system using the data.

2.0 "PARTS COUNT" PREDICTION DATA

Non-operating and operating failure rates are presented in the following pages for electronic, electrical, electromechanical, hydraulic, pneumatic, and ordnance devices. Failure rates are given in FITS, failures per billion hours.

These failure rates represent recorded failures which in most cases have been attributed to a defect or wear out of the part itself. Secondary failures resulting from mishandling, system design or test equipment problems are not included in the failure rates.

Table 2-1 lists the major device groupings and the page on which they are presented.

The failure rates presented assume an exponential failure distribution and are averages for the stated environments. In some cases, the failure rate is broken out by quality level and complexity. In other cases, it is the average for a range of quality levels and complexities.

Quality levels include MIL-STD-883, Class A, B and C levels for microelectronics; MIL-S-19500, JAN, JANTX and JANTXV levels for discrete semiconductors; and other device quality levels as defined in the applicable military reference.

Prediction data for four device types (Hybrid Microelectronics, Vacuum Tubes, Ordnance and Laser devices) are presented in the Appendices. In the case of Hybrid Microelectronics and Lasers, the diversity of parts does not allow a simple "parts count" prediction. In the case of vacuum tubes and ordnance devices, the exponential failure distribution does not apply in all cases.

TABLE 2-1. MAJOR DEVICE GROUPINGS

MONOLITHIC MICROELECTRONIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
BIPOLAR DIGITAL (TTL & DTL)										
1-20 Gates										
Class A	0.85	3.5	3.5	14.5	45.5	46.5	45.5	60.0	70.0	105.
Class B	3.30	7.0	7.0	29.0	91.0	93.0	91.0	120.	140.	210.
Class C	3.73	56.0	56.0	232.	728.	744.	728.	960.	1120.	1680.
21-50 Gates										
Class A	0.85	10.0	10.0	31.0	80.0	85.0	80.0	115.	125.	170.
Class B	3.30	20.0	20.0	62.0	160.	170.	160.	230.	250.	340.
Class C	3.73	160.	160.	496.	1280.	1360.	1280.	1840.	2000.	2720.
50-100 Gates										
Class A	0.85	16.0	16.0	47.0	115.	120.	115.	170.	180.	235.
Class B	3.30	32.0	32.0	94.0	230.	240.	230.	340.	360.	470.
Class C	3.73	256.	256.	752.	1840.	1920.	1840.	2720.	2880.	3760.
BIPOLAR LINEAR										
<32 Trans.										
Class A	0.85	6.0	6.0	26.0	75.0	80.	75.0	135.	135.	165.
Class B	3.30	12.0	12.0	52.0	150.	160.	150.	270.	270.	330.
Class C	3.73	96.0	96.0	416.	1200.	1280.	1200.	2160.	2160.	2640.
33-100 Trans.										
Class A	0.85	20.8	20.8	96.	256.	280.	256.	480.	488.	544.
Class B	3.30	26.0	26.0	120.	320.	350.	320.	600.	610.	680.
Class C	3.73	208.	208.	960.	2560.	2800.	2560.	4800.	4880.	5440.
BIPOLAR MEMORIES										
<1000 bits										
Class A	-	60.0	60.0	150.	305.	335.	305.	490.	495.	550.
Class B	-	120.0	120.	300.	610.	670.	610.	980.	990.	1100.
Class C	-	960.	960.	2400.	4880.	5360.	4880.	7840.	7920.	8800.
1001-4000 bits										
Class A	-	130.	130.	350.	700.	750.	700.	1150.	1150.	1300.
Class B	-	260.	260.	700.	1400.	1500.	1400.	2300.	2300.	2600.
Class C	-	2080.	2080.	5600.	11200.	12000.	11200.	18400.	18400.	20800.

MONOLITHIC MICROELECTRONIC DEVICES (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
BIPOLAR MEMORIES										
4001-8000 bits										
Class A	-	220.	220.	600.	1200.	1300.	1200.	1900.	1950.	2250.
Class B	-	440.	440.	1200.	2400.	2600.	2400.	3800.	3900.	4500.
Class C	-	3520.	3520.	9600.	19200.	20800.	19200.	30400.	31200.	36000.
MOS DEVICES										
1-20 Gates										
Class A	-	5.	5.	24.	60.	70.	60.	125.	120.	120.
Class B	-	10.	10.	48.	120.	140.	120.	250.	240.	240.
Class C	-	80.	80.	384.	960.	1120.	960.	2000.	1920.	1920.
21-50 Gates										
Class A	-	24.	24.	95.	170.	215.	170.	460.	395.	260.
Class B	-	48.	48.	190.	340.	430.	340.	920.	790.	520.
Class C	-	384.	384.	1520.	2720.	3440.	2720.	7360.	6320.	4160.
51-100 Gates										
Class A	-	38.	38.	155.	270.	340.	270.	750.	650.	390.
Class B	-	76.	76.	310.	540.	680.	540.	1500.	1300.	780.
Class C	-	608.	608.	2480.	4320.	5440.	4320.	12000.	10400.	6240.
MOS MEMORIES										
<1000 bits										
Class A	-	160.	160.	600.	950.	1200.	950.	2850.	2350.	1200.
Class B	-	320.	320.	1200.	1900.	2400.	1900.	5700.	4700.	2400.
Class C	-	2560.	2560.	9600.	15200.	19200.	15200.	45600.	37600.	19200.
1001-4000 bits										
Class A	-	350.	350.	1350.	2150.	2800.	2150.	6500.	5500.	2750.
Class B	-	700.	700.	2700.	4300.	5600.	4300.	13000.	11000.	5500.
Class C	-	5600.	5600.	21600.	34400.	44800.	34400.	104000.	88000.	44000.
4001-8000 bits										
Class A	-	600.	600.	2250.	3600.	4700.	3600.	11000.	9000.	4650.
Class B	-	1200.	1200.	4500.	7200.	9400.	7200.	22000.	18000.	9300.
Class C	-	9600.	9600.	36000.	57600.	752000.	57600.	176000.	144000.	74400.

HYBRID MICROELECTRONIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
SEE APPENDIX "A"										

DISCRETE SEMICONDUCTORS - TRANSISTORS

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
SILICON NPN										
JANTX	1.51	5.6	5.6	36.	196.	220.	196.	280.	400.	320.
JAN	8.82	28.	28.	180.	980.	1100.	980.	1400.	2000.	1600.
SILICON PNP										
JANTX	1.51	8.4	8.4	58.	320.	340.	320.	460.	640.	500.
JAN	8.82	42.	42.	290.	1600.	1700.	1600.	2300.	3200.	2500.
GERMANIUM PNP										
JANTX	1.51	8.4	8.4	82.	520.	700.	520.	700*	520*	840.
JAN	8.82	42.	42.	410.	2600.	3500.	2600.	3500*	2600*	4200.
GERMANIUM NPN										
JANTX	1.51	24.	24.	220.	1420.	1800.	1420.	1800*	2200*	2200.
JAN	8.82	120.	120.	1100.	7100.	9000.	7100.	9000*	11000*	11000.
FIELD EFFECT										
JANTX	1.15	15.2	15.2	104.	540.	580.	540.	780.	1120.	880.
JAN	5.75	76.	76.	520.	2700.	2900.	2700.	3900.	5600.	4400.
UNIJUNCTION										
JANTX	388.	50.	50.	340.	1880.	2000.	1880.	3000.	4200.	3000.
JAN	776.	250.	250.	1700.	9400.	10000.	9400.	15000.	21000.	15000.
MICROWAVE										
JANTX	58.8	240.	240.	480.	2400.	2400.	2400.	2880	3840.	3840.
JAN	117.6	480.	480.	960	4800.	4800.	4800.	5760.	7680.	7680.

*This value valid only for electrical stress, S ≤ 0.3.

DISCRETE SEMICONDUCTORS - DIODES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
SILICON GENERAL PURPOSE										
JANTX	.29	3.4	3.4	24.	136.	150.	136.	220.	320.	220.
JAN	6.25	17.	17.	120.	680.	750.	680.	1100.	1600.	1100.
GERMANIUM GENERAL PURPOSE										
JANTX	.29	4.4	4.4	52.	340.	500.	340.	500*	580*	540.
JAN	6.25	22.	22.	260.	1700.	2500.	1700.	2500*	2900*	2700.
ZENER & AVALANCHE										
JANTX	1.56	5.4	5.4	32.	170.	180.	170.	240.	360.	280.
JAN	1.56	27.	27.	160.	850.	910.	850.	1200.	1800.	1400.
THYRISTORS										
JANTX	5.0	4.6	4.6	32.	180.	200.	180.	280.	400.	280.
JAN	25.0	23.	23.	160.	900.	1000.	900.	1400.	2000.	1400.
SILICON MICROWAVE DETECTOR										
JANTX	14.7	114.	114.	1320.	7200.	7800.	7200.	10200.	15000.	27600.
JAN	24.5	190.	190.	2200.	12000.	13000.	12000.	17000.	25000.	46000.
GERMANIUM MICRO-WAVE DETECTOR										
JANTX	14.7	246.	246.	3360*	21000*	**	21000*	**	**	**
JAN	24.5	410.	410.	5600*	35000*	**	35000*	**	**	**
SILICON MICROWAVE MIXER										
JANTX	14.7	150.	150.	1800.	12800.	10200.	12800.	13800.	20400.	38400.
JAN	24.5	250.	250.	3000.	16000.	17000.	16000.	23000.	34000.	64000.

*This value valid only for electrical stress, $S \leq 0.3$.

**Not to be used in these environments.

DISCRETE SEMICONDUCTORS -- DIODES (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
GERMANIUM MICRO-WAVE MIXER										
JANTX	14.7	432.	432.	6000*	36600*	**	36600*	**	**	**
JAN	24.5	720.	720.	10000*	61000*	**	61000*	**	**	**
VARACTORS, STEP RECOVERY & TUNNEL										
JANTX	105.	48.	48.	300.	1620.	1760.	1620.	3400.	2400.	2600.
JAN	523.	240.	240.	1500.	8100.	8800.	8100.	17000.	12000.	13000.
SILICON CONTROLLED RECTIFIERS										
JANTX	1.96	5.1	5.1	36.	204.	225.	204.	330.	480.	330.
JAN	9.8	26.	26.	180.	1020.	1125.	1020.	1650.	2400.	1650.

* This value valid only for electrical stress, $S \leq 0.3$.

** Not to be used in these environments.

TUBES, ELECTRONIC VACUUM

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
RECEIVER TUBES										
Tetrode, Triode, Pentode	12.0	2500	2500	5000	32500	32500	50000	50000	50000	400000
Power Rectifier	12.0	5000	5000	10000	65000	65000	100000	100000	100000	800000
KLYSTRON										
Low Power	See Appendix C	15000	15000	30000	195000	195000	300000	300000	300000	2400000
High Power		100000	100000	200000	1300000	1300000	2000000	2000000	2000000	16000000
MAGNETRON										
Medium Power	See Appendix C	100000	100000	200000	1300000	1300000	2000000	2000000	2000000	16000000
High Power		225000	225000	450000	2925000	2925000	4500000	4500000	4500000	3600000
TWT										
Peak Power <100 watts	See Appendix C	15000	15000	30000	195000	195000	300000	300000	300000	2400000
Peak Power >100 watts <10,000 watts		50000	50000	100000	650000	650000	1000000	1000000	1000000	8000000
TRANSMITTING										
Triode	TBD	37500	37500	75000	488000	488000	750000	750000	750000	6000000
Tetrode & Pentode	TBD	50000	50000	100000	650000	650000	1000000	1000000	1000000	8000000

RESISTORS

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
FIXED COMPOSITION (Insulated)										
MIL-R-39008 Style RCR Hi-Rel	<.066	.45	.45	2.	4.8	7.7	8.5	21.	18.	18.
MIL-R-11 Style RC MIL-STD	.22	2.3	2.3	10.	24.	39.	43.	110.	90.	90.
FIXED FILM (Insulated)										
MIL-R-39017 Style RLR Hi-Rel MIL-STD	.017	2.4	2.4	15.	20.	26.	37.	52.	54.	110.
MIL-R-22684 Style RLC MIL-STD	0.11	13.	13.	75.	100.	130.	190.	260.	270.	550.
FIXED FILM										
MIL-R-55182 Style RNR, RNC Hi-Rel	.017	.28	.28	1.7	2.3	3.	4.2	6.2	6.3	12.
MIL-R-10509 Style RN MIL-STD	<.11	2.8	2.8	17.	23.	30.	42.	62.	63.	120.
POWER FILM										
MIL-R-11804 Style RD/P MIL-STD	TBD	180.	180.	960.	1300.	1500.	2300.	2800.	3100.	6800.

RESISTORS (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
FIXED WIREWOUND ACCURATE										
MIL-R-39005 Style RBR Hi-Rel	.20	8.5	8.5	56.	150.	180.	190.	260.	320.	680.
MIL-R-93 Style RB MIL-STD	1.19	43.	43.	280.	750.	900.	950.	1300.	1600.	3400.
FIXED WIREWOUND POWER TYPE										
MIL-R-39007 Style RWR Hi-Rel	.20	9.	9.	33.	66.	85.	110.	160.	260.	330.
MIL-R-26 Style RW MIL-STD	1.19	46.	46.	170.	330.	430.	550.	800.	1300.	1700.
FIXED WIREWOUND POWER TYPE CHASSIS MOUNTED										
MIL-R-39009 Style RER Hi-Rel	.20	16.	16.	62.	130.	160.	220.	300.	340.	660.
MIL-R-18546 Style RE MIL-STD	1.19	80.	80.	310.	650.	800.	1100.	1500.	1700.	3300.
THERMISTOR										
MIL-T-23648 Hi-Rel MIL-STD	<16.9 133.3	21.	21.	100.	250.	300.	520.	400.	340.	1200.

RESISTORS (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
VARIABLE WIREWOUND LEADSCREW ACTUATED										
MIL-R-39015 Style RTR Hi-Rel	3.71	18.	18.	66.	140.	170.	180.	340.	300.	1400.
MIL-R-27208 Style RT MIL-STD	3.79	90.	90.	[illegible]	700.	850.	900.	1500.	1700.	9000.
WIREWOUND POTENTIOMETERS										
Precision MIL-R-12934 Style RR										
MIL-STD	<8.4	430.	430.	2700.	5800.	6100.	5800.	9000.	11000.	70000.
Semiprecision MIL-R-19 Style RA & MIL-R-39002 Style RK										
MIL-STD	<8.4	260.	*	2300.	6400.	8600.	8500.	*	*	*
Power MIL-R-22 Style RP										
MIL-STD	<8.4	290.	*	2300.	6000.	7500.	8100.	*	*	*

RESISTORS (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
VARIABLE (NON-WIREWOUND TRIMMER)										
MIL-R-39035 Style RJR Hi-Rel	3.71	650.	*	2300.	4750.	6500.	8000.	11500.	13500.	50000.
MIL-R-22097 Style RJ MIL-STD	<8.4	1300.	*	4600.	9500.	13000.	16000.	23000.	27000.	100000.
COMPOSITION (LOW-PRECISION) POTENTIOMETERS										
MI[illegible]94 Sty[illegible]RV MIL-STD	<8.4	270.	*	3700.	20000.	22000.	20000.	34000.	34000.	40000.
TIN OXIDE	<2.1									
NETWORK	<909.1									

CAPACITORS

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
<u>PAPER & PLASTIC FILM</u>										
MIL-C-39022 Style CHR; MIL-C-14157 Style CPV; MIL-C-19978 Style CQR										
Hi-Rel	1.11	.2	.2	.6	1.2	1.6	1.2	9.	12.	6.
MIL-C-19978 Style CQ MIL-STD	4.1	2.	2.	6.	12.	16.	12.	90.	120.	60.
<u>MICA</u>										
MIL-C-39001 Style CMR										
Hi-Rel	.61	.3	.3	3.2	6.0	7.8	6.0	34.	48.	30.
MIL-C-5 Style CM MIL-STD	.61	3.	3.	32.	60.	78.	60.	340.	480.	300.
MIL-C-10950 Style CB MIL-STD	.61	120.	120.	580.	930.	990.	930.	3700.	4800.	4700.
<u>GLASS</u>										
MIL-C-23269 Style CYR										
Hi-Rel	.63	1.3	1.3	11.	21.	25.	21.	110.	160.	110.

CAPACITORS (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
CERAMIC										
MIL-C-20 Style CCR MIL-C-39014 Style CKR Hi-Rel	.32	10.	10.	22.	44.	44.	44.	96.	110.	170.
MIL-C-20 Style CC MIL-C-11015 Style CK MIL-STD	2.14	100.	100.	220.	440.	440.	440.	960.	1100.	1700.
TANTALUM ELECTROLYTIC (SOLID)										
MIL-C-39003 Style CSR Hi-Rel	.13	11.	11.	26.	52.	56.	52.	170.	260.	260.
TANTALUM ELECTROLYTIC (NON-SOLID)										
MIL-C-39006 Style CLR Hi-Rel	9.0	15.	15.	34.	110.	110.	110.	340.	440.	540.
MIL-C-3965 Style CL MIL-STD	12.5	150.	150.	340.	1100.	1100.	1100.	3400.	4400.	5400.
ALUMINUM OXIDE										
MIL-C-39018 Style CU MIL-STD	<6.46	73.	73.	230.	1600.	1900.	1600.	5300.	6900.	5400.

CAPACITORS (cont'd)

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
ALUMINUM DRY ELECTROLYTIC										
MIL-C-62 Style CE MIL-STD	TBD	110.	110.	410.	3000.	3800.	3000.	14000.	16000.	10000.
VARIABLE, CERAMIC										
MIL-C-81 Style CV MIL-STD	TBD	200.	200.	1100.	2400.	2700.	2400.	12000.	22000.	21000.
VARIABLE, PISTON TYPE										
MIL-C-14409 Style PC MIL-STD	<6.46	16.	16.	110.	410.	470.	410.	3800.	5300.	4900.
TITANIUM	<19.6									
TUBULAR, TEMP.	<78.1									
DIFFERENTIAL, DUAL MODE	<15.7									
METALLIZED POLY-CARBONITE	18.5									
VARIABLE, AIR	35.8									
NETWORK	<909.1									

NDUCTIVE DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
TRANSFORMERS & INDUCTORS										
MIL-T-39013 Hi-Rel	.91	1.25	1.25	3.3	9.	10.	5.5	13.5	17.	18.
MIL-T-27 MIL-STD	13.9	2.5	2.5	6.6	18.	20.	11.	27.	14.	36.
COILS, RADIO FREQUENCY										
MIL-C-15305										
Hi-Rel	1.11	4.8	4.8	11.	30.	33.	18.	42.	55.	60.
MIL-STD	<1.34	9.6	9.6	22.	60.	66.	36.	84.	110.	120.
TRANSFORMERS PULSE, LOW POWER										
MIL-T-39026 Hi-Rel	.91	.79	.79	1.78	4.95	5.48	2.97	7.26	9.24	9.9
MIL-T-21038 MIL-STD	13.9	1.2	1.2	2.7	7.5	8.3	4.5	11.	14.	15.
FILTERS & CHOKES										
Hi-Rel	.55	3.75	3.75	11.	28.	32.	17.	48.	60.	55.
MIL-STD	9.62	7.5	7.5	21.	56.	64.	34.	96.	120.	110.
REACTORS										
Hi-Rel	3.12									
MIL-STD	<76.9									

MISCELLANEOUS ELECTRICAL AND ELECTRONIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
CRYSTALS	39.3		200.						
PRINTED WIRING BOARD	.67	1.5	2.4	4.8	7.2	24.	12.0	4.8	
CONNECTIONS & CONNECTORS									
Pin Connector	.012		.6						
Solder Connection	<0.028		3.9		22.5		8.5		
Weld Connection	<0.18		1.7		44.6				
Wrap Connection	TBD		.014		10.				
INSTRUMENTS	94.7	3000000		756	179215			17094	238000
FUSES	<213.		100						
HEATERS	<385.		1000						
MAGNETIC CORE	<.028								
SOLAR CELLS	10.7								
SENSOR, TEMP.	<476.		2413	21964	97193			285714	161572
LAMPS	37.9		200						

ELECTROMECHANICAL DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
ACCELEROMETER									
General	29.7	<8929.	52523.	<27027.	236585				
GYROSCOPE									
Rate	133.		26005.	333333.	371772	541667			254902
RELAY									
General	8.5	8.4	166.		6743		754.	1278.	62031
Armature	8.5		233.	1229	1951		916.	1030.	
Crystal Can, Latching	8.5		21277.						
Latching, General	8.5	<269.	569.					342.	
Reed	8.5		184.				1973.		
Thermal	8.5		13089.		25641		746.		
Time Delay	8.5		1446.	4246.	17254		1599.	674.	

ELECTROMECHANICAL DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
SWITCH									
General	82.8	508.	<742.		107004			506.	98639.
Pressure	54.2		2095.	6112.	56027		22556	6525.	332378.
Pushbutton	26.0		271.		27870		458	78.	<778.
Rotary	82.8	418.	1329.		17695		1536	1584.	21739.
Sensitive	82.8		1133.		14650	250000		1110.	4918.
Thermostatic	17.1		2511.		6535		634	3808.	41284.
Toggle	26.0		568.	2786.	7193		474		18605.
Stepping	400.						21368		
Solenoid	109.3	715.	90909		62151			25641.	100000.
Motor Driven	138.2								
Inertial	66.4								
ROTATING DEVICES									
AC Generator	795.5		<500000	523256	1105253		23460		466667.
Slip Ring Assy.	<120.1	<2451.	<2288.	49879				39918.	214286.
Torquer Motor	308.8		<4566.					464.	
Resolvers & Synchros	140.9		18443.	4198	28800		55556	353.	150000.
AC Motor	431.6		2161.	7550					
DC Motor	34.4		3788.	792	82690		333333	12513.	39216.
Blowers & Fans	36.1		1424.	5654	43868		18451	457.	85222.

ELECTROMECHANICAL DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
TRANSDUCERS, PRESSURE	1905		75269	79055	94520				154622
ANTENNA ASSY.	11.7	<1835	9000000		90231				116994
ROTARY INVERTER	<46.3								

HYDRAULIC & PNEUMATIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
ACCUMULATORS									
General	32.5	<18500	250000	29800	17700	-	-	-	500000
Hydraulic	32.6	1500	55800	15006	118000	1500	-	-	80300
ACTUATORS									
General	167.	-	-	-	50400	-	-	-	712794
Linear, Elec.	167.	-	-	-	66900	-	-	-	712794
Hydrau., Gen.	199.	-	15200	53300	137000	-	-	10700	108000
Hydrau., Servo	199.	-	126000	-	130000	-	-	-	107000
Mechanical Driven	167.	-	-	-	58000	-	-	-	-
Pneu., Gen/Lin	87.9	-	12104	-	204000	-	-	-	-
Pneu., Piston	87.9	-	1510	-	-	-	-	-	107330
Rotary, Gen.	167.	-	-	-	172000	-	-	-	-
Rotary, Elec.	167.	-	-	-	<8550	-	-	484.	-
BATTERIES									
Silver Zinc	<42.4								
Thermal	94.3								
Rechargeable	-	132.	1498.	27027	348852				676768
Rechargeable/ Solar	-	1.9							
BEARINGS									
General	14.5	-	2060	21900	8200	-	-	-	16200
Ball	14.5	<751	946	94	3420	-	<45500	4730	13400
Needle	14.5	-	-	-	<2970	-	-	-	-
Roller	14.5	-	280	-	284	-	1210	-	24000
Spherical	14.5	-	-	206	6380	-	-	-	26600
Sleeve	14.5	-	-	-	-	-	-	-	40000
COMPRESSORS									
General	<4080.	-	12700	-	297000	-	-	-	500000
CYLINDERS									
General	75.0	-	33200	-	212000	-	-	-	973000

HYDRAULIC & PNEUMATIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
FILTERS NON-ELECTRIC									
General	<1.42	<225	<11800	73700	3.34	-	-	-	1990
Gaseous	<1.42	-	1200	1670	26600	-	-	-	26000
Liquid	<1.42	-	2990	11400	26200	-	-	-	49500
FITTINGS									
General	<1510.		1105.						29655
Quick Disconn. Liquid, Gd.	<1510.			13035	943583				300000
Quick Disconn. Liquid, Sub.	499.			13035	943583				300000
Hydraulic Swivel, Hydrau.	<2776.				30612				3898
GASKETS									
General	11.	-	1430	1610	-	-	3770	-	20300
O-Rings	78.	-	-	1180	2390	-	-	-	280000
Packing	1.5	-	3530	273	1510	-	-	-	5860
GASKETS & SEALS									
General	9.98	-	-	2180	28100	-	-	-	35400
Magnetic	23.	-	-	-	601000	-	-	-	-
Pressure	9.98	-	-	-	87100	-	-	-	-

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
HOSES									
Flexible Metal	1746.			240	115830				40046
PUMPS									
General	406.	-	4220	-	109000	-	43600	25700	328000
PUMPS, FIXED DISPLACEMENT									
General	380.	-	-	-	-	-	-	-	-
Gear	439.	-	-	-	-	-	-	-	-
Piston	350.	-	-	-	-	-	-	-	-
Vane	300.	-	-	-	-	-	-	-	-
PUMPS, VARIABLE DISPLACEMENT									
General	475.	-	-	-	-	-	-	-	-
Piston	544.	-	-	-	-	-	-	-	-
Vane	406.	-	-	-	-	-	-	-	-
PUMPS									
Centrifugal	200.	-	12100	-	-	-	298000	-	-
Fuel	<124.	-	24400	23100	45100	-	-	-	159000
Fuel Boost	<124.	-	176000	-	69100	-	-	-	200000
Fuel Jettison	<124.	-	-	-	13000	-	-	-	-
Fuel Transfer Hyd. Driven	<124.	-	-	-	188000	-	-	-	-
Hydrau., Gen.	95.3	-	1680	67000	458000	-	-	-	366000
Manual	95.3	-	-	-	2300	-	-	-	-
Variable Delivery	95.3	-	-	-	17600	-	-	-	166000

HYDRAULIC AND PNEUMATIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
PUMPS (cont'd)									
Impeller	406.	-	<1900	-	-	-	-	-	-
Oil	406.	-	-	-	59500	-	-	-	-
REGULATORS									
General	173.	-	-	-	108000	-	-	-	-
Bellmouth Controller, Jet Engine	173.	-	-	-	95600	-	-	-	-
Fluid, Tension	173.	-	-	-	5220	-	-	-	-
Fuel	173.	-	-	-	179000	-	-	-	136000
Pressure	1330.	2860	10700	2250	125000	-	-	-	-
Temperature	<199.	3480	4340	17400	148000	-	-	-	-
VALVES									
General	12.4	-	14900	1180	65300	136000	370000	-	98800
General, Ball	12.4	-	<235	1440	-	-	-	-	-
General, Butterfly	12.4	-	166	-	<100	-	-	-	-
General, Check	12.4	-	3010	-	28000	-	-	-	10000
General, Control	12.4	-	-	-	107000	-	-	-	-
General, Globe	12.4	-	<202	-	-	-	-	-	-
General, Relief	12.4	-	1510	8770	30700	-	-	-	148000
General, Selector	12.4	-	-	<21700	95200	-	-	-	-
General, Sequence	194.0	-	-	-	-	-	-	-	-
General, Shutoff	12.4	-	-	14200	93000	-	-	-	30500
General, Solenoid	8.5	-	<2620	16900	101000	-	-	-	125000
Freon	1380.	-	-	-	22600	-	-	-	-
VALVES, FUEL									
General	84.4	-	<9090	<1270	38100	-	-	-	-
Check	235.	-	-	<2600	2850	-	-	-	40000

HYDRAULIC AND PNEUMATIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
VALVES, FUEL (cont'd)									
Dump	84.4	-	-	-	1420	-	-	-	-
Float	84.4	-	-	-	67100	-	-	-	40000
Gate	84.4	-	-	-	37600	-	-	-	71400
Pressure Regulator	2390.	-	-	-	65000	-	-	-	55300
Selector	84.4	-	-	-	42900	-	-	-	-
Shutoff	84.4	-	-	-	16200	-	-	-	-
Solenoid	84.4	-	1280	-	57700	-	-	-	-
VALVES, HYDRAULIC									
General	2.82	-	2710	7360	34900	-	-	-	-
Ball	374.	-	-	-	-	-	-	-	-
Bleeder	<4.75	-	-	-	-	-	-	-	-
Check	22.9	-	-	-	12600	-	-	-	-
Control	<6.66	-	-	-	103000	-	-	-	-
Pressure Regulator	2.82	-	-	8420	28400	-	-	-	-
Relief	1.4	-	868	14700	-	-	-	-	42900
Restrictor	5.55	-	-	-	19400	-	-	-	-
Sequencer	2.82	-	-	-	19800	-	-	-	-
Servo	146.	-	<71400	-	158000	-	-	-	316000
Shuttle	146.	-	-	-	63300	-	-	-	-
Shut-off	<4.66	-	-	-	4640	-	-	-	300000
Solenoid	8.53	-	-	-	44500	-	-	-	-
Spool, 4-way	2.82	-	-	-	174000	-	-	-	-
VALVE, OIL									
General	12.4	-	4220	-	36800	-	-	-	-
VALVES, PNEUMATIC									
General	214.	-	6640	-	61400	-	-	-	-
Bleed	214.	-	-	<1840	218000	-	-	-	213000
Check	<242.	-	1200	-	7340	-	-	-	-
Control	17.5	-	-	-	80100	-	-	-	-
Pressure, Regulator	<1590.		<228	20400	116000	-	-	-	-

HYDRAULIC AND PNEUMATIC DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS							
		SATELLITE	GROUND	GROUND MOBILE	AIR-BORNE	MISSILE	SHIP-BOARD	SUB-MARINE	HELI-COPTER
VALVES, PNEUMATIC									
Relief	17.5	-	79	4690	8010	-	-	-	9760
Selector	17.5	-	-	-	289000	-	-	-	-
Shut-off	17.5	-	-	-	69900	-	-	-	-
Solenoid	17.5	-	-	-	1990	-	-	-	-
VALVES, MOTOR OPERATED									
General	113.	-	-	-	-	-	-	-	-
Sequence	194.	-	-	-	-	-	-	-	-
Freon	<1500.	-	34500	-	-	-	-	-	-
Fuel	84.4	-	8230	-	-	-	-	-	-

ORDNANCE DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
ORDNANCE DEVICES		SEE APPENDIX B								

OPTICAL & ELECTRO-OPTICAL DEVICES

PART TYPE	STORAGE FAILURE RATE IN FITS	OPERATIONAL FAILURE RATE IN FITS								
		GROUND BENIGN	SPACE FLIGHT	GROUND FIXED	AIR-BORNE INHAB.	NAVAL SHEL.	GROUND MOBILE	NAVAL UNSHEL	AIR-BORNE UNINHAB	MISSILE LAUNCH
OPTICAL & ELECTRO-OPTICAL DEVICES										
Lasers	TBD	SEE APPENDIX D								
Vidicon Electron Tube	143.8									
Video Signal Detector Assy	47.2									
Lens Assembly	<48.3									
Sun Shutter Assy	340.									
Vidicon Cable	48.6									

SECTION 3

FAILURE RATE STATISTICS AND RANGES

Statistics and ranges for each of the failure rates in Section 2.0 are contained in the following pages. Further detail is available in report LC-78-2, "Storage Reliability Analysis Summary Report," dated February 1978.

The failure rate data is presented in two formats, one for electrical and electronic and a second for non-electronic. These formats are described below.

3.1 Part Category and Description

All devices are identified by the generic category and are further defined in the description. The major categories are listed in Table 3-1 with the corresponding page number which begins that category. Included are electronic, electrical, electromechanical, hydraulic, pneumatic, ordnance, optical and electro-optical devices. Note that for hybrid microelectronic devices, vacuum tubes, ordnance and laser devices, the user is referred to detailed models in the appendices. In the case of hybrids and laser devices, the diversity of types precludes a simple classification and failure rate prediction. In the case of vacuum tubes and ordnance devices, aging trends have been identified which do not fit the exponential distribution assumption.

3.2 Non-Operating Data

The non-operating data for both data formats is identical. The following parameters are listed:

Failures
Part Hours (10^6) - Million hours
Failure rate in Fits - Failures per billion hours
  Best Estimate
  90% Confidence - One-sided upper limit
  Range
    ° Low
    ° High

TABLE 3-1.

DEVICE LIST

MONOLITHIC MICROELECTRONICS	PAGE NO.
Bipolar Digital (TTL & DTL)	
1-20 Gates	3-10
21-50 Gates	3-11
51-100 Gates	3-12
Bipolar Linear	
<32 Trans.	3-13
33-100 Trans.	3-14
Bipolar Memories	
<1000 bits	3-15
1001-4000 bits	3-16
4001-8000 bits	3-17
MOS Devices	
1-20 Gates	3-18
21-50 Gates	3-19
51-100 Gates	3-20
MOS Memories	
<1000 bits	3-21
1001-4000 bits	3-22
4001-8000 bits	3-23
HYBRID MICROELECTRONICS	3-24
TRANSISTORS	
Silicon NPN	3-25
Silicon PNP	3-26
Germanium PNP	3-27
Germanium NPN	3-28
Field Effect	3-29
Unijunction	3-30
Microwave	3-31
DIODES	
Silicon General Purpose	3-32
Germanium General Purpose	3-33
Zener & Avalanche	3-34
Thyristors	3-35
Diodes (cont'd)	
Silicon Microwave Detector	3-36
Germanium Microwave Detector	3-37
Silicon Microwave Mixer	3-38
Germanium Microwave Mixer	3-39
Varactors, Step Recovery & Tunnel	3-40
Silicon Controlled Rectifier	3-41
Vacuum Tubes	
Receiver Tubes Tetrode, Triode, Pentode	3-42
Power Rectifier	3-43
Klystron	
Low Power	3-44
High Power	3-45
Magnetron	
Medium Power	3-46
High Power	3-47
TWT	
Peak Power <100 watts	3-48
Peak Power >100 watts <10,000 watts	3-49
Transmitting Triode	3-50
Tetrode & Pentode	3-51
RESISTORS	
Fixed Composition (Insulated)	
MIL-R-39008 Style RCR	3-52
MIL-R-11 Style RC	3-53

TABLE 3-1. (cont'd)

DEVICE LIST

RESISTORS (cont'd)	PAGE NO.
Fixed Film (Insulated)	
MIL-R-39017 Style RLR	3-54
MIL-R-22684 Style RL	3-55
Fixed Film	
MIL-R-55182 Style RNR & RNC	3-56
MIL-R-10509 Style RN	3-56
Power Film	
MIL-R-11804 Style RD/P	3-57
Fixed Wirewound Accurate	
MIL-R-39005 Style RBR	3-58
MIL-R-93 Style RB	3-59
Fixed Wirewound Power Type	
MIL-R-39007 Style RWR	3-60
MIL-R-26 Style RW	3-61
Fixed Wirewound Power Type Chassis Mounted	
MIL-R-39009 Style RER	3-62
MIL-R-18546 Style RE	3-63
THERMISTOR	
MIL-T-23648 Style RTH	3-64
Variable Wirewound Leadscrew Actuated	
MIL-R-39015 Style RTR	3-65
MIL-R-27208 Style RT	3-66
Wirewound Potentiometers	
Precision MIL-R-12934 Style RR	3-67
Semiprecision MIL-R-19 Style RA	3-68
MIL-R-39002 Style RK	3-68
Power MIL-R-22 Style RP	3-69
Variable (Non-Wirewound Trimmer)	
MIL-R-39035 Style RJR	3-70
MIL-R-22097 Style RJ	3-71
Composition (Low Precision) Potentiometers	
MIL-R-94 Style RV	3-72
Tin Oxide	3-73
Network	3-74
CAPACITORS	
Paper & Plastic Film	
MIL-C-39022 Style CHR	3-75
MIL-C-14157 Style CPV	3-75
MIL-C-19978 Style CQR	3-75
MIL-C-19978 Style CQ	3-76

TABLE 3-1. (cont'd)

DEVICE LIST

CAPACITORS (cont'd)	PAGE NO.
Mica	
MIL-C-39001 Style CMR	3-77
MIL-C-5 Style CM	3-78
MIL-C-10950 Style CB	3-79
Glass	
MIL-C-23269 Style CYR	3-80
Ceramic	
MIL-C-39014 Style CKR	3-81
MIL-C-20 Style CCR	3-81
MIL-C-11015 Style CK	3-82
MIL-C-20 Style CC	3-82
Tantalum Electrolytic (Solid)	
MIL-C-39003 Style CSR	3-83
Tantalum Electrolytic (Non-Solid)	
MIL-C-39006 Style CLR	3-84
MIL-C-3965 Style CL	3-85
Aluminum Oxide	
MIL-C-39018 Style CU	3-86
Aluminum Dry Electrolytic	
MIL-C-62 Style CE	3-87
Variable, Ceramic	
MIL-C-81 Style CV	3-88

CAPACITORS (cont'd)	PAGE NO.
Variable, Piston Type	
MIL-C-14409 Style PC	3-89
Titanium	3-90
Tubular Temp.	3-91
Differential, Dual Mode	3-92
Metalized Polycarbonite	3-93
Variable, Air	3-94
Network	3-95
INDUCTIVE DEVICES	
Transformers & Inductors	
MIL-T-27	3-96
MIL-T-39013	3-96
Coils, Radio Frequency	
MIL-C-15305	3-97
Transformers Pulse, Low Power	
MIL-T-21038	3-98
MIL-T-39026	3-98
Filters & Chokes	3-99
Reactors	3-100
MISC. E & E	
Crystals	3-101
Printed Wiring Board	3-102
Connections & Connectors	
Pin Connector	3-103
Solder Connector	3-104
Weld Connection	3-105
Instruments	3-106
Fuses	3-107
Heaters	3-108

TABLE 3-1. (cont'd)

DEVICE LIST

MISC. E & E (cont'd)	PAGE NO.
Magnetic Core	3-109
Solar Cells	3-110
Sensor, Temp.	3-111
Lamps	3-112
ELECTROMECHANICAL	
Accelerometer	
General	3-113
Gyroscope	
Rate	3-114
Relay	
General	3-115
Armature	3-116
Crystal Can, Latching	3-117
Latching, General	3-118
Reed	3-119
Thermal	3-120
Time Delay	3-121
Switch	
General	3-122
Pressure	3-123
Pushbutton	3-124
Rotary	3-125
Sensitive	3-126
Thermostatic	3-127
Toggle	3-128
Stepping	3-129
Solenoid	3-130
Motor Driven	3-131
Inertial	3-132

Rotating Devices	PAGE NO.
AC Generator	3-133
Slip Ring Assy.	3-134
Torquer Motor	3-135
Resolvers & Synchros	3-136
AC Motor	3-137
DC Motor	3-138
Blowers & Fans	3-139
Misc. Electromechanical Devices	
Transducer, Pressure	3-140
Antenna Assy.	3-141
Rotary Inverter	3-142
HYDRAULIC & PNEUMATIC	
Accumulators	
General	3-143
Hydraulic	3-144
Actuators	
General	3-145
Linear, Elect.	3-146
Hydrau., Gen.	3-147
Hydraul, Servo	3-148
Mechanical Driven	3-149
Pneu., General & Linear	3-150
Pneu., Piston	3-151
Rotary, Gen.	3-152
Rotary, Elec.	3-153
Batteries	
Silver Zinc	3-154
Thermal	3-155
Rechargeable	3-156
Rechargeable, Solar	3-157

TABLE 3-1. (cont'd)

DEVICE LIST

HYDRAULIC & PNEUMATIC (cont'd)	PAGE NO.
Bearings	
General	3-158
Ball	3-159
Needle	3-160
Roller	3-161
Spherical	3-162
Sleeve	3-163
Compressors	
General	3-164
Cylinders	
General	3-165
Filters Non-Electric	
General	3-166
Gaseous	3-167
Liquid	3-168
Fittings	
General	3-169
Quick Disc.	3-170
Quick Disc.	3-171
Hydraulic	3-172
Swivel	3-173
Gaskets & Seals	
General	3-174
O-Rings	3-175
Packing	3-176
Seals, Gen.	3-177
Seals, Magn.	3-178
Seals, Pressure	3-179
Hoses	
Flexible Metal	3-180
Pumps	
General	3-181

Pumps, Fixed Displacement	PAGE NO.
General	3-182
Gear	3-183
Piston	3-184
Vane	3-185
Pumps, Variable Displacement	
General	3-186
Piston	3-187
Vane	3-188
Pumps	
Centrifugal	3-189
Fuel	3-190
Fuel Boost	3-191
Fuel Jettison	3-192
Fuel Transfer Hyd. Driven	3-193
Hydraul, Gen	3-194
Manual	3-195
Variable Delivery	3-196
Impeller	3-197
Oil	3-198
Regulators	
General	3-199
Bellmouth Controller, Jet Engine	3-200
Fluid Tension	3-201
Fuel	3-202
Pressure	3-203
Temperature	3-204
Valves	
General	3-205
General, Ball	3-206
General, Butterfly	3-207

TABLE 3-1. (cont'd)

DEVICE LIST

Valves (cont'd)	PAGE NO.
General, Check	3-208
General, Control	3-209
General, Globe	3-210
General, Relief	3-211
General, Selector	3-212
General, Sequence	3-213
General, Shutoff	3-214
General, Solenoid	3-215
Freon	3-216
Valves, Fuel	
General	3-217
Check	3-218
Dump	3-219
Float	3-220
Gate	3-221
Pressure Regulator	3-222
Selector	3-223
Shutoff	3-224
Solenoid	3-225
Valves, Hydraulic	
General	3-226
Ball	3-227
Bleeder	3-228
Check	3-229
Control	3-230
Pressure Regulator	3-231
Relief	3-232
Restrictor	3-233
Sequencer	3-234
Servo	3-235
Shuttle	3-236
Shutoff	3-237
Solenoid	3-238
Spool, 4 Way	3-239

Valve, Oil	PAGE NO.
General	3-240
Valves, Pneumatic	
General	3-241
Bleed	3-242
Check	3-243
Control	3-244
Pressure, Regulator	3-245
Relief	3-246
Selector	3-247
Shutoff	3-248
Solenoid	3-249
Valves, Motor Operated	
General	3-250
Sequence	3-251
Freon	3-252
Fuel	3-253
ORDNANCE	3-254
Optical & Electro-optical Devices	
Lasers	3-255
Vidicon	3-256
Video Detec.	3-257
Lens Assy.	3-258
Sun Shutter	3-259
Vidicon Cable	3-260

The device failures listed represent part defects, aging, corrosion, etc. Secondary failures (for example, mishandling, faults caused by test equipment failure, design defects, etc.) are not included.

The part hours represent total non-operating hours experienced by all parts in the sample.

Four measures of failure rate are given. The first is the best estimate and is the number of failures divided by the total part hours.

The 90% confidence failure rate represents a 90% confidence that the failure rate is equal to or less than this value. This statistic is based on the chi-square distribution.

The low and high failure rate range, where available, represents the best and the worst reliability experience of the numerous sources from which data was collected.

3.3 Electrical and Electronic Operating Data

The majority of the electrical and electronic operating data was extracted from MIL-HDBK-217B, "Reliability Prediction of Electronic Equipment," dated 20 September 1974.

For this data, part failure and hours are not available and therefore do not appear on the data sheets. Statistics given include failure rate in fits with the best estimate and low and high ranges.

The best estimate was extracted from the parts count predictions in Section 3 of MIL-HDBK-217B.

The low and high failure rate ranges were also extracted from MIL-HDBK-217B. For each device type and environment, the detailed failure rate models were exercised with the least severe stress and complexity and the most severe stress and complexity. The resulting failure rates were then recorded as the low and high range respectively.

3.4 Non-Electronic Operating Data

The majority of the non-electronic operating data was extracted from RADC-TR-74-268, "Revision of RADC Nonelectronic

Reliability Notebook," dated October 1974.

For this data, the format is identical to the non-operating data. However, no information on low or high failure rate ranges is available.

3.5 Environmental Factors

Operating data is presented for various environments as described in Section 1. Environmental factors are listed in this section for each environment for the convenience of the user. The non-operating environment is used as the base environment with a factor equal to 1.0. The other environmental factors are a ratio to the non-operating environment. These were calculated using the best estimate failure rate for all environments. Each environment failure rate was divided by the non-operating failure rate to obtain the factor.

3.6 Quality Factors

For a large portion of the electrical and electronic devices, data is broken out by the quality level of the device. For microelectronic devices, Class A, B and C quality levels are listed. The levels are defined in MIL-STD-883.

For discrete semiconductor devices, JANTXV, JANTX, and JAN quality levels are listed. These levels are defined in MIL-S-19500.

For other electrical and electronic devices, various quality classifications are used and are defined in the noted military specification.

Quality factors are given separately for non-operating and operating environments. They are obtained by defining one level as a base with a factor equal to one. Then the best estimate failure rate for that quality level is divided into the other quality level failure rates to determine the failure rate ratio to the base quality level.

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR DIGITAL (1-20 GATES)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C*	8	2103.	3.73	6.18	-	4.1
CLASS B*	22	6672.	3.30	4.38	1.7	48.5
CLASS A*	5	5861.	0.85	1.59	-	1.87

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	12.9	56.	724.	1.61	7.	91.
SPACE FLIGHT	12.9	56.	724.	1.61	7.	91.
GROUND, FIXED	64.5	232.	3620.	8.06	29.	453.
AIRBORNE, INHAB	258.	728.	14500.	32.2	91.	1810.
NAVAL, SHELTERED	258.	744.	14500.	32.2	93.	1810.
GROUND, MOBILE	258.	728.	14500.	32.2	91.	1810.
NAVAL, UNSHEL	322.	960.	18100.	40.3	120.	2270.
AIRBORNE, UNINHAB	387.	1120.	21700.	48.4	140.	2720.
MISSILE, LAUNCH	645.	1680.	36200.	80.6	210.	4530.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C	1.0	15.	15.	62.	195.	199.	195.	257.	300.	450.
CLASS B	1.0	2.1	2.1	8.8	28.	28.	28.	36.	42.	64.

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
4.4	3.9	1	8	1	.5

*Mono metal - metallization/interconnection system.

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR DIGITAL (21-50 GATES)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C	*	*	3.73	6.18	-	4.1
CLASS B	*	*	3.30	4.38	1.7	48.5
CLASS A	*	*	0.85	1.59	-	1.87

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	38.4	160.	1320	4.8	20.	165.
SPACE FLIGHT	38.4	160.	1320	4.8	20.	165.
GROUND, FIXED	192.	496.	6590	24.	62.	824.
AIRBORNE, INHAB	768.	1280.	26400	96.	160.	3300.
NAVAL, SHELTERED	768.	1360.	26400	96.	170.	3300.
GROUND, MOBILE	768.	1280.	26400	96.	160.	3300.
NAVAL, UNSHEL	960.	1840.	33000	120.	230.	4120.
AIRBORNE, UNINHAB	1150.	2000.	40000	120.	250.	4940.
MISSILE, LAUNCH	1920.	2720.	65900	240.	340.	8240.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C	1.0	43.	43.	133.	343.	365.	343.	493.	536.	729.
CLASS B	1.0	6.1	6.1	19.	48.	52.	48.	70.	76.	103.

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
4.4	3.9	1.	8	1	.5

*See Bipolar, Digital (1-20 gates).

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR DIGITAL (51-100 GATES)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C	*	*	3.73	6.18	-	4.1
CLASS B	*	*	3.30	4.38	1.7	48.5
CLASS A	*	*	0.85	1.59	-	1.87

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	57.	256.	2120	7.1	32.	264.
SPACE FLIGHT	57.	256.	2120	7.1	32.	264.
GROUND, FIXED	285.	752.	10600	35.6	94.	1320.
AIRBORNE, INHAB	1140.	1840.	42400	142.	230.	5280.
NAVAL, SHELTERED	1140.	1920.	42400	142.	240.	5280.
GROUND, MOBILE	1140.	1840.	42400	142.	230.	5280.
NAVAL, UNSHEL	1425.	2720.	53000	178.	340.	6600.
AIRBORNE, UNINHAB	1710.	2880.	63600	214.	360.	7920.
MISSILE, LAUNCH	2850.	3760.	106000	356.	470.	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C	1.0	69.	69.	202.	493.	515.	493.	729.	772.	1008.
CLASS B	1.0	9.7	9.7	28.	70.	73.	70.	103.	109.	142.

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
4.4	3.9	1	8	1	.5

*See Bipolar Digital (1-20 gates).

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR LINEAR ($\leq$ 32 TRANSISTORS)

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED						
CLASS C	*	*	3.73	6.18	-	4.1
CLASS B	*	*	3.30	4.38	1.7	48.5
CLASS A	*	*	0,83	1.59	-	1.87

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
<u>OPERATING</u>						
GROUND, BENIGN	18.4	96.	22400	2.3	12.	2800
SPACE FLIGHT	18.4	96.	22400	2.3	12.	2800
GROUND, FIXED	92.	416.	112000	11.5	52.	14000
AIRBORNE, INHAB	368.	1200.	448000	46.0	150.	56000
NAVAL, SHELTERED	368.	1280.	448000	46.0	160.	56000
GROUND, MOBILE	368.	1200.	448000	46.0	150.	56000
NAVAL, UNSHEL	460.	2160.	560000	57.5	270.	70000
AIRBORNE, UNINHAB	552.	2160.	672000	69.0	270.	84000
MISSILE, LAUNCH	920.	2640.	$1x10^6$	115.0	330.	$1x10^5$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C	1.0	26.	26.	112.	322.	343.	322.	570.	579.	708.
CLASS B	1.0	3.6	3.6	16.	45.	48.	45.	82.	82.	100.

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
4.4	3.9	1	8	1	.5

*See Bipolar, Digital (1-20 gates).

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR LINEAR (33-100 TRANSISTORS)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C	*	*	3.73	6.18	-	4.1
CLASS B	*	*	3.30	4.38	1.7	48.5
CLASS A	*	*	0.85	1.59	-	1.87

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	56.8	208.	56000	7.1	26.	7000
SPACE FLIGHT	56.8	208.	56000	7.1	26.	7000
GROUND, FIXED	284.	960.	280000	35.5	120.	35000
AIRBORNE, INHAB	1136.	2560.	$1x10^6$	142.	320.	$1x10^5$
NAVAL, SHELTERED	1136.	2800.	$1x10^6$	142.	350.	$1x10^5$
GROUND, MOBILE	1136.	2560.	$1x10^6$	142.	320.	$1x10^5$
NAVAL, UNSHEL	1420.	4800.	$1x10^6$	177.	600.	$2x10^5$
AIRBORNE, UNINHAB	1700.	4880.	$2x10^6$	213.	610.	$2x10^5$
MISSILE, LAUNCH	2840.	5440.	$3x10^6$	355.	680.	$4x10^5$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C	1.0	56.	56.	257.	686.	751.	686.	1287	1308	1450
CLASS B	1.0	7.9	7.9	36.	97.	106.	97.	182.	185.	206.

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
4.4	3.9	1	8	1	.8

*See Bipolar, Digital (1-20 gates).

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES
DESCRIPTION: BIPOLAR MEMORIES ($\leq$ 1000 BITS)

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	8.	960.	6600	1.	120.	824
SPACE FLIGHT	8.	960.	6600	1.	120.	824
GROUND, FIXED	40.	2400.	33000	5.	300.	4120
AIRBORNE, INHAB	160.	4880.	132000	20.	610.	16500
NAVAL, SHELTERED	160.	5360.	132000	20.	670.	16500
GROUND, MOBILE	160.	4880.	132000	20.	610.	16500
NAVAL, UNSHEL	200.	7840.	165000	25.	980.	20600
AIRBORNE, UNINHAB	240.	7920.	198000	30.	990.	24700
MISSILE, LAUNCH	400.	8800.	330000	50.	1100.	4×10^4

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR MEMORIES (1001-4000 BITS)

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	440.	2080.	16500	55.	260.	2060
SPACE FLIGHT	440.	2080.	16500	55.	260.	2060
GROUND, FIXED	2200.	5600.	82400	275.	700.	10300
AIRBORNE, INHAB	8800.	11200.	330000	1100.	1400.	41200
NAVAL, SHELTERED	8800.	12000.	330000	1100.	1500.	41200
GROUND, MOBILE	8800.	11200.	330000	1100.	1400.	41200
NAVAL, UNSHEL	11000.	18400.	412000	1375.	2300.	51500
AIRBORNE, UNINHAB	13200.	18400.	494000	1650.	2300.	61800
MISSILE, LAUNCH	22000.	20800.	824000	2750.	2600.	$1x10^5$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: BIPOLAR MEMORIES (4001 - 8000 BITS)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	278	3520.	21400	34.8	440.	2680
SPACE FLIGHT	278	3520.	21400	34.8	440.	2680
GROUND, FIXED	1390	9600.	107000	174.	1200.	13400
AIRBORNE, INHAB	5560	19200.	428000	696.	2400.	53600
NAVAL, SHELTERED	5560	20800.	428000	696.	2600.	53600
GROUND, MOBILE	5560	19200.	428000	696.	2400.	53600
NAVAL, UNSHEL	6950	30400.	535000	870.	3800.	67000
AIRBORNE, UNINHAB	8340	31200.	642000	1044.	3900.	80400
MISSILE, LAUNCH	13900	36000.	$1x10^6$	1740.	4500.	$1x10^5$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: MOS (1-20 GATES)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	13.	80.	28800	1.6	10.	3600
SPACE FLIGHT	13.	80.	28800	1.6	10.	3600
GROUND, FIXED	65.	384.	144000	8.1	48.	18000
AIRBORNE, INHAB	260.	960.	576000	32.	120.	72000
NAVAL, SHELTERED	260.	1120.	576000	32.	140.	72000
GROUND, MOBILE	260.	960.	576000	32.	120.	72000
NAVAL, UNSHEL	325.	2000.	720000	40.	250.	90000
AIRBORNE, UNINHAB	390.	1920.	864000	49.	240.	$1x10^5$
MISSILE, LAUNCH	650.	1920.	$1x10^6$	81.	240.	$2x10^5$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: MOS (21-50 GATES)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	38.	384.	52800	4.8	48.	6600
SPACE FLIGHT	38.	384.	52800	4.8	48.	6600
GROUND, FIXED	192.	1520.	264000	24.	190.	33000
AIRBORNE, INHAB	768.	2720.	$1x10^6$	96.	340.	$1x10^5$
NAVAL, SHELTERED	768.	3440.	$1x10^6$	96.	430.	$1x10^5$
GROUND, MOBILE	768.	2720.	$1x10^6$	96.	340.	$1x10^5$
NAVAL, UNSHEL	960.	7360.	$1x10^6$	120.	920.	$2x10^5$
AIRBORNE, UNINHAB	1150.	6320.	$2x10^6$	144.	790.	$2x10^5$
MISSILE, LAUNCH	1920.	4160.	$3x10^6$	240.	520.	$3x10^5$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: MOS (51-100 GATES)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	58.	608.	84800	7.2	76.	10600
SPACE FLIGHT	58.	608.	84800	7.2	76.	10600
GROUND, FIXED	288.	2480.	424000	36.	310.	53000
AIRBORNE, INHAB	1150.	4320.	2x10^{6}	144.	540.	2x10^{5}
NAVAL, SHELTERED	1150.	5440.	2x10^{6}	144.	680.	2x10^{5}
GROUND, MOBILE	1150.	4320.	2x10^{6}	144.	540.	2x10^{5}
NAVAL, UNSHEL	1440.	12000.	2x10^{6}	180.	1500.	3x10^{5}
AIRBORNE, UNINHAB	1730.	10400.	3x10^{6}	216.	1300.	3x10^{5}
MISSILE, LAUNCH	2880.	6240.	4x10^{6}	360.	780.	5x10^{5}

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: MOS MEMORIES ($\leq$ 1000 BITS)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	8.	2560.	270000	1.	320.	33800
SPACE FLIGHT	8.	2560.	270000	1.	320.	33800
GROUND, FIXED	40.	9600.	1x10^{6}	5.	1200.	2x10^{5}
AIRBORNE, INHAB	160.	15200.	5x10^{6}	20.	1900.	7x10^{5}
NAVAL, SHELTERED	160.	19200.	5x10^{6}	20.	2400.	7x10^{5}
GROUND, MOBILE	160.	15200.	5x10^{6}	20.	1900.	7x10^{5}
NAVAL, UNSHEL	200.	45600.	7x10^{6}	25.	5700.	8x10^{5}
AIRBORNE, UNINHAB	240.	37600.	8x10^{6}	30.	4700.	1x10^{6}
MISSILE, LAUNCH	400.	19200.	1x10^{7}	50.	2400.	2x10^{6}

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: MOS MEMORIES (1001 - 4000 BITS)

ENVIRONMENT	FAILURES	PART HOURS (10^{6})	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	11.	5600.	676000	1.4	700.	84400
SPACE FLIGHT	11.	5600.	676000	1.4	700.	84400
GROUND, FIXED	57.	21600.	$3x10^{6}$	7.1	2700.	$4x10^{5}$
AIRBORNE, INHAB	228.	34400.	$1x10^{7}$	28.4	4300.	$2x10^{6}$
NAVAL, SHELTERED	228.	44800.	$1x10^{7}$	28.4	5600.	$2x10^{6}$
GROUND, MOBILE	228.	34400.	$1x10^{7}$	28.4	4300.	$2x10^{6}$
NAVAL, UNSHEL	285.	104000.	$2x10^{7}$	35.5	13000.	$2x10^{6}$
AIRBORNE, UNINHAB	342.	88000.	$2x10^{7}$	42.6	11000.	$3x10^{6}$
MISSILE, LAUNCH	570.	44000.	$3x10^{7}$	710.	5500.	$4x10^{6}$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: MONOLITHIC MICROELECTRONIC DEVICES

DESCRIPTION: MOS MEMORIES (4001 - 8000 BITS)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	278.	9600.	880000	35.	1200.	1×10^{5}
SPACE FLIGHT	278.	9600.	880000	35.	1200.	1×10^{5}
GROUND, FIXED	1390.	36000.	4×10^{6}	174.	4500.	6×10^{5}
AIRBORNE, INHAB	5560.	57600.	2×10^{7}	696.	7200.	2×10^{6}
NAVAL, SHELTERED	5560.	75200.	2×10^{7}	696.	9400.	2×10^{6}
GROUND, MOBILE	5560.	57600.	2×10^{7}	696.	7200.	2×10^{6}
NAVAL, UNSHEL	6950.	176000.	2×10^{7}	870.	22000.	3×10^{6}
AIRBORNE, UNINHAB	8340.	144000.	3×10^{7}	1040.	18000.	3×10^{6}
MISSILE, LAUNCH	13900.	74400.	4x[illegible]	1740.	9300.	6×10^{6}

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A
			8	1	.5

PART CATEGORY: HYBRID MICROELECTRONICS

DESCRIPTION: SEE APPENDIX A

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
CLASS C						
CLASS B						

ENVIRONMENT	FAILURE RATE IN FITS					
	CLASS C			CLASS B		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
CLASS C										
CLASS B										

QUALITY FACTORS

NON-OPERATING			OPERATING		
CLASS C	CLASS B	CLASS A	CLASS C	CLASS B	CLASS A

PART CATEGORY: TRANSISTOR

DESCRIPTION: SILICON NPN

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	20	2268	8.82	11.9	–	10.5
JANTX	30	19900	1.51	1.93	.75	62.9

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	4.	28.	150.	.8	5.6	30.
SPACE FLIGHT	4.	28.	150.	.8	5.6	30.
GROUND, FIXED	24.	180.	750.	4.7	36.	150.
AIRBORNE, INHAB	126.	980.	4350.	25.2	196.	870.
NAVAL, SHELTERED	134.	1100.	4950.	26.7	220.	990.
GROUND, MOBILE	126.	980	4350.	25.2	196.	870.
NAVAL, UNSHEL	150.	1400.	4350.	30.0	280.	870.
AIRBORNE, UNINHAB	228.	2000.	6000.	45.6	400.	1200.
MISSILE, LAUNCH	154.	1600.	7920.	30.7	320.	1580.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	3.2	3.2	20.	111.	125.	111.	159.	227.	181.
JANTX	1.0	3.7	3.7	24.	130.	146.	130.	185.	265.	212.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.17	-	1.0	.2	.1

PART CATEGORY: TRANSISTOR

DESCRIPTION: SILICON PNP

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	8.82	11.9	-	10.5
JANTX	*	*	1.51	1.93	.75	62.9

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	6.	42.	135.	1.2	8.4	27.
SPACE FLIGHT	6.	42.	135.	1.2	8.4	27.
GROUND, FIXED	36.	290	1350.	7.2	58.	27.
AIRBORNE, INHAB	195.	1600.	7950.	39.	320.	1590.
NAVAL, SHELTERED	195.	1700.	7950.	39.	340.	1590.
GROUND, MOBILE	195.	1600.	7950.	39.	320.	1590.
NAVAL, UNSHEL	210.	2300.	6750.	42.	460.	1350.
AIRBORNE, UNINHAB	312.	3200.	15120	62.	640.	3020.
MISSILE, LAUNCH	288.	2500.	10800	58.	500.	2160.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	4.8	4.8	33.	181.	193.	181.	261.	363.	283.
JANTX	1.0	5.6	5.6	38.	212.	225.	212.	305.	424.	331.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.17	-	1.0	.2	.1

*See Transistor, Silicon, NPN

PART CATEGORY: TRANSISTOR

DESCRIPTION: GERMANIUM PNP

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	8.82	11.9	-	10.5
JANTX	*	*	1.51	1.93	.75	62.9

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	4.5	42.	246.	.9	8.4	49.
SPACE FLIGHT	4.5	42.	246.	.9	8.4	49.
GROUND, FIXED	30.	410.	1230.	6.	82.	246.
AIRBORNE, INHAB	180.	2600.	8400.	36.	520.	1680.
NAVAL, SHELTERED	410.	3500.	10500.	82.	700.	700.
GROUND, MOBILE	180.	2600.	8400.	36.	520.	1680.
NAVAL, UNSHEL	410.	3500.**	10500.	82.	700.**	700.
AIRBORNE, UNINHAB	310.	2600.**	13440.	62.	520.**	2690.
MISSILE, LAUNCH	310.	4200.	13440.	62.	840.	2690.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	4.8	4.8	46.	295.	397.	295.	397.	295.	476.
JANTX	1.0	5.6	5.6	54.	344.	464.	344.	464.	344.	556.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.17	-	1.0	.2	.1

*See Transistor, Silicon, NPN.
**This value is valid only for electrical stress, $S \leq 0.3$.

PART CATEGORY: TRANSISTOR

DESCRIPTION: GERMANIUM NPN

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	8.82	11.9	-	10.5
JANTX	*	*	1.51	1.92	.75	62.9

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	14.4	120.	720.	2.9	24.	144.
SPACE FLIGHT	14.4	120.	720.	2.9	24.	144.
GROUND, FIXED	108.	1100.	3600.	21.6	220.	720.
AIRBORNE, INHAB	750.	7100.	21000.	150.	1420.	4200.
NAVAL, SHELTERED	900.	9000.	27000.	180.	1800.	5400.
GROUND, MOBILE	750.	7100.	21000.	150.	1420.	4200.
NAVAL, UNSHEL	900.	9000**	27000.	180.	1800**	5400.
AIRBORNE, UNINHAB	1200.	11000**	33600.	240.	2200**	6700.
MISSILE, LAUNCH	1200.	11000.	33600.	240.	2200.	6700.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	14.	14.	125.	805.	1020	805	1020	1247	1247
JANTX	1.0	16.	16.	146.	940.	1192	940	1192	1457	1457

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.17	-	1.0	.2	.1

*See Transistor, Silicon, NPN

**This value valid only for electrical stress, S ≤0.3

PART CATEGORY: TRANSISTOR

DESCRIPTION: FIELD EFFECT

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	-	-	5.75*	-	-	-
JANTX	3	2616	1.15	2.55	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	38.	76.	152.	7.6	15.2	30.
SPACE FLIGHT	38.	76.	152.	7.6	15.2	30.
GROUND, FIXED	220.	520.	760.	44.	104.	152.
AIRBORNE, INHAB	1100.	2700.	4400.	220.	540.	880.
NAVAL, SHELTERED	1100.	2900.	4400.	220.	580.	880.
GROUND, MOBILE	1100.	2700.	4400.	220.	540.	880.
NAVAL, UNSHEL	1300.	3900.	4400.	260.	780.	880.
AIRBORNE, UNINHAB	2000.	5600.	7000.	400.	1120.	1400.
MISSILE, LAUNCH	1800.	4400.	6400.	360.	880.	1300.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	13.	13.	90.	470.	504.	470.	678.	974.	765.
JANTX	1.0	13.	13.	90.	470.	504.	470.	678.	974.	765.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.2	-	1.0	.2	.1

* Extrapolated from Hi-Rel data using MIL-HDBK-217B quality factor.

PART CATEGORY: TRANSISTOR

DESCRIPTION: UNIJUNCTION

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	-	-	776.*	-	-	-
JANTX	-	-	388.*	-	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	88.	250.	880	18.	50.	176.
SPACE FLIGHT	88.	250.	880	18.	50.	176.
GROUND, FIXED	640.	1700.	5200	128.	340.	1040.
AIRBORNE, INHAB	3400.	9400.	30000	680.	1880.	6000.
NAVAL, SHELTERED	3800.	10000.	22000	760.	2000.	4400.
GROUND, MOBILE	3400.	9400.	30000	680.	1880.	6000.
NAVAL, UNSHEL	4800.	15000.	22000	960.	3000.	4400.
AIRBORNE, UNINHAB	7000.	21000.	48000	1400.	4200.	9600.
MISSILE, LAUNCH	5400.	15000.	48000	1100.	3000.	9600.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	.6	.6	4.	24.	26.	24.	54.	39.	39.
JANTX	1.0	.6	.6	4.	24.	26.	24.	54.	39.	39.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.2	-	1.0	.2	.1

*Extrapolated from MIL-HDBK-217B minimum stress level.

PART CATEGORY: TRANSISTOR

DESCRIPTION: MICROWAVE*

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	-	-	117.6**	-	-	-
JANTX	1	17	58.8	229.	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	60.	480.	$1x10^5$	30.	240.	77000
SPACE FLIGHT	60.	480.	$1x10^5$	30.	240.	77000
GROUND, FIXED	120.	960.	$3x10^5$	60.	480.	$1x10^5$
AIRBORNE, INHAB	600.	4800.	$1x10^6$	300.	2400.	$8x10^5$
NAVAL, SHELTERED	600.	4800.	$1x10^6$	300.	2400.	$8x10^5$
GROUND, MOBILE	600.	4800.	$1x10^6$	300.	2400.	$8x10^5$
NAVAL, UNSHEL	720.	5760.	$2x10^6$	360.	2880.	$9x10^5$
AIRBORNE, UNINHAB	960.	7680.	$2x10^6$	480.	3840.	$1x10^6$
MISSILE, LAUNCH	960.	7680.	$2x10^6$	480.	3840.	$1x10^6$

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	4.1	4.1	8.2	41.	41.	41.	49.	65.	65.
JANTX	1.0	4.1	4.1	8.2	41.	41.	41.	49.	65.	65.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
4	2	-	4	2	1

*Gold Refractory Metallizaiton.

**Extrapolated from Hi-Rel data using MIL-HDBK-217B quality factor.

PART CATEGORY: DIODE

DESCRIPTION: SILICON, GENERAL PURPOSE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	49	7834	6.25	7.55	184	12.4
JANTX	8	27254	.29	.48	-	.42

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	5.6	17.	80.	1.1	3.4	16.
SPACE FLIGHT	5.6	17.	80.	1.1	3.4	16.
GROUND, FIXED	38.5	120.	450.	7.7	24.	90.
AIRBORNE, INHAB	210.	680.	2500.	42.	136.	500.
NAVAL, SHELTERED	230.	750.	2500.	46.	150.	500.
GROUND, MOBILE	210.	680.	2500.	42.	136.	500.
NAVAL, UNSHEL	290.	1100.	2500.	58.	220.	500.
AIRBORNE, UNINHAB	420.	1600.	5000.	84.	320.	800.
MISSILE, LAUNCH	340.	1100.	4000.	68.	220.	800.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	2.7	2.7	19.	109.	120.	109.	176.	256.	176.
JANTX	1.0	12.	12.	83.	469.	517.	469.	759.	1103	759.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.05	-	1.0	.2	.1

PART CATEGORY: DIODE

DESCRIPTION: GERMANIUM, GENERAL PURPOSE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	6.25	7.55	1.84	12.4
JANTX	*	*	.29	.48	-	.42

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	6.6	22.	120.	1.3	4.4	24.
SPACE FLIGHT	6.6	22.	120.	1.3	4.4	24.
GROUND, FIXED	77.	260.	600.	15.4	52.	120.
AIRBORNE, INHAB	350.	1700.	3000.	70.	340.	600.
NAVAL, SHELTERED	530.	2500.	3000.	110.	500.	600.
GROUND, MOBILE	350.	1700.	3000.	70.	340.	600.
NAVAL, UNSHEL	1140.	2500**	2500.	230.	500**	500.
AIRBORNE, UNINHAB	1260.	2900**	2900.	250.	580**	580.
MISSILE, LAUNCH	560.	2700.	4800.	110.	540.	960.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	3.5	3.5	42.	272.	400.	272.	400.	464.	432.
JANTX	1.0	15.	15.	179.	1172	1724	1172	1724	2000	1862.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.05	-	1.0	.2	.1

*See Diodes, Silicon, General Purpose.

**This value is valid only for electrical stress, S ≤ 0.3

PART CATEGORY: DIODE

DESCRIPTION: ZENER AND AVALANCHE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	0	786	1.56*	3.12	-	-
JANTX	4	1775	1.56*	3.12	1.11	87.

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	16.5	27.	75.	2.3	5.4	15.
SPACE FLIGHT	16.5	27.	75.	2.3	5.4	15.
GROUND, FIXED	95.	160.	375.	19.	32.	75.
AIRBORNE, INHAB	488.	850.	2250.	98.	170.	450.
NAVAL, SHELTERED	513.	910.	2250.	103.	180.	450.
GROUND, MOBILE	488.	850.	2250.	98.	170.	450.
NAVAL, UNSHEL	588.	1200.	2250.	118.	240.	450.
AIRBORNE, UNINHAB	900.	1800.	3600.	180.	360.	720.
MISSILE, LAUNCH	800.	1400.	3600.	160.	280.	720.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	17.	17.	103.	545.	583.	545.	769.	1154.	897.
JANTX	1.0	3.5	3.5	21.	109.	115.	109.	154.	231.	179.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	1.0	-	1.0	.2	.1

*Combination JAN/JANTX Data

PART CATEGORY: DIODE

DESCRIPTION: THYRISTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	-	-	25.*	-	-	-
JANTX	-	-	5.*	-	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	7.	23.	90.	1.4	4.6	18.
SPACE FLIGHT	7.	23.	90.	1.4	4.6	18.
GROUND, FIXED	50.	160.	480.	10.	32.	96.
AIRBORNE, INHAB	270.	900.	2750.	54.	180.	550.
NAVAL, SHELTERED	300.	1000.	2750.	60.	200.	550.
GROUND, MOBILE	270.	900.	2750.	54.	180.	550.
NAVAL, UNSHEL	410.	1400.	2750.	82.	280.	550.
AIRBORNE, UNINHAB	600.	2000.	4400.	120.	400.	880.
MISSILE, LAUNCH	400.	1400.	4400.	80.	280.	880.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	1.	1.	6.	36.	40.	36.	56.	80.	56.
JANTX	1.0	1.	1.	6.	36.	40.	36.	56.	80.	56.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.2	-	1.0	.2	.1

*Extrapolated from MIL-HDBK-217B minimum stress level.

PART CATEGORY: DIODE

DESCRIPTION: SILICON MICROWAVE DETECTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	-	-	24.5*	-	-	-
JANTX	3	204.	14.7	32.6	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	140	190.	450	84	114.	270
SPACE FLIGHT	140	190.	450	84	114.	270
GROUND, FIXED	1540	2200.	5250	924	1320.	3150
AIRBORNE, INHAB	7880	12000.	26250	4730	7200.	15750
NAVAL, SHELTERED	8230	13000.	26250	4940	7800.	15750
GROUND, MOBILE	7880	12000.	26250	4730	7200.	15750
NAVAL, UNSHEL	8750	17000.	26250	5250	10200.	15750
AIRBORNE, UNINHAB	13720	25000.	42000	8230	15000.	25200
MISSILE, LAUNCH	31500	46000.	$1x10^5$	18900	27600.	63000

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	7.8	7.8	90.	490.	531.	490.	694.	1020.	1878.
JANTX	1.0	7.8	7.8	90.	490.	531.	490.	694.	1020.	1878.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.6	-	1.0	.6	.3

*Extrapolated from JANTX data using MIL-HDBK-217B quality factor.

PART CATEGORY: DIODE

DESCRIPTION: GERMANIUM MICROWAVE DETECTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	24.5	-	-	-
JANTX	*	*	14.7	32.6	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	290	410.	770	170	246.	460
SPACE FLIGHT	290	410.	770	170	246.	460
GROUND, FIXED	1730	5600**	5600	1040	3360**	3360**
AIRBORNE, INHAB	21000	35000**	35000	12600	21000**	21000**
NAVAL, SHELTERED		***			***	
GROUND, MOBILE	21000	35000**	35000	12600	21000**	21000**
NAVAL, UNSHEL		***			***	
AIRBORNE, UNINHAB		***			***	
MISSILE, LAUNCH		***			***	

ENVIRONMENTAL FACTOR

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	17.	17.	229.	1429.	***	1429.	***	***	***
JANTX	1.0	17.	17.	229.	1429.	***	1429.	***	***	***

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.6	-	1.0	.6	.3

*See Diode, Silicon Microwave Detector. **This value valid only for electrical stress, S ≤ 0.3. ***Not used in these environments.

PART CATEGORY: DIODE

DESCRIPTION: SILICON MICROWAVE MIXER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	24.5	-	-	-
JANTX	*	*	14.7	32.6	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	193	250.	700	116	150.	420
SPACE FLIGHT	193	250.	700	116	150.	420
GROUND, FIXED	2100	3000.	7000	1260	1800.	4200
AIRBORNE, INHAB	10700	16000.	35000	6420	12800.	21000
NAVAL, SHELTERED	11000	17000.	35000	6600	10200.	21000
GROUND, MOBILE	10700	16000.	35000	6420	12800.	21000
NAVAL, UNSHEL	12100	23000.	35000	7260	13800.	21000
AIRBORNE, UNINHAB	18800	34000.	56000	11280	20400.	33600
MISSILE, LAUNCH	42700	64000.	$1x10^5$	25620	38400.	84000

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	10.	10.	122.	653.	694.	653.	939.	1388.	2612.
JANTX	1.0	10.	10.	122.	653.	694.	653.	939.	1388.	2612.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.6	-	1.0	.6	.3

*See Diode, Silicon Microwave Detector

PART CATEGORY: DIODE

DESCRIPTION: GERMANIUM MICROWAVE MIXER

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	*	*	24.5	-	-	-
JANTX	*	*	14.7	32.6	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	490	720.	1330	290	432.	800
SPACE FLIGHT	490	720.	1330	290	432.	800
GROUND, FIXED	5950	10000**	10000	3570	6000**	6000
AIRBORNE, INHAB	36750	61000**	61000	22000	36600**	36600
NAVAL, SHELTERED		***			***	
GROUND, MOBILE	36750	61000**	61000	22000	36600**	36600
NAVAL, UNSHEL		***			***	
AIRBORNE, UNINHAB		***			***	
MISSILE, LAUNCH		***			***	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	29.	29.	408.	2490.	***	2490.	***	***	***
JANTX	1.0	29.	29.	408.	2490.	***	2490.	***	****	***

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.6	-	1.0	.6	.3

*See Diode, Silicon Microwave Detector. **This value valid only for electrical stress, $S \leq 0.3$. ***Not used in these environments.

PART CATEGORY: DIODE

DESCRIPTION: VARACTORS, STEP RECOVERY & TUNNEL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
JAN	-	-	523.*	-	-	-
JANTX	0	4.0	105.*	577.	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	120	240.	900	24	48.	180
SPACE FLIGHT	120	240.	900	24	48.	180
GROUND, FIXED	750	1500.	4500	150	300.	900
AIRBORNE, INHAB	4000	8100.	22500	800	1620.	4500
NAVAL, SHELTERED	4300	8800.	22500	860	1760.	4500
GROUND, MOBILE	4000	8100.	22500	800	1620.	4500
NAVAL, UNSHEL	5900	17000.	22500	1180	3400.	4500
AIRBORNE, UNINHAB	6000	12000.	36000	1200	2400.	7200
MISSILE, LAUNCH	6400	13000.	36000	1280	2600.	7200

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	.5	.5	3.	15.	17.	15.	33.	23.	25.
JANTX	1.0	.5	.5	3.	15.	17.	15.	33.	23.	25.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.2	-	1.0	.2	.1

*Extrapolated from MIL-HDBK-217B minimum stress level.

PART CATEGORY: DIODES

DESCRIPTION: SILICON CONTROLLED RECTIFIER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>**NON-OPERATING**</u>						
GROUND, FIXED						
JAN	-	-	9.8*	-	-	-
JANTX	1	509.2	1.96	7.64	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	JAN			JANTX		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
<u>OPERATING</u>						
GROUND, BENIGN	8.4	26.	120.	1.7	5.1	24
SPACE FLIGHT	8.4	26.	120.	1.7	5.1	24
GROUND, FIXED	58.	180.	675.	12.	36.	135
AIRBORNE, INHAB	315.	1020.	3750.	63.	204.	750
NAVAL, SHELTERED	345.	1125.	3750.	69.	225.	750
GROUND, MOBILE	315.	1020.	3750.	63.	204.	750
NAVAL, UNSHEL.	435.	1650.	3750.	87.	330.	750
AIRBORNE, UNINHAB	630	2400.	7500.	126.	480.	120
MISSILE, LAUNCH	510	1650	6000.	102.	330.	120.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
JAN	1.0	2.7	2.7	18.	104.	115.	104.	168.	245.	168.
JANTX	1.0	2.6	2.6	18.	104.	115.	104.	168.	245.	168.

QUALITY FACTORS

NON-OPERATING			OPERATING		
JAN	JANTX	JANTXV	JAN	JANTX	JANTXV
1.0	.2	-	1.0	.2	.1

*Extrapolated from JANTX data based on MIL-HDBK-217B Quality Factor.

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: RECEIVER, TRIODE, TETRODE, PENTODE, MIL-E-1

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL	12	983	12.0	18.1	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN		2500.				
SPACE FLIGHT		2500.				
GROUND, FIXED		5000.				
AIRBORNE, INHAB		32500.				
NAVAL, SHELTERED		32500.				
GROUND, MOBILE		50000.				
NAVAL, UNSHEL.		50000.				
AIRBORNE, UNINHAB		50000.				
MISSILE, LAUNCH		400000.				

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	208	208	417	2708	2708	4167	4167	4167	33333
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: RECEIVER, POWER RECTIFIER, MIL-E-1

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL	*	*	12.0	18.1	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN		5000.				
SPACE FLIGHT		5000.				
GROUND, FIXED		10000.				
AIRBORNE, INHAB		65000.				
NAVAL, SHELTERED		65000.				
GROUND, MOBILE		100000.				
NAVAL, UNSHEL.		100000.				
AIRBORNE, UNINHAB		100000.				
MISSILE, LAUNCH		800000.				

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	417	417	833	5417	5417	8333	8333	8333	66667
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

*See Tubes, Receiver, Triode, Tetrode, Pentode

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: KLYSTRON, LOW POWER (LOCAL OSCILLATOR)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED MIL-STD HI-REL		SEE APPENDIX C				

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: KLYSTRON, HIGH POWER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL		SEE APPENDIX C				

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: MAGNETRON, MEDIUM POWER <10 KILOWATTS (PEAK)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL		SEE APPENDIX C				

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: MAGNETRON, HIGH POWER, ≥ 10 KILOWATTS (PEAK)

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING		SEE APPENDIX C				

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	F	R	S

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: TWT, PEAK POWER <100 WATTS

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD		SEE APPENDIX C				
HI-REL						

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: TUBES ELECTRONIC VACUUM

DESCRIPTION: TWT, PEAK POWER ≥100 WATTS, ≤10000 WATTS

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED		SEE APPENDIX C				
MIL-STD						
HI-REL						

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: TUBES, ELECTRONIC VACUUM

DESCRIPTION: TRANSMITTING, TRIODE, MIL-E-1

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED MIL-STD HI-REL			TBD			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN		37500.				
SPACE FLIGHT		37500.				
GROUND, FIXED		75000.				
AIRBORNE, INHAB		488000.				
NAVAL, SHELTERED		488000.				
GROUND, MOBILE		750000.				
NAVAL, UNSHEL.		750000.				
AIRBORNE, UNINHAB		750000.				
MISSILE, LAUNCH		$6x10^6$				

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L	
MIL-STD											

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: TUBE, ELECTRONIC VACUUM

DESCRIPTION: TRANSMITTING, TETRODE & PENTODE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			TBD			
HI-REL						

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN		50000.				
SPACE FLIGHT		50000.				
GROUND, FIXED		100000.				
AIRBORNE, INHAB		650000.				
NAVAL, SHELTERED		650000.				
GROUND, MOBILE		$1x10^6$				
NAVAL, UNSHEL.		$1x10^6$				
AIRBORNE, UNINHAB		$1x10^6$				
MISSILE, LAUNCH		$8x10^6$				

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: RESISTOR

DESCRIPTION: INSULATED FIXED COMPOSITION, MIL-R-39008, Style RCR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	0	15065.	<0.066	0.15	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				.2	.45	2.3
SPACE FLIGHT				.2	.45	2.3
GROUND, FIXED				1.0	2.0	16.
AIRBORNE, INHAB				2.0	4.8	32.
NAVAL, SHELTERED				3.0	7.7	49.
GROUND, MOBILE				3.5	8.5	56.
NAVAL, UNSHEL.				9.0	21.	109.
AIRBORNE, UNINHAB				8.0	18.	118.
MISSILE, LAUNCH				8.0	18.	120.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	6.8	6.8	30.	73.	117.	129.	318.	273.	273.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.3	-	1.0	.3	.1	.01

PART CATEGORY: RESISTOR

DESCRIPTION: INSULATED FIXED COMPOSITION, MIL-R-11, Style RC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	2	9131	0.22	0.58	-	0.45
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	1.	2.3	18.		N/A	
SPACE FLIGHT	1.	2.3	18.			
GROUND, FIXED	4.	10.	65.			
AIRBORNE, INHAB	10.	24.	160.			
NAVAL, SHELTERED	18.	39.	300.			
GROUND, MOBILE	18.	43.	300.			
NAVAL, UNSHEL.	45.	110.	550.			
AIRBORNE, UNINHAB	40.	90.	600.			
MISSILE, LAUNCH	38.	90.	600.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	10.	10.	45.	109.	177.	195.	500.	409.	409.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.3					

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED FILM (INSULATED), MIL-R-39017, Style RLR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	1	57303.	0.017	0.07	-	0.08

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				1.5	2.4	11.
SPACE FLIGHT				1.5	2.4	11.
GROUND, FIXED				9.	15.	73.
AIRBORNE, INHAB				10.	20.	78.
NAVAL, SHELTERED				14.	26.	103.
GROUND, MOBILE				19.	37.	145.
NAVAL, UNSHEL.				31.	52.	213.
AIRBORNE, UNINHAB				33.	54.	230.
MISSILE, LAUNCH				67.	110.	508.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	141	141	882	1176	1529	2176	3059	3176	6471

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.15	-	1.0	.3	.1	.01

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED FILM (INSULATED), MIL-R-22684, Style RL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	1	9237.	0.11	0.42	-	0.19
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	8.	13.	60.		N/A	
SPACE FLIGHT	24.	13.	60.			
GROUND, FIXED	48.	75.	338.			
AIRBORNE, INHAB	52.	100.	390.			
NAVAL, SHELTERED	68.	130.	510.			
GROUND, MOBILE	102.	190.	765.			
NAVAL, UNSHEL.	140.	260.	1080.			
AIRBORNE, UNINHAB	150.	270.	1160.			
MISSILE, LAUNCH	300.	550.	2230.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	118	118	682	909	1182	1727	2364	2455	2727
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.15					

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED FILM, MIL-R-55182, Style RNR & RNC and MIL-R-10509, Style Rn

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	0.11	0.42	-	0.19
HI-REL	*	*	0.017	0.07	-	0.08

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	1.7	2.8	12.3	.17	.28	1.23
SPACE FLIGHT	1.7	2.8	12.3	.17	.28	1.23
GROUND, FIXED	9.5	17.	81.2	.95	1.7	8.12
AIRBORNE, INHAB	13.5	23.	115.	1.35	2.3	11.5
NAVAL, SHELTERED	18.	30.	143.	1.8	3.0	14.3
GROUND, MOBILE	25.	42.	202.	2.5	4.2	20.2
NAVAL, UNSHEL.	34.	62.	302.	3.4	6.2	30.2
AIRBORNE, UNINHAB	36.	63.	302.	3.6	6.3	30.2
MISSILE, LAUNCH	68.	120.	585.	6.8	12.	58.5

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_J	A_U	M_L
MIL-STD	1.0	25.	25.	154.	209.	273.	382.	564.	573.	1091.
HI-REL	1.0	16.	16.	100.	135.	176.	247.	365.	371.	706.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
		-	1.0	.3	.1	.01

*See Resistor, Fixed Film (Insulated), MIL-R-39017, Style RLR, & MIL-R-22684, Style RL

PART CATEGORY: RESISTOR

DESCRIPTION: POWER FILM, MIL-R-11804, Style RD/P

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	-	-	700.*	-	-	-
HI-REL	-	-	280.*	-	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	150.	180.	940	60.	72.	380
SPACE FLIGHT	150.	180.	940	60.	72.	380
GROUND, FIXED	790.	960.	4900	320.	384.	2000
AIRBORNE, INHAB	1000.	1300.	6300	400.	520.	2500
NAVAL, SHELTERED	1200.	1500.	7000	480.	600.	2800
GROUND, MOBILE	1900.	2300.	11200	760.	920.	4500
NAVAL, UNSHEL.	2200.	2800.	12600	880.	1100.	5000
AIRBORNE, UNINHAB	2500.	3100.	14300	1000.	1200.	5700
MISSILE, LAUNCH	5500.	6800.	33200	2200.	2700.	13300

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	.3	.3	1.	2.	2.	3.	4.	4.	10.
HI-REL	1.0	.3	.3	1.	2.	2.	3.	4.	4.	10.

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL
1.0	.4	3.0	1.0	.4

*Extrapolated from MIL-HDBK-217B minimum stress level.

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED, WIREWOUND (ACCURATE), MIL-R-39005, Style RBR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	1	5064.	0.20	0.77	-	0.82

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				5.1	8.5	110.
SPACE FLIGHT				5.1	3.5	110.
GROUND, FIXED				32.	56.	750.
AIRBORNE, INHAB				88.	150.	2100.
NAVAL, SHELTERED				110.	180.	2500.
GROUND, MOBILE				110.	190.	2500.
NAVAL, UNSHEL.				150.	260.	3700.
AIRBORNE, UNINHAB				190.	320.	4800.
MISSILE, LAUNCH				410.	600.	10000.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	43	43	280	750	900	950	1300	1600	3400

QUALITY FACTORS

NON-OPERATING

MIL-STD	HI-REL
1.0	.17

OPERATING

L	M	P	R	S
-	1.0	.3	.1	.01

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED, WIREWOUND (ACCURATE), MIL-R-93, Style RB

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	2	1675.	1.19	3.18	-	5.32
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	25.	43.	580		N/A	
SPACE FLIGHT	25.	43.	580			
GROUND, FIXED	160.	280.	3700			
AIRBORNE, INHAB	440.	750.	10000			
NAVAL, SHELTERED	530.	900.	12000			
GROUND, MOBILE	590.	950.	14000			
NAVAL, UNSHEL.	740.	1300.	19000			
AIRBORNE, UNINHAB	960.	1600.	24000			
MISSILE, LAUNCH	2100.	3400.	49000			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	36.	36.	235.	630.	756.	798.	1092	1345	2857
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.17					

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED, WIREWOUND (POWER TYPE), MIL-R-39007, Style RWR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	*	*	0.20*	0.77	-	0.82

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				3.6	9.	38.
SPACE FLIGHT				3.6	9.	38.
GROUND, FIXED				13.	33.	110.
AIRBORNE, INHAB				25.	66.	220.
NAVAL, SHELTERED				31.	85.	290.
GROUND, MOBILE				42.	110.	370.
NAVAL, UNSHEL.				59.	160.	460.
AIRBORNE, UNINHAB				86.	260.	580.
MISSILE, LAUNCH				130.	330.	1100.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	45.	45.	165.	330.	425.	550.	800.	1300.	1650.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.17					

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*See Resistor, Fixed, Wirewound (Accurate), MIL-R-39005, Style RBR

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED, WIREWOUND (POWER TYPE), MIL-R-26, Style RW

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL	*	*	1.49* N/A	3.18	-	5.32

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	18.	46.	180.		N/A	
SPACE FLIGHT	18.	46.	180.			
GROUND, FIXED	63.	170.	540.			
AIRBORNE, INHAB	130.	330.	1100.			
NAVAL, SHELTERED	160.	430.	1400.			
GROUND, MOBILE	210.	550.	1800.			
NAVAL, UNSHEL.	270.	800.	2100.			
AIRBORNE, UNINHAB	430.	1300.	2900.			
MISSILE, LAUNCH	630.	1700.	5600.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	39	39	143	277	361	462	672	1092	1429

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.17					

*See Resistor, Fixed, Wirewound, (Accurate), MIL-R-93, Style RB.

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED, WIREWOUND (POWER TYPE, CHASSIS MOUNTED), MIL-R-39009, Style RER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	*	*	0.20	0.77	-	0.82

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				6.1	16.	70.
SPACE FLIGHT				6.1	16.	70.
GROUND, FIXED				22.	62	220.
AIRBORNE, INHAB				44.	130.	450.
NAVAL, SHELTERED				56.	160.	610.
GROUND, MOBILE				74.	220.	740.
NAVAL, UNSHEL.				99.	300.	850.
AIRBORNE, UNINHAB				110.	340.	930.
MISSILE, LAUNCH				220.	660.	2200.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	80	80	310	650	300	1100	1500	1700	3300

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.17	-	1.0	.3	.1	.01

*See Resistor, Fixed, Wirewound (Accurate), MIL-R-39005, Style RBR.

PART CATEGORY: RESISTOR

DESCRIPTION: FIXED, WIREWOUND (POWER TYPE, CHASSIS MOUNTED),
MIL-R-18546, Style RE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL	*	*	1.19* N/A	3.18	-	5.32

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	30.	80.	350		N/A	
SPACE FLIGHT	30.	80.	350			
GROUND, FIXED	110.	310.	1100			
AIRBORNE, INHAB	220.	650.	2200			
NAVAL, SHELTERED	280.	800.	3000			
GROUND, MOBILE	370.	1100.	3700			
NAVAL, UNSHEL.	490.	1500.	4200			
AIRBORNE, UNINHAB	540.	1700.	4600			
MISSILE, LAUNCH	1100.	3300.	11200			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	67	67	261	546	672	924	1261	1429	2773
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.17					

*See Resistor, Fixed, Wirewound (Accurate), MIL-R-93, Style RB

PART CATEGORY: RESISTOR

DESCRIPTION: THERMISTOR, MIL-STD and MIL-T-23648, Style RTH

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	3	22.5	133.3	236.	31.6	-
HI-REL	0	59.1	<16.9	39.1	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	BEAD TYPE			DISK TYPE		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN		21.			65.	
SPACE FLIGHT		21.			65.	
GROUND, FIXED		100.			310.	
AIRBORNE, INHAB		250.			750.	
NAVAL, SHELTERED		300.			900.	
GROUND, MOBILE		520.			1600.	
NAVAL, UNSHEL.		400.			1200.	
AIRBORNE, UNINHAB		340.			1000.	
MISSILE, LAUNCH		1200.			3600.	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
BEAD TYPE	1.0	.2	.2	.8	1.9	2.3	3.9	3.0	2.6	9.0
DISK TYPE	1.0	3.8	3.8	18.	44.	53.	95.	71.	59.	213.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: RESISTOR

DESCRIPTION: VARIABLE, WIREWOUND (LEAD SCREW-ACTUATED),
MIL-R-39015, Style RTR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	2	539.	3.71	9.87	-	43.5

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				11.	18.	130.
SPACE FLIGHT				11.	18.	130.
GROUND, FIXED				42.	66.	500.
AIRBORNE, INHAB				84.	140.	1100.
NAVAL, SHELTERED				98.	170.	1300.
GROUND, MOBILE				110.	180.	1300.
NAVAL, UNSHEL.				180.	300.	2300.
AIRBORNE, UNINHAB				200.	340.	2400.
MISSILE, LAUNCH				840.	1400.	11000.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	4.9	4.9	18.	38.	46.	49.	81.	92.	377.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	1.0	-	1.0	.3	.1	.03

PART CATEGORY: RESISTOR

DESCRIPTION: VARIABLE, WIREWOUND (LEAD SCREW ACTUATED)
MIL-R-27208, Style RT

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	2	528.	3.79	10.1	1.94	90.9
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	55.	90.	640.		N/A	
SPACE FLIGHT	55.	90.	640.			
GROUND, FIXED	210.	330.	2500.			
AIRBORNE, INHAB	420.	700.	5400.			
NAVAL, SHELTERED	490.	850.	6300.			
GROUND, MOBILE	560.	900.	6700.			
NAVAL, UNSHEL.	850.	1500.	11000.			
AIRBORNE, UNINHAB	960.	1700.	12000.			
MISSILE, LAUNCH	5100.	9000.	68000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	24.	24.	87.	185.	224.	237.	396.	449.	2375.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	1.0					

PART CATEGORY: RESISTOR

DESCRIPTION: PRECISION WIREWOUND POTENTIOMETER, MIL-R-12934, Style RR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	0	119.	<8.4	19.4	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	340.	430.	$5x10^4$			
SPACE FLIGHT	340.	430.	$5x10^4$			
GROUND, FIXED	2100.	2700.	$3x10^5$			
AIRBORNE, INHAB	4100.	5800.	$7x10^5$			
NAVAL, SHELTERED	4600.	6100.	$8x10^5$			
GROUND, MOBILE	4100.	5800.	$7x10^5$			
NAVAL, UNSHEL.	6300.	9000.	$1x10^6$			
AIRBORNE, UNINHAB	7900.	11000.	$1x10^6$			
MISSILE, LAUNCH	50000.	70000.	$8x10^6$			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	51.	51,	321.	690.	726.	690.	1071.	1310	8333
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

PART CATEGORY: RESISTOR

DESCRIPTION: SEMIPRECISION, WIREWOUND POTENTIOMETER,
MIL-R-19, Style RA and MIL-R-39002, Style RK

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	<8.4*	19.4	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	150.	260.	4600			
SPACE FLIGHT	-	**	-			
GROUND, FIXED	1100.	2300.	45000			
AIRBORNE, INHAB	3000.	6400.	135000			
NAVAL, SHELTERED	3900.	8600.	197000			
GROUND, MOBILE	4000.	8500.	180000			
NAVAL, UNSHEL.		**				
AIRBORNE, UNINHAB		**				
MISSILE, LAUNCH		**				

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	31.	**	274.	762.	1024.	1012.	**	**	**
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

*See Resistor, Precision WW Potentiometer, MIL-R-12934, Style RR
**Not normally used in these environments.

PART CATEGORY: RESISTOR

DESCRIPTION: WIREWOUND (POWER) POTENTIOMETER, MIL-R-22, style RP

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	<8.4*	19.4	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	190.	290.	7900			
SPACE FLIGHT		**				
GROUND, FIXED	1400.	2300.	59000			
AIRBORNE, INHAB	3500.	6000.	180000			
NAVAL, SHELTERED	4700.	7500.	216000			
GROUND, MOBILE	5200.	8100.	241000			
NAVAL, UNSHEL.		**				
AIRBORNE, UNINHAB		**				
MISSILE, LAUNCH		**				

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	35.	**	274.	714.	893.	964.	**	**	**
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

*See Resistor, Precision Wirewound Potentiometer, MIL-R-12934.
**Not normally used in these environments.

PART CATEGORY: RESISTOR

DESCRIPTION: VARIABLE (NON-WIREWOUND TRIMMER) MIL-R-39035, Style RJR

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	*	*	3.71	9.87	-	43.5

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN	550.	650	3650			
SPACE FLIGHT		**				
GROUND, FIXED	1750	2300	13000			
AIRBORNE, INHAB	3750	4750	29000			
NAVAL, SHELTERED	5000	6500	38500			
GROUND, MOBILE	6000	8000	48500			
NAVAL, UNSHEL.	8500	11500	50000			
AIRBORNE, UNINHAB	10000	13500	$1x10^5$			
MISSILE, LAUNCH	40500	50000	$3x10^5$			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	175	**	620	1280	1752	2156	3100	3639	13477

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

*See Resistor, Variable, Wirewound, MIL-R-39015, Style RTR

**Not normally used in these environments.

PART CATEGORY: RESISTOR

DESCRIPTION: VARIABLE (NON-WIREWOUND TRIMMERS), MIL-R-22097, Style RJ

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	<8.4*	19.4	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	1100	1300.	7300			
SPACE FLIGHT		**				
GROUND, FIXED	3500	4600.	26000			
AIRBORNE, INHAB	7500	9500.	58000			
NAVAL, SHELTERED	10000	13000.	77000			
GROUND, MOBILE	12000	16000.	97000			
NAVAL, UNSHEL.	17000	23000.	$1x10^5$			
AIRBORNE, UNINHAB	20000	27000.	$2x10^5$			
MISSILE, LAUNCH	81000	100000.	$5x10^5$			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	155	**	548	1131	1548	1905	2738	3214	11905
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

*See Resistor, Precision WW, Potentiometer, MIL-R-12934, Style RR

**Not normally used in these environments.

PART CATEGORY: RESISTOR

DESCRIPTION: COMPOSITION (LOW PRECISION) POTENTIOMETER, MIL-R-94, style RV

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	<8.4*	19.4	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	200	270.	1800			
SPACE FLIGHT		**				
GROUND, FIXED	2200	3700.	28000			
AIRBORNE, INHAB	12000	20000.	$2x10^5$			
NAVAL, SHELTERED	13000	22000.	94000			
GROUND, MOBILE	12000	20000.	$2x10^5$			
NAVAL, UNSHEL.	18000	34000.	$3x10^5$			
AIRBORNE, UNINHAB	18000	34000.	$3x10^5$			
MISSILE, LAUNCH	25000	40000.	$3x10^5$			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	32	**	440	2381	2619	2381	4048	4048	4762
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

*See Resistor, Precision WW Potentiometer, MIL-R-12934, Style RR

**Not normally used in these environments.

PART CATEGORY: RESISTOR

DESCRIPTION: TIN OXIDE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	465.5	(<2.1)	5.0		

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING	OPERATING

PART CATEGORY: RESISTOR

DESCRIPTION: NETWORK

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	-	-	-	-	-	-
HI-REL	0	1.1	(<909.1)	2100.	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING

OPERATING

PART CATEGORY: CAPACITOR

DESCRIPTION: PAPER & PLASTIC FILM - MIL-C-39022, Style CHR;
MIL-C-14157, Style CPV; & MIL-C 19978, Style CQR.

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED MIL-STD HI-REL	2	1797.	1.11	2.96	-	41.7

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				.07	.2	7.
SPACE FLIGHT				.07	.2	7.
GROUND, FIXED				.16	.6	15.
AIRBORNE, INHAB				.36	1.2	34.
NAVAL, SHELTERED				.40	1.6	40.
GROUND, MOBILE				.36	1.2	34.
NAVAL, UNSHEL.				1.8	9.0	210.
AIRBORNE, UNINHAB				3.0	12.	340.
MISSILE, LAUNCH				1.8	6.	170.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	.18	.18	.54	1.1	1.4	1.1	8.1	11.	5.4

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.27	1.5	1.0	.3	.1	.01

PART CATEGORY: **CAPACITOR**

DESCRIPTION: PAPER & PLASTIC FILM - MIL-C-19978, Style CQ

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS BEST ESTIMATE	90% CONFIDENCE	RANGE LOW	RANGE HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	.8	1950.	4.1	6.67	-	6.08
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS MIL-STD RANGE LOW	BEST EST	HIGH	HI-REL RANGE LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	.7	2.	70.		N/A	
SPACE FLIGHT	.7	2.	70.			
GROUND, FIXED	1.6	6.	150.			
AIRBORNE, INHAB	3.6	12.	340.			
NAVAL, SHELTERED	4.0	16.	400.			
GROUND, MOBILE	3.6	12.	340.			
NAVAL, UNSHEL.	18.	90.	2100.			
AIRBORNE, UNINHAB	30.	120.	3400.			
MISSILE, LAUNCH	18.	60.	1700.			

ENVIRONMENTAL FACTORS

	NON-OPERATING G_F	OPERATING G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	.5	.5	1.5	2.9	3.9	2.9	22.	29.	15.
HI-REL										

QUALITY FACTORS

NON-OPERATING MIL-STD	HI-REL	OPERATING L	M	P	R	S
1.0	.27					

PART CATEGORY: CAPACITOR

DESCRIPTION: MICA, MIL-C-39001, Style CMR

ENVIRONMENT	**FAILURES**	**PART HOURS (10^6)**	**FAILURE RATE IN FITS**			
			BEST ESTIMATE	**90% CONFIDENCE**	**RANGE**	
					LOW	**HIGH**
NON-OPERATING						
GROUND, FIXED MIL-STD HI-REL	2	3271.	.61*	1.63	-	434.

ENVIRONMENT	**FAILURE RATE IN FITS**					
	MIL-STD			**HI-REL**		
	RANGE			**RANGE**		
	LOW	**BEST EST.**	**HIGH**	**LOW**	**BEST EST.**	**HIGH**
OPERATING						
GROUND, BENIGN				.1	.3	2.2
SPACE FLIGHT				.1	.3	2.2
GROUND, FIXED				.8	3.2	13.
AIRBORNE, INHAB				1.8	6.0	37.
NAVAL, SHELTERED				1.8	7.8	29.
GROUND, MOBILE				1.8	6.0	37.
NAVAL, UNSHEL.				11.	34.	180.
AIRBORNE, UNINHAB				14.	48.	260.
MISSILE, LAUNCH				6.	30.	120.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	.5	.5	5.2	9.8	13.	98.	56.	79.	49.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	1.0	-	1.0	.3	.1	.03

*Combination MIL-STD & HI-REL Data.

PART CATEGORY: CAPACITOR

DESCRIPTION: MICA, MIL-C-5, Style CM

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	.61	1.63	-	434.
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	1.	3.	22.		N/A	
SPACE FLIGHT	1.	3.	22.			
GROUND, FIXED	8.	32.	130.			
AIRBORNE, INHAB	18.	60.	370.			
NAVAL, SHELTERED	18.	78.	290.			
GROUND, MOBILE	18.	60.	370.			
NAVAL, UNSHEL.	110.	340.	1800.			
AIRBORNE, UNINHAB	140.	480.	2600.			
MISSILE, LAUNCH	60.	300.	1200.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	4.9	4.9	52.	98.	128.	98.	557.	787.	492.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	1.0					

*See Capacitor, Mica, MIL-C-39001, Style CMR.

PART CATEGORY: CAPACITOR

DESCRIPTION: MICA, MIL-C-10950, Style CB

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	.61	1.63	-	434.
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	41.	120.	670.		N/A	
SPACE FLIGHT	41.	120.	670.			
GROUND, FIXED	200.	580.	3300.			
AIRBORNE, INHAB	320.	930.	5100.			
NAVAL, SHELTERED	350.	990.	5600.			
GROUND, MOBILE	320.	930.	5100.			
NAVAL, UNSHEL.	1300.	3700.	21000.			
AIRBORNE, UNINHAB	1600.	4800.	26000.			
MISSILE, LAUNCH	1600.	4700.	26000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	197	197	951	1525	1623	1525	6066	7869	7705
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

*See Capacitor, MICA-MIL-C-39001, Style CMR

PART CATEGORY: CAPACITOR

DESCRIPTION: GLASS, MIL-C-23269, Style CYR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	0	1597.	<0.63	1.45	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				.6	1.3	10.
SPACE FLIGHT				.6	1.3	10.
GROUND, FIXED				5.6	11.	96.
AIRBORNE, INHAB				10.	21.	170.
NAVAL, SHELTERED				13.	25.	220.
GROUND, MOBILE				10.	21.	170.
NAVAL, UNSHEL.				55.	110.	920.
AIRBORNE, UNINHAB				84.	160.	1400.
MISSILE, LAUNCH				33.	110.	570.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	21.	21.	17.	33.	40.	33.	175.	254.	175.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: CAPACITOR

DESCRIPTION: CERAMIC, MIL-C-20, Style CCR
MIL-C-39014, Style CKR

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	2	6163.	0.32	0.86	.27	.64

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				1.9	10.	71.
SPACE FLIGHT				1.9	10.	71.
GROUND, FIXED				4.	22.	150.
AIRBORNE, INHAB				8.	44.	300.
NAVAL, SHELTERED				8.	44.	300.
GROUND, MOBILE				8.	44.	300.
NAVAL, UNSHEL.				18.	96.	650.
AIRBORNE, UNINHAB				20.	110.	760.
MISSILE, LAUNCH				30.	170.	1100.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	31.	31.	69.	138.	138.	138.	300.	344.	531.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.15	1.5	1.0	.3	.1	.01

PART CATEGORY: CAPACITOR

DESCRIPTION: CERAMIC, MIL-C-20, Style CC, MIL-C-11015, Style CK

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	3	1400	2.14	4.76	-	4.12
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	19.	100.	710.		N/A	
SPACE FLIGHT	19.	100.	710.			
GROUND, FIXED	40.	220.	1500.			
AIRBORNE, INHAB	80.	440.	3000.			
NAVAL, SHELTERED	80.	440.	3000.			
GROUND, MOBILE	80.	440.	3000.			
NAVAL, UNSHEL.	180.	960.	6500.			
AIRBORNE, UNINHAB	200.	1100.	7600.			
MISSILE, LAUNCH	300.	1700.	11000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	47.	47.	103.	206.	206.	206.	449.	514.	794.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.15					

PART CATEGORY: CAPACITOR

DESCRIPTION: TANTALUM ELECTROLYTIC (SOLID), MIL-C-39003, Style CSR

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL	1	7687	N/A 0.13	0.51	-	.49

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				3.8	11.	62.
SPACE FLIGHT				3.8	11.	62.
GROUND, FIXED				9.0	26.	150.
AIRBORNE, INHAB				18.	52.	300.
NAVAL, SHELTERED				20.	56.	330.
GROUND, MOBILE				18.	52.	300.
NAVAL, UNSHEL.				59.	170.	900.
AIRBORNE, UNINHAB				90.	260.	1500.
MISSILE, LAUNCH				96.	260.	1600.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD HI-REL	1.0	85.	85.	200.	400.	431.	400.	1308.	2000.	2000.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: CAPACITOR

DESCRIPTION: TANTALUM ELECTROLYTIC (NON-SOLID), MIL-C-39006, Style CLR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			N/A			
HI-REL	4	446.	9.0	17.9	-	9.3

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN				5.0	15.	82.
SPACE FLIGHT				5.0	15.	82.
GROUND, FIXED				11.	34.	190.
AIRBORNE, INHAB				37.	110.	600.
NAVAL, SHELTERED				37.	110.	600.
GROUND, MOBILE				37.	110.	600.
NAVAL, UNSHEL				120.	340.	1900.
AIRBORNE, UNINHAB				150.	440.	2500.
MISSILE, LAUNCH				180.	540.	3000.

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL	1.0	1.7	1.7	3.8	12.	12.	12.	38.	49.	60.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.7	1.5	1.0	.3	.1	.01

PART CATEGORY: CAPACITOR

DESCRIPTION: TANTALUM ELECTROLYTIC (NON-SOLID), MIL-C-3965, Style CL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	4	319.	12.5	25.1	-	2500.
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	50.	150.	820.		N/A	
SPACE FLIGHT	50.	150.	820.			
GROUND, FIXED	110.	340.	1900.			
AIRBORNE, INHAB	370.	1100.	6000.			
NAVAL, SHELTERED	370.	1100.	6000.			
GROUND, MOBILE	370.	1100.	6000.			
NAVAL, UNSHEL.	120.	3400.	19000.			
AIRBORNE, UNINHAB	150.	4400.	25000.			
MISSILE, LAUNCH	180.	5400.	30000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	12.	12.	27.	88.	88.	88.	272.	352.	432.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.7					

PART CATEGORY: CAPACITOR

DESCRIPTION: ALUMINUM OXIDE, MIL-C-39018, Style CU

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	0	155.	<6.46	14.9	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	36.	73.	300.		N/A	
SPACE FLIGHT	36.	73.	300.			
GROUND, FIXED	110.	230.	1000.			
AIRBORNE, INHAB	830.	1600.	7200.			
NAVAL, SHELTERED	940.	1900.	8300.			
GROUND, MOBILE	830.	1600.	7200.			
NAVAL, UNSHEL.	2600.	5300.	24000.			
AIRBORNE, UNINHAB	3600.	6900.	33000.			
MISSILE, LAUNCH	2800.	5400.	24000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	11.	11.	36.	248.	294.	248.	820.	1068.	836.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: CAPACITOR

DESCRIPTION: ALUMINUM DRY ELECTROLYTIC, MIL-C-62, Style CE

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED MIL-STD HI-REL			TBD			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	60.	110.	420.		N/A	
SPACE FLIGHT	60.	110.	420.			
GROUND, FIXED	240.	410.	1600.			
AIRBORNE, INHAB	1700.	3000.	12000.			
NAVAL, SHELTERED	2200.	3800.	15000.			
GROUND, MOBILE	1700.	3000.	12000.			
NAVAL, UNSHEL.	8100.	14000.	56000.			
AIRBORNE, UNINHAB	9100.	16000.	63000.			
MISSILE, LAUNCH	5800.	10000.	40000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: CAPACITOR

DESCRIPTION: VARIABLE CERAMIC, MIL-C-81, Style CV

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD			TBD			
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	11.	200.	1600		N/A	
SPACE FLIGHT	11.	200.	1600			
GROUND, FIXED	51.	1100.	8600			
AIRBORNE, INHAB	110.	2400.	19000			
NAVAL, SHELTERED	120.	2700.	11000			
GROUND, MOBILE	110.	2400.	19000			
NAVAL, UNSHEL.	570.	12000.	97000			
AIRBORNE, UNINHAB	1000.	22000.	170000			
MISSILE, LAUNCH	980.	21000.	165000			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: CAPACITOR

DESCRIPTION: VARIABLE, PISTON TYPE, MIL-C-14409, Style PC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	0	154.8	<6.46	14.9	-	-
HI-REL			N/A			

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN	4.4	16.	120.			
SPACE FLIGHT	4.4	16.	120.			
GROUND, FIXED	24.	110.	670.			
AIRBORNE, INHAB	90.	410.	2700.			
NAVAL, SHELTERED	110.	470.	3000.			
GROUND, MOBILE	90.	410.	2700.			
NAVAL, UNSHEL.	820.	3800.	22000.			
AIRBORNE, UNINHAB	870.	5300.	24000.			
MISSILE, LAUNCH	710.	4900.	20000.			

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	2.5	2.5	17.	63.	73.	63.	588.	820.	759.
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: CAPACITOR

DESCRIPTION: TITANIUM

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	51	(<19.6)	45.3	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING	OPERATING

PART CATEGORY: CAPACITOR

DESCRIPTION: TUBULAR TEMP.

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING GROUND, FIXED	0	12.8	(<78.1)	180.	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING	OPERATING

PART CATEGORY: CAPACITOR

DESCRIPTION: DIFFERENTIAL, DUAL MODE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	63.8	(<15.7)	36.2	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING

G_F ____

OPERATING

G_B ____ S_F ____ G_F ____ A_I ____ N_S ____ G_M ____ N_U ____ A_U ____ M_L ____

QUALITY FACTORS

NON-OPERATING

OPERATING

PART CATEGORY: CAPACITOR

DESCRIPTION: METALIZED POLYCARBONATE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	2	108.4	18.5	49.1	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING	OPERATING

PART CATEGORY: CAPACITOR

DESCRIPTION: VARIABLE, AIR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	2	55.8	35.8	95.3	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING	OPERATING

PART CATEGORY: CAPACITOR

DESCRIPTION: NETWORK

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED CLASS B	0	1.1	(<909.1)	2100.	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING

OPERATING

PART CATEGORY: INDUCTIVE DEVICES

DESCRIPTION: TRANSFORMERS & INDUCTORS, MIL-T-39013 (ER) and MIL-T-27

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	9	649.	13.9	21.9	-	17.7
HI-REL	3	3309.	0.91	2.01	-	1.0

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN		2.5			1.25	
SPACE FLIGHT		2.5			1.25	
GROUND, FIXED		6.6			3.3	
AIRBORNE, INHAB		18.			9.	
NAVAL, SHELTERED		20.			10.	
GROUND, MOBILE		11.			5.5	
NAVAL, UNSHEL.		27.			13.5	
AIRBORNE, UNINHAB		34.			17.	
MISSILE, LAUNCH		36.			18.	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	.18	.18	.47	1.3	1.4	.79	1.9	2.4	2.6
HI-REL	1.0	1.4	1.4	3.6	9.9	11.	6.0	15.	19.	20.

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL
1.0	0.07	-	1.0	.5

PART CATEGORY: INDUCTIVE DEVICES

DESCRIPTION: COILS, RADIO FREQUENCY, MIL-C-15305

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	0	746.	< 1.34	3.10	-	-
HI-REL	2	1806.	1.11	2.95	-	2.74

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN		9.6			4.8	
SPACE FLIGHT		9.6			4.8	
GROUND, FIXED		22.			11.	
AIRBORNE, INHAB		60.			30.	
NAVAL, SHELTERED		66.			33.	
GROUND, MOBILE		36.			18.	
NAVAL, UNSHEL.		84.			42.	
AIRBORNE, UNINHAB		110.			55.	
MISSILE, LAUNCH		120.			60.	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	7.2	7.2	16.	45.	49.	27.	63.	82.	90.
HI-REL	1.0	4.3	4.3	9.9	27.	30.	16.	38.	50.	54.

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL
1.0	.8	-	1.0	.5

PART CATEGORY: INDUCTIVE DEVICES

DESCRIPTION: TRANSFORMERS, PULSE, LOW POWER, MIL-T-39026 (ER) and MIL-T-21038

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	*	*	13.9	21.9	-	17.7
HI-REL	*	*	0.91	2.01	-	1.0

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN		1.2			.79	
SPACE FLIGHT		1.2			.79	
GROUND, FIXED		2.7			1.78	
AIRBORNE, INHAB		7.5			4.95	
NAVAL, SHELTERED		8.3			5.48	
GROUND, MOBILE		4.5			2.97	
NAVAL, UNSHELTERED		11.			7.26	
AIRBORNE, UNINHAB		14.			9.24	
MISSILE, LAUNCH		15.			9.9	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	.09	.09	.19	.54	.60	.32	.79	1.0	1.1
HI-REL	1.0	.87	.87	2.0	5.4	6.0	3.3	8.0	10.	11.

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL
1.0	.07	-	1.0	.66

*See Inductive Devices, Transformers & Inductors, MIL-T-27.

PART CATEGORY: INDUCTIVE DEVICES

DESCRIPTION: FILTERS & CHOKES

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	1	104.	9.62	37.4	-	2645.
HI-REL	2	3615.	0.55	1.47	-	.57

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN		7.5			3.75	
SPACE FLIGHT		7.5			3.75	
GROUND, FIXED		21.			11.	
AIRBORNE, INHAB		56.			28.	
NAVAL, SHELTERED		64.			32.	
GROUND, MOBILE		34.			17.	
NAVAL, UNSHEL.		96.			48.	
AIRBORNE, UNINHAB		120.			60.	
MISSILE, LAUNCH		110.			55.	

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING									
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	1.0	.78	.78	2.2	5.8	6.7	3.5	10.	12.	11.
HI-REL	1.0	6.8	6.8	20.	51.	58.	31.	87.	109.	100.

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S
1.0	.06					

PART CATEGORY: INDUCTIVE DEVICES

DESCRIPTION: REACTORS

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
MIL-STD	0	13.	<76.9	178.	-	-
HI-REL	1	321.	3.12	12.1	-	4.05

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST	HIGH	LOW	BEST EST	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

	NON-OPERATING	OPERATING								
	G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD										
HI-REL										

QUALITY FACTORS

NON-OPERATING		OPERATING		
MIL-STD	HI-REL	LOWER GRADE	MIL-STD	HI-REL

PART CATEGORY: CRYSTALS

DESCRIPTION: MIL-C-3098

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	102.	39.3	78.6	-	-
OPERATING						
SATELLITE						
GROUND			200.			
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		5.1						

PART CATEGORY: PRINTED WIRING BOARD

DESCRIPTION:

ENVIRONMENT	**FAILURES**	**PART HOURS (10^6)**	**FAILURE RATE IN FITS**			
			BEST ESTIMATE	**90% CONFIDENCE**	**RANGE**	
					LOW	**HIGH**
NON-OPERATING						
GROUND, FIXED	2	2977	.67	1.79	-	3.81

ENVIRONMENT	**FAILURE RATE IN FITS**					
	MIL-STD			**HI-REL**		
	RANGE			**RANGE**		
	LOW	**BEST EST.**	**HIGH**	**LOW**	**BEST EST.**	**HIGH**
OPERATING						
GROUND, BENIGN		1.5				
SPACE FLIGHT		1.5				
GROUND, FIXED		2.4				
AIRBORNE, INHAB		7.2				
NAVAL, SHELTERED		4.8				
GROUND, MOBILE		4.8				
NAVAL, UNSHEL.		12.				
AIRBORNE, UNINHAB		24.				
MISSILE, LAUNCH		24.				

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
1.0	2.2	2.2	3.6	11.	7.2	7.2	18.	36.	36.

QUALITY FACTORS

NON-OPERATING

MIL-STD HI-REL

OPERATING

L M P R S

PART CATEGORY: CONNECTIONS & CONNECTORS

DESCRIPTION: PIN CONNECTOR

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	82444.	0.012	0.47	-	2.90
OPERATING						
SATELLITE						
GROUND	0	1514.	<.6	1.5		
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		50						

PART CATEGORY: CONNECTIONS & CONNECTORS

DESCRIPTION: SOLDER CONNECTION

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	25385	<.028	.065	-	-
OPERATING						
SATELLITE						
GROUND	634	162329	3.9	4.1		
GROUND, MOBILE						
AIRBORNE	135	6000	22.5	25.2		
MISSILE						
SHIPBOARD	14	1640	8.5	12.3		
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		139.		804.		304.		

PART CATEGORY: CONNECTIONS & CONNECTORS

DESCRIPTION: WELD CONNECTIONS

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	5580.	<0.18	0.41	-	-
OPERATING						
SATELLITE						
GROUND	112	65750	1.7	1.9		
GROUND, MOBILE						
AIRBORNE	7	157.	44.6	75.1		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		9.4		248.				

PART CATEGORY: INSTRUMENTS, MISSILE FLIGHT

DESCRIPTION:

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	25	264.	94.7	124.	-	-
<u>OPERATING</u>						
SATELLITE	3	.001	3000000.	6670000		
GROUND						
GROUND, MOBILE	44	58.18	756.	924.		
AIRBORNE	169.	.943	179215.	198152.		
MISSILE						
SHIPBOARD						
SUBMARINE	12	.702	17094.	25392.		
HELICOPTER	119	.5	233000.	268368		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	31679.		8.0	1892.			181.	2513.

PART CATEGORY: FUSES

DESCRIPTION:

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	4.7	(<212.8)	491.	-	-

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED		100.				
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: HEATERS

DESCRIPTION:

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	2.6	(<384.6)	888.		

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED		1000.				
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
			2.6						

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: MAGNETIC CORE

DESCRIPTION:

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	35799.	(<.028)	.065		

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: SOLAR CELLS

DESCRIPTION:

ENVIRONMENT	**FAILURES**	**PART HOURS (10^6)**	**FAILURE RATE IN FITS**			
			BEST ESTIMATE	**90% CONFIDENCE**	**RANGE**	
					LOW	**HIGH**
NON-OPERATING						
GROUND, FIXED	8	748.6	10.7	17.4		

ENVIRONMENT	**FAILURE RATE IN FITS**					
	MIL-STD			**HI-REL**		
	RANGE			**RANGE**		
	LOW	**BEST EST.**	**HIGH**	**LOW**	**BEST EST.**	**HIGH**
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED						
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: SENSOR

DESCRIPTION: TEMPERATURE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	2.1	(<476.2)	1100.		
OPERATING						
SATELLITE						
GROUND	2	.829	2413.	6416.		
GROUND, MOBILE	34	1.548	21964.	27607.		
AIRBORNE	682	7.017	97193.	102130		
MISSILE						
SHIPBOARD						
SUBMARINE	2	.007	285714.	759878.		
HELICOPTER	74	.458	161572	188225.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		5.1	46	204			600.	339.

PART CATEGORY: LAMPS

DESCRIPTION:

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	2	52.9	37.9	101.		

ENVIRONMENT	FAILURE RATE IN FITS					
	MIL-STD			HI-REL		
	RANGE			RANGE		
	LOW	BEST EST.	HIGH	LOW	BEST EST.	HIGH
OPERATING						
GROUND, BENIGN						
SPACE FLIGHT						
GROUND, FIXED		200				
AIRBORNE, INHAB						
NAVAL, SHELTERED						
GROUND, MOBILE						
NAVAL, UNSHEL.						
AIRBORNE, UNINHAB						
MISSILE, LAUNCH						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING								
G_F	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
			5.3						

QUALITY FACTORS

NON-OPERATING		OPERATING				
MIL-STD	HI-REL	L	M	P	R	S

PART CATEGORY: ACCELEROMETERS

DESCRIPTION: GENERAL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	135.	29.7	59.3	24.	1923.
OPERATING						
SATELLITE	0	.112	<8929.	20620.		
GROUND	485	9.234	52523.	55708.		
GROUND, MOBILE	0	.037	<27027.	62418.		
AIRBORNE	2619	11.07	236585.	242615.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	301.	1768.	910.	7966.	-	-	-	-

PART CATEGORY: GYROSCOPE

DESCRIPTION: RATE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	24.	181.	133.	174.	121.	524.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	33	1.269	26005.	32834.		
GROUND, MOBILE	4	.012	333333.	666667.		
AIRBORNE	5413	14.56	371772.	378328.		
MISSILE	26	.048	541667.	703829.		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	65	.255	254902.	299356.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	196	2506	2795	4073	-	-	1917

PART CATEGORY: RELAY

DESCRIPTION: GENERAL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	469.7	8.5	17.0	-	637.
OPERATING						
SATELLITE	1	118.8	8.4	33.		
GROUND	13	78.26	166.	242.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	58	8.602	6743.	8017.		
MISSILE	-	-	-	-		
SHIPBOARD	17	22.55	754.	1048.		
SUBMARINE	55	43.03	1278.	1529.		
HELICOPTER	157	2.531	62031.	68849.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	1.0	20.	-	793.	-	89.	150.	7298.

PART CATEGORY: RELAY

DESCRIPTION: ARMATURE

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	8.5	17.0		637
OPERATING						
SATELLITE	-	-	-	-		
GROUND	13	55.71	233.	341.		
GROUND, MOBILE	1	.814	1229.	4780.		
AIRBORNE	4	2.05	1951.	3902.		
MISSILE	-	-	-	-		
SHIPBOARD	116	126.7	916.	1034.		
SUBMARINE	6953.	6750.	1030.	1046.		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	27.	145.	230.	-	108.	121.	

* See Relay, General

PART CATEGORY: RELAY

DESCRIPTION: CRYSTAL CAN, LATCHING

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	8.5	17.0	-	637
OPERATING						
SATELLITE	-	-	-	-		
GROUND	1	.047	21277.	82788.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	2503.	-	-	-	-	-	-

* See Relay, General

PART CATEGORY: RELAY

DESCRIPTION: LATCHING, GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	8.5	17.0	-	637
OPERATING						
SATELLITE	0	3.721	<269.	621.		
GROUND	1	1.756	569.	2216.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	601	1759.	342.	360.		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	32	67	-	-	-	-	40	-

* See Relay, General

PART CATEGORY: RELAY

DESCRIPTION: REED

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	8.5	17.0	-	637
OPERATING						
SATELLITE	-	-	-	-		
GROUND	15	81.5	184.	262.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	39	19.77	1973.	2444.		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	22.	-	-	-	232.	-	-

* See Relay, General

PART CATEGORY: RELAY

DESCRIPTION: THERMAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	8.5	17.0	-	637.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	5	.382	13089.	24465.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1	.039	25641.	99771.		
MISSILE	-	-	-	-		
SHIPBOARD	2	2.68	746.	1985.		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	1540	-	3017	-	88.	-	-

* See Relay, General

PART CATEGORY: RELAY

DESCRIPTION: TIME DELAY

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	8.5	17.0	-	637.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	10	6.918	1446.	2231.		
GROUND, MOBILE	2	.471	4246.	11293.		
AIRBORNE	23	1.333	17254.	22802.		
MISSILE	-	-	-	-		
SHIPBOARD	55	34.39	1599.	1913.		
SUBMARINE	3	4.45	674.	1498.		
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	170	500	2030	-	188	79	-

* See Relay, General

PART CATEGORY: SWITCH

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	11	133.	82.8	125.3	-	291.
OPERATING						
SATELLITE	4	7.88	508.	1015.		
GROUND	0	1.347	<742.	1715.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1100	10.28	107004.	111253.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	2	3.952	506.	1346.		
HELICOPTER	348	3.528	98639.	105752.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	6.	9.	-	1292.	-	-	6.	1191.

PART CATEGORY: SWITCH

DESCRIPTION: PRESSURE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	73.8	54.2	108.4		323.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	100	47.74	2095.	2388.		
GROUND, MOBILE	105	17.18	6112.	6946.		
AIRBORNE	1929	34.43	56027.	57695.		
MISSILE	-	-	-	-		
SHIPBOARD	18	.798	22556.	31018.		
SUBMARINE	4	.613	6525.	13051.		
HELICOPTER	348	1.047	332378.	356344.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	39	113	1034	-	416	120	6132

* See Switch, General

PART CATEGORY: SWITCH

DESCRIPTION: PUSHBUTTON

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	38.5	26.0	101.1	-	58.8
OPERATING						
SATELLITE	-	-	-	-		
GROUND	6	22.18	271.	476.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	101	3.624	27870.	31757.		
MISSILE	-	-	-	-		
SHIPBOARD	55	120.2	458.	547.		
SUBMARINE	7	89.88	78.	131.		
HELICOPTER	0	1.286	<778.	1796.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	10	-	1072	-	18	3	30

* See Switch, General

PART CATEGORY: SWITCH

DESCRIPTION: ROTARY

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	82.8	125.3	-	291.
OPERATING						
SATELLITE	1	2.391	418.	1627.		
GROUND	48	36.11	1329.	1610.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	261	14.75	17695.	19179.		
MISSILE	-	-	-	-		
SHIPBOARD	80	52.1	1536.	1777.		
SUBMARINE	32	20.2	1584.	2004.		
HELICOPTER	2	.092	21739.	57817.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	5	16	-	214	-	19	19	263

* See Switch, General

PART CATEGORY: SWITCH

DESCRIPTION: SENSITIVE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	82.8	125.3	-	291.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	13	11.47	1133.	1654.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	184	12.56	14650.	16129.		
MISSILE	2	.008	250000.	664894.		
SHIPBOARD	-	-	-	-		
SUBMARINE	51	45.93	1110.	1336.		
HELICOPTER	3	.61	4918.	10929.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	14	-	177	3019	-	13	59

*See Switch, Sensitive

PART CATEGORY: SWITCH

DESCRIPTION: THERMOSTATIC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	58.5	17.1	66.6	-	29.4
OPERATING						
SATELLITE	-	-	-	-		
GROUND	11	4.381	2511.	3798.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	44	6.733	6535.	7985.		
MISSILE	-	-	-	-		
SHIPBOARD	29	45.77	634.	812.		
SUBMARINE	7	1.838	3808.	6416.		
HELICOPTER	9	.218	41284.	65251.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	147	-	382	-	37	223	2414

* See Switch, General

PART CATEGORY: SWITCH

DESCRIPTION: TOGGLE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	26.0	101.1	–	58.8
OPERATING						
SATELLITE	–	–	–	–		
GROUND	135	237.5	568.	636.		
GROUND, MOBILE	1	.359	2786.	10839.		
AIRBORNE	255	35.45	7193.	7804.		
MISSILE	–	–	–	–		
SHIPBOARD	67	141.4	474.	557.		
SUBMARINE	–	–	–	–		
HELICOPTER	8	.43	18605.	30242.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	22	107	277	-	18	-	716

* See Switch, Pushbutton

PART CATEGORY: SWITCH

DESCRIPTION: STEPPING

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	2	5.0	400.	1064.		
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD	5	.234	21368.	39939.		
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0						53.		

PART CATEGORY: SWITCH

DESCRIPTION: SOLENOID

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	9	82.4	109.3	172.7		
OPERATING						
SATELLITE	1	1.399	715.	2781.		
GROUND	3	.033	90909.	202020		
GROUND, MOBILE						
AIRBORNE	612	9.847	62151.	65490.		
MISSILE						
SHIPBOARD						
SUBMARINE	6	.234	25641.	45079.		
HELICOPTER	3	.03	100000.	222222.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	6.5	832		569			235	915

PART CATEGORY: SWITCH

DESCRIPTION: MOTOR DRIVEN S&A

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	9	65.1	138.2	218.5		
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: SWITCH

DESCRIPTION: INERTIAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	12	180.6	66.4	98.7	65.6	1130.
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: AC GENERATOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	11	13.8	795.5	1203		
OPERATING						
SATELLITE						
GROUND	0	.002	<500000	1154734		
GROUND, MOBILE	45	.086	523256	638896		
AIRBORNE	6017	5.444	1105253	1123727		
MISSILE						
SHIPBOARD	8	.341	23460	38135		
SUBMARINE						
HELICOPTER	7	.015	466667	786164		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S	H
1.0		629	658	1389		29		587

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: SLIP RING ASSEMBLY

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	8.3	<120.1	277		
OPERATING						
SATELLITE	0	.408	<2451	5660		
GROUND	0	.437	<2288	5285		
GROUND, MOBILE	103	2.065	49879	56762		
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE	39	.977	39918	49446		
HELICOPTER	3	.014	214286	476190		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	20	19	415				332	1784

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: TORQUER MOTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	14	45.3	308.8	445.	-	340
OPERATING						
SATELLITE						
GROUND	0	.219	<4566.	10546.		
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE	0	2.153	464	1073.		
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		15					1.5	

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: RESOLVERS & SYNCHROS

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	2	14.2	140.9	375.		
OPERATING						
SATELLITE						
GROUND	18	.976	18443.	25361.		
GROUND, MOBILE	29	6.908	4198.	5381.		
AIRBORNE	18.	.625	28800.	39604.		
MISSILE						
SHIPBOARD	2.	.036	55556.	147754.		
SUBMARINE	3	8.506	353.	784.		
HELICOPTER	15	.1	150000.	213220.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	C	G_M	A	M	S_H	S_U	H
1.0		131	30	204		394	2.5	1065

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: AC MOTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	2.3	431.6	1679	-	499
OPERATING						
SATELLITE						
GROUND	9	4.164	2161.	3416		
GROUND, MOBILE	184	24.37	7550.	8313		
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		5.0	17.					

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: DC MOTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	3.	87.1	34.4	77	-	4702
OPERATING						
SATELLITE						
GROUND	0	.264	<3788.	8748		
GROUND, MOBILE	2	2.524	792.	2107		
AIRBORNE	75	.907	82690	95873		
MISSILE						
SHIPBOARD	1	.003	333333	1297017		
SUBMARINE	702	56.1	12513	13140		
HELICOPTER	2	.051	39216	104297		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		110	23	2404		9690	364	1140

PART CATEGORY: ROTATING ELECTROMECHANICAL DEVICES

DESCRIPTION: BLOWERS & FANS

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	27.7	36.1	83.		
OPERATING						
SATELLITE						
GROUND	46	32.3	1424.	1730.		
GROUND, MOBILE	108	19.1	5654.	6415.		
AIRBORNE	2132	48.6	43868.	45110.		
MISSILE						
SHIPBOARD	112	6.07	18451.	20884.		
SUBMARINE	5	10.95	457.	853.		
HELICOPTER	173	2.03	85222.	94115.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		39	157	1215		511	13	2361

PART CATEGORY: TRANSDUCER

DESCRIPTION: PRESSURE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	2.1	1905	3810		
OPERATING						
SATELLITE						
GROUND	14	.186	75269	108394		
GROUND, MOBILE	97	1.227	79055	90326		
AIRBORNE	902	9.543	94520	98676		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	92	.595	154622	177315		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		40	41	50				81

PART CATEGORY: ANTENNA ASSEMBLY

DESCRIPTION:

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	85.7	11.7	45.4		
OPERATING						
SATELLITE	0	.545	<1835.	4238.		
GROUND	9	.001	9000000.	1422475	1	
GROUND, MOBILE						
AIRBORNE	1560	17.289	90231.	93226		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	137	1.172	116894	130718		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	157	769231	7712					9991

PART CATEGORY: ROTARY INVERTER

DESCRIPTION:

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	21.6	<46.3	107.		
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY:	ACCUMULATORS
DESCRIPTION:	GENERAL

- Diaphragm Separator
- Bag-Type Separator
- Piston Type Separator
- Class 1500 and 3000

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	7	215.	32.5	54.8	-	120.
OPERATING						
SATELLITE	0	.054	18500.	42800.		
GROUND	1	.004	250000.	973000.		
GROUND, MOBILE	2	.067	29800.	79400.		
AIRBORNE	36	2.031	17700.	22100.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	7	.014	500000.	842000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	570	7700	910	540	-	-	-	15000

*See Hydraulic Accumulators

PART CATEGORY: ACCUMULATORS

DESCRIPTION: HYDRAULIC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	7	215.01	32.6	54.8	-	120.
OPERATING						
SATELLITE	71	47.22	1500.	1760		
GROUND	664	11.888	55800	58700		
GROUND, MOBILE	129	8.604	15000	16800		
AIRBORNE	1396	11.803	118000	122000		
MISSILE	71	47.22	1500	1760		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	45	.560	80300	98100		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	46	1700	460	3600	46	-	-	2500

PART CATEGORY: ACTUATORS

DESCRIPTION: GENERAL

ENVIRONMENT	FAIL- URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI- DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	142	847.6	167.	187.	9.8	27300.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	384	7.625	50400.	53800.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	273	.383	712794.	787581		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	302	-	-	-	4268

PART CATEGORY:	ACTUATORS, LINEAR	
DESCRIPTION:	ELECTRICAL (GENERAL)	Electropneumatic Electrohydraulic

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	167.	187.	9.8	27300.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	747	11.158	66900.	70200.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	273	.383	712794.	787581.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	360	-	-	-	4268

* See Actuators, General

PART CATEGORY: ACTUATORS

DESCRIPTION: HYDRAULIC (General)

- Linear
- Rotary
- Piston
- Plunger
- Vane

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	121	608.6	199	269	9.8	27300
OPERATING						
SATELLITE	-	-	-	-		
GROUND	3	.197	15200	33800		
GROUND, MOBILE	38	.713	53300	66200		
AIRBORNE	16407	119.9	137000	138000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	5	.467	10700	20000		
HELICOPTER	129	1.197	108000	121000		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	76	270	690	-	-	54	540

PART CATEGORY: ACTUATORS, LINEAR

DESCRIPTION: HYDRAULIC SERVO

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	199	269	9.8	27300
OPERATING						
SATELLITE	-	-	-	-		
GROUND	51	.406	126000	151000		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1404	10.765	130000	135000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	82	.764	107000	125000		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	630	-	650	-	-	-	540

* See Actuator, Hydraulic, General

PART CATEGORY: ACTUATORS, LINEAR

DESCRIPTION: MECHANICAL DRIVEN

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	167	187	9.8	27300
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1144	19.739	58000	60200		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	350	-	-	-	-

*See Actuator, General

PART CATEGORY: ACTUATORS

DESCRIPTION: PNEUMATIC, GENERAL & LINEAR

- Control
- Springless
- Diaphragm

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	21	239	87.9	118	63.	256.
OPERATING						
SATELLITE	-	-	-	-		
GROUND (cycles)	13	1.074	12104.0	19227.	-	-
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1250	6.127	204000.	212000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	2300	-	-	-	-

PART CATEGORY: ACTUATOR, LINEAR

DESCRIPTION: PNEUMATIC, PISTON
ROLLING DIAPHRAGM

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	87.9	118	63	256
OPERATING						
SATELLITE	-	-	-	-		
GROUND	10	6.636	1510.	2320		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	82	.764	107330.	128783.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	17	-	-	-	-	-	1221.0

*See Actuator, Pneumatic, General

PART CATEGORY: ACTUATOR, ROTARY

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS BEST ESTIMATE	90% CONFIDENCE	RANGE LOW	RANGE HIGH
NON-OPERATING						
GROUND, FIXED	*	*	167	187	9.8	27300
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	445	2.585	172000	183000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	1030	-	-	-	-

*See Actuator, General

PART CATEGORY: ACTUATOR, ROTARY

DESCRIPTION: ELECTRICAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	167.	187	9.8	27300
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	0	.117	<8850.	19700		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	0	1.893	484.0	1221.	-	-
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	51	-	-	3	-

* See Actuator, General

PART CATEGORY: BATTERIES

DESCRIPTION: SILVER/ZINC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	23.6	<42.4	97.9		
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: BATTERIES

DESCRIPTION: THERMAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	10.6	94.3	367.		
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: BATTERIES

DESCRIPTION: RECHARGEABLE

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED						
<u>OPERATING</u>						
SATELLITE	8	60.591	132.0	238.		
GROUND	8	5.339	1498.0	2706.		
GROUND, MOBILE	4	0.148	27027.	61824.		
AIRBORNE	2810	8.055	348852.	359855.		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	201	0.297	676768.	760242.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	3	35	637	8019				15961

PART CATEGORY: BATTERIES

DESCRIPTION: RECHARGEABLE, SOLAR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED						
OPERATING						
SATELLITE	8	7483.	1.1	1.9		
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY:	BEARING
DESCRIPTION:	GENERAL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	14.5	23.5	5.0	2990
OPERATING						
SATELLITE	-	-	-	-		
GROUND	32	15.547	2060.	2600.		
GROUND, MOBILE	34	1.551	21900.	27600.		
AIRBORNE	268	32.677	8200.	8870.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	200	12.364	16200.	17700.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	140	1500	560	-	-	-	1100

*See Bearing, Ball

PART CATEGORY: BEARING

DESCRIPTION: BALL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	8	552.5	14.5	23.5	5.0	2990.
<u>OPERATING</u>						
SATELLITE	0	1.332	<751	1730		
GROUND	27	28.532	946	1220		
GROUND, MOBILE	4	42.554	94	188		
AIRBORNE	200	58.48	3420	3750		
MISSILE	-	-	-	-		
SHIPBOARD	2	.022	<45500	105000		
SUBMARINE	2	.423	4730	12600		
HELICOPTER	22	1.642	13400	17800		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	52	65	6	240	-	3100	330	920

PART CATEGORY: BEARING

DESCRIPTION: NEEDLE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	*	*	14.5	23.5	5.	2990.
<u>OPERATING</u>						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	0	.337	<2970.	6850.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	200	-	-	-	-

*See Bearing, Ball

PART CATEGORY: BEARING

DESCRIPTION: ROLLER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	14.5	23.5	5.0	2990
OPERATING						
SATELLITE	-	-	-	-		
GROUND	8	28.562	280.	455.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	11	38.774	284	429.		
MISSILE	-	-	-	-		
SHIPBOARD	4	3.317	1210	2410		
SUBMARINE	-	-	-	-		
HELICOPTER	6	.25	24000	42200		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	19	-	20	-	83	-	1600

*See Bearing, Ball

PART CATEGORY: BEARING

DESCRIPTION: SPHERICAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	14.5	23.5	5.	2990.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	22	106.73	206.	274.		
AIRBORNE	429	67.18	6380.	6790.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	168	6.313	26600.	29400.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	14	440	-	-	-	1800

*See Bearing, Ball

PART CATEGORY: BEARING

DESCRIPTION: SLEEVE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	14.5	23.5	5.	2990.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	2	.05	40000.	106000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	-	-	-	-	2800

*See Bearing, Ball

PART CATEGORY: COMPRESSOR

DESCRIPTION: GENERAL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	.2448	<4080	9430	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	16	1.259	12700	17800		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	2217	7.47	297000	305000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	15	.03	500000	711000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	3	-	73	-	-	-	120

PART CATEGORY:	CYLINDER	° Type I, II, III & IV Systems
DESCRIPTION:	GENERAL	° Class 3000

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	12	160	75.	111.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	27	.814	33200.	42900.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	9841	46.38	212000	215000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	142	.146	973000.	1080000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	440	-	2800	-	-	-	13000

PART CATEGORY: FILTER, NONELECTRIC

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	706.51	<1.42	3.26	-	-
OPERATING						
SATELLITE	0	4.45	<225.	519.		
GROUND	0	.085	<11800.	27200.		
GROUND, MOBILE	55	.746	73700.	88200.		
AIRBORNE	71	21263.	3.34	3.92		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	32	16.07	1990.	2520.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	160	8300	52000	2	-	-	-	1400

PART CATEGORY: FILTER, NONELECTRIC

DESCRIPTION: GASEOUS

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	1.42	3.26	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	7	5.827	1200.	2020.		
GROUND, MOBILE	15	8.979	1670.	2380.		
AIRBORNE	15	.564	26600.	37800.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	2	.077	26000	69100.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	840	1200	19000	-	-	-	18000

*See Filter, Nonelectric, General

PART CATEGORY: FILTER, NONELECTRIC

DESCRIPTION: LIQUID

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	<1.42	3.26	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	36	12.054	2990.	3720.		
GROUND, MOBILE	716	62.926	11400.	11900.		
AIRBORNE	225	8.603	26200.	28526.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-		-	-		
HELICOPTER	36	.727	49500.	61700.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	2100	8000	18000	-	-	-	35000

*See Filter, Nonelectric, General

PART CATEGORY: FITTINGS

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	.662	1510.	3496.		
OPERATING						
SATELLITE						
GROUND	0	.829	1105.	-	-	-
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	43	1.45	29655.	38241.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0		.73						19

PART CATEGORY:	FITTINGS
DESCRIPTION:	QUICK, DISCONNECT LIQUID, GROUND

ENVIRONMENT	**FAIL-URES**	**PART HOURS (10^6)**	**FAILURE RATE IN FITS**			
			BEST ESTIMATE	**90% CONFIDENCE**	**RANGE**	
					LOW	**HIGH**
NON-OPERATING						
GROUND, FIXED	*	*	1510.	3496.	-	-
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE	7	.537	13035.	24488.		
AIRBORNE	669	.709	943583.	1005639		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	3	10.	300000.	775000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0			8.6	624				198

*See Fittings, General

PART CATEGORY: FITTINGS

DESCRIPTION: QUICK, DISCONNECT
LIQUID/SUB

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	8.012	499.0	485.	170	1142
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE	7	.537	13035.	24488.	-	-
AIRBORNE	669	.709	943583.	1005639	-	-
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	3	.010	300000.	795000.	-	-

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0			26	1890				601

PART CATEGORY: FITTINGS

DESCRIPTION: HYDRAULIC, GROUND

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	.330	2776.0	7003.	-	-
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	32	8.21	3898.	5238.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								1.4

PART CATEGORY: FITTINGS

DESCRIPTION: SWIVEL, HYDRAULIC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED						
<u>OPERATING</u>						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE	3	.098	30612.	79082.	-	-
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: GASKETS & SEALS

DESCRIPTION: GASKETS, GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	11.	-	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	9	6.282	1430.	2260.		
GROUND, MOBILE	85	52.67	1610.	1860.		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	11	2.92	3770.	5700.		
SUBMARINE	-	-	-	-		
HELICOPTER	35	1.72	20300	25500.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	130	150	-	-	340	-	1800

PART CATEGORY: GASKETS & SEALS

DESCRIPTION: O-Rings

			FAILURE RATE IN FITS			
ENVIRONMENT	FAILURES	PART HOURS (10^6)	BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	78.	-	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	9	7.613	1180.	1870.		
AIRBORNE	44	18.431	2390.	2920.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	7	.025	280000.	472000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	15	31	-	-	-	3600

PART CATEGORY: GASKETS & SEALS

DESCRIPTION: PACKING

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	1.5	-	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	9	2.549	3530.	5580		
GROUND, MOBILE	2	7.31	273.	728		
AIRBORNE	17	11.244	1510	2100		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	545	93.047	5860.	6190		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	2300	180	1000	-	-	-	3900

PART CATEGORY: GASKETS & SEALS

DESCRIPTION: SEALS, GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	100.2	9.98	38.8	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	171	78.496	2180.	2410.		
AIRBORNE	9296	331.11	28100.	28400.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	339	9.581	35400.	38000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	220	2800	-	-	-	3500

PART CATEGORY:	GASKETS & SEALS
DESCRIPTION:	SEALS, MAGNETIC

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	23	-	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	92	.153	601000	690000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	2600	-	-	-	-

PART CATEGORY:	GASKETS & SEALS
DESCRIPTION:	SEALS, PRESSURE

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	9.98	38.8	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1558	17.893	87100.	90000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	8700	-	-	-	-

*See Gaskets & Seals, Seals, General

PART CATEGORY: HOSES

DESCRIPTION: FLEXIBLE METAL
SUB

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	7	4.009	1746.0	-	819	3280
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE	16	66.76	240.	364.		
AIRBORNE	30	.259	115830.	157143.		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER	208	5.194	40046.	44897.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY:	PUMP
DESCRIPTION:	GENERAL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	953	2360.1	406	423	200	1500
OPERATING						
SATELLITE	-	-	-	-		
GROUND	22	5.215	4220	5610		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	20918	192.2	109000	110000		
MISSILE	-	-	-	-		
SHIPBOARD	19	.436	43600	59400		
SUBMARINE	12	.467	25700	38200		
HELICOPTER	520	1.5845	328000	347000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	10	-	270	-	110	63	810

PART CATEGORY:	PUMP
DESCRIPTION:	FIXED DISPLACEMENT, GENERAL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	327	860.05	380	408	200	582
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: PUMP, FIXED DISPLACEMENT

DESCRIPTION: GEAR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	167	380.	439	486	300	582
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: PUMP, FIXED DISPLACEMENT

DESCRIPTION: PISTON

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	112	320	350	486	200	500
<u>OPERATING</u>						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: PUMP, FIXED DISPLACEMENT

DESCRIPTION: VANE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	48	160	300	363	-	-
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: PUMPS, VARIABLE DISPLACEMENT

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	152	320	475	528	200	700
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY:	PUMPS, VARIABLE DISPLACEMENT
DESCRIPTION:	PISTON

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	87	160	544	626	200	700
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: PUMPS, VARIABLE DISPLACEMENT

DESCRIPTION: VANE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	65	160	406	477	200	500
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: PUMP

DESCRIPTION: CENTRIFUGAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	32	160	200	253	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	15	1.244	12100	17100		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	254	.852	298000	323000		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	60		-	-	1500	-	-

PART CATEGORY: PUMP

DESCRIPTION: FUEL (General)

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	8.07	<124	286	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	1	.041	24400.	94900		
GROUND, MOBILE	191	8.261	23100.	25400		
AIRBORNE	554	12.289	45100.	47600		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	90	.566	159000	183000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	200	190	360	-	-	-	1300

PART CATEGORY: PUMP

DESCRIPTION: FUEL BOOST

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	<124	286	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	30	.17	176000	225000		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1354	19.602	69100	71500		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	41	.205	200000	246000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	1400	-	560	-	-	-	1600

*See Pump, Fuel, General

PART CATEGORY: PUMP

DESCRIPTION: FUEL JETTISON

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	<124	286	-	-
OPERATING						
SATELLITE	-		-			
GROUND	-		-			
GROUND, MOBILE	-		-			
AIRBORNE	6	.462	13000	28800		
MISSILE	-		-			
SHIPBOARD	-		-			
SUBMARINE	-		-			
HELICOPTER	-		-			

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	100	-	-	-	-

*See Pump, Fuel, General

PART CATEGORY: PUMP

DESCRIPTION: FUEL TRANSFER, HYDRAULIC DRIVEN

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	*	*	<124	286	-	-
<u>OPERATING</u>						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	231	1.228	188000	205000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	1500	-	-	-	-

*See Pump, Fuel, General

PART CATEGORY: PUMP, HYDRAULIC

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	3	31.48	95.3	212	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	5	2.985	1680	3130		
GROUND, MOBILE	1442	21.514	67000	69300		
AIRBORNE	8034	17.526	458000	465000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	208	.569	366000	400000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	18	700	4800	-	-	-	3800

PART CATEGORY: PUMP, HYDRAULIC

DESCRIPTION: MANUAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	95.3	212	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1	.435	2300.	8940		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	24	-	-	-	-

*See Pump, Hydraulic, General

PART CATEGORY: PUMP, HYDRAULIC

DESCRIPTION: VARIABLE DELIVERY

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS: BEST ESTIMATE	FAILURE RATE IN FITS: 90% CONFIDENCE	FAILURE RATE IN FITS: RANGE LOW	FAILURE RATE IN FITS: RANGE HIGH
NON-OPERATING						
GROUND, FIXED	*	*	95.3	212	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	12	.683	17600.	26100		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	70	.421	166000	195000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	180	-	-	-	1700

PART CATEGORY: PUMP

DESCRIPTION: IMPELLER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	406	423	200	1500
OPERATING						
SATELLITE	-	-	-	-		
GROUND	0	.526	<1900	4390		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	5	-	-	-	-	-	-

*See Pump, General

PART CATEGORY: PUMP

DESCRIPTION: OIL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	406	423	200	1500
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	33	.555	59500	75100		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	150	-	-	-	-

*See Pump, General

PART CATEGORY: REGULATOR

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	5.777	173	674	-	1330
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	365	3.382	108000	115000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	620	-	-	-	-

PART CATEGORY: REGULATOR

DESCRIPTION: BELL MOUTH CONTROLLER, JET ENGINE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	173	674	-	1330
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	106	1.109	95600	109000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	550	-	-	-	-

* See Regulator, General

PART CATEGORY: REGULATOR

DESCRIPTION: FLUID TENSION

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE LOW	RANGE HIGH
NON-OPERATING						
GROUND, FIXED	*	*	173	574	-	1330
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	28	5.363	5220	6710		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	30	-	-	-	-

*See Regulator, General

PART CATEGORY: REGULATOR

DESCRIPTION: FUEL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	*	*	173	674	-	1330
<u>OPERATING</u>						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	1031	5.766	179000	186000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	41	.301	136000	168000		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	1000	-	-	-	790

*See Regulator, General

PART CATEGORY: REGULATOR
DESCRIPTION: PRESSURE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	.753	1330	5170	-	-
OPERATING						
SATELLITE	1	.35	2860	11100		
GROUND	3	.28	10700	23800		
GROUND, MOBILE	19	8.449	2250	3070		
AIRBORNE	1631	13.047	125000	129000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	2	8	2	94	-	-	-	-

PART CATEGORY: REGULATORS

DESCRIPTION: TEMPERATURE

ENVIRONMENT	FAILURES.	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	5.024	<199	460	-	-
OPERATING						
SATELLITE	1	.287	3480	13600		
GROUND	49	11.296	4340	5240		
GROUND, MOBILE	27	1.553	17400	22500		
AIRBORNE	3663	24.783	148000	151000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	17	22	87	740	-	-	-	-

PART CATEGORY: VALVES

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	30	2424.3	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-			
GROUND	171	11.5	14900.	16400		
GROUND, MOBILE	1	.846	1180.	4600		
AIRBORNE	14244	218.2	65300.	66000		
MISSILE	30	.22	136000.	174000		
SHIPBOARD	2	.0054	370000.	985000		
SUBMARINE	-	-	-			
HELICOPTER	223	2.257	98800.	108000		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	1200	95	5300	11000	30000	-	8000

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: BALL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	0	4.254	<235.	543.		
GROUND, MOBILE	5	3.469	1440.	2690.		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	19	120	-	-	-	-	-

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: BUTTERFLY

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	1	6.013	166.	647		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	0	.01	<100	231		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	13	-	8	-	-	-	-

*See Valves, General

PART CATEGORY:	VALVES, GENERAL
DESCRIPTION:	CHECK

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	5	1.659	3010.	5630.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	2356	84.24	28000.	28700.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	6	0.597	10000.	177000.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	240	-	2300	-	-	-	810

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: CONTROL

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	3228	30.071	107000.	110000		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	8600	-	-	-	-

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: GLOBE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	0	4.955	<202.	466.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	-	-	-	-		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	16	-	-	-	-	-	-

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: RELIEF

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	17	11.23	1510.	2100.		
GROUND, MOBILE	2	.228	8770.	23300.		
AIRBORNE	897	29.26	30700.	32000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	90	0.607	148000.	170000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	120	710	2500	-	-	-	12000

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: SELECTOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	0	.046	<21700.	50200.		
AIRBORNE	2	.021	95200	253000.		
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	1700	7700	-	-	-	-

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: SEQUENCE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	194.	-	-	-
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: SHUTOFF

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	2	.141	14200.	37700.		
AIRBORNE	4360	46.9	93000.	94800.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	6	.197	30500	53500		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	1100	7500	-	-	-	2500

*See Valves, General

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: SOLENOID

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	7	820.65	8.5	14.4	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	0	.381	<2620.	6060.		
GROUND, MOBILE	1	.059	16900.	66000.		
AIRBORNE	285	2.824	101000.	109000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	40	.321	125000.	153000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	310	2000	12000	-	-	-	15000

PART CATEGORY: VALVES, GENERAL

DESCRIPTION: FREON

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	1380.	-	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	12	.53	22600.	33600		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	16	-	-	-	-

PART CATEGORY: VALVES, FUEL

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	11.853	84.4	328.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	0	.11	<9090	21000.		
GROUND, MOBILE	0	.786	<1270	2940.		
AIRBORNE	142	3.727	38100	42500.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	110	15	450	-	-	-	-

PART CATEGORY: VALVE, FUEL

DESCRIPTION: CHECK

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	4.25	235.	916.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	0	.384	<2600.	6010.		
AIRBORNE	18	6.314	2850.	3920.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	6	.15	40000.	70300.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	11	12	-	-	-	170

PART CATEGORY:	VALVE, FUEL
DESCRIPTION:	DUMP

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	84.4	328.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	4	2.811	1420.	2850.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	17	-	-	-	-

*See Valve, Fuel, General

PART CATEGORY: VALVE, FUEL

DESCRIPTION: FLOAT

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	84.4	328.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	803	11.959	67100.	70300.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	2	.05	40000.	106000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	800	-	-	-	470

*See Valve, Fuel, General

PART CATEGORY: VALVE, FUEL
DESCRIPTION: GATE

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	84.4	328.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	72	1.914	37600.	43900.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	5	.07	71400.	134000.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	440	-	-	-	850

*See Valve, Fuel, General

PART CATEGORY: VALVE, FUEL

DESCRIPTION: PRESSURE REGULATOR

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	2390.	-	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	90	1.384	65000.	74700.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	26	.47	55300.	71900.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	27	-	-	-	23

ENVIRONMENTAL FACTORS

Applicability		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Capacitors, Aluminum Oxide MIL-C-39018 Aluminum Dry Electrolytic MIL-C-62	MIL-STD	0.5	0.5	1.0	6.0	6.0	6.0	10.0	15.0	20.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Capacitors, Variable, Ceramic MIL-C-81	MIL-STD	0.3	-	1.0	2.0	2.0	2.0	6.0	12.5	17.5

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Capacitors, Variable, Piston Type MIL-C-14409	MIL-STD	0.3	0.3	1.0	3.0	3.0	3.0	16.7	26.7	40.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
All Inductive Devices	L-STD	0.5	0.5	1.0	2.5	2.5	1.5	2.5	3.5	5.0
	HI-REL	0.5	0.5	1.0	2.5	2.5	1.5	2.5	3.5	5.0

ENVIRONMENTAL FACTORS

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Lasers	0.2	0.2	1.0	5.	5.	5.	5.	8.	8.

PART CATEGORY: VALVE, FUEL

DESCRIPTION: SHUT-OFF

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	84.4	328.	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	36	2.219	16200.	20200.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	190	-	-	-	-

*See Valve, Fuel, General

PART CATEGORY: VALVE, FUEL

DESCRIPTION: SOLENOID

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	84.4	328	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	54	42.315	1280.	1520		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	197	3.416	57700	63300		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	15	-	680	-	-	-	-

*See Valve, Fuel, General

PART CATEGORY:	VALVE, HYDRAULIC
DESCRIPTION:	GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	4	1419.2	2.82	5.64	1.4	22.9
OPERATING						
SATELLITE	-	-	-	-		
GROUND	9	3.316	2710.	4290.		
GROUND, MOBILE	40	5.432	7360.	9070.		
AIRBORNE	784	22.47	34900.	36500.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	960	2600	12000	-	-	-	-

PART CATEGORY: VALVE, HYDRAULIC
DESCRIPTION: BALL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	374.	-	-	-
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: BLEEDER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	210.43	<4.75	11.0	-	-
OPERATING						
SATELLITE						
GROUND						
GROUND, MOBILE						
AIRBORNE						
MISSILE						
SHIPBOARD						
SUBMARINE						
HELICOPTER						

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0								

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: CHECK

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	3	131.02	22.9	50.9	-	761.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	362	28.66	12600.	13500.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	550	-	-	-	-

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: CONTROL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	150.2	<6.66	15.4	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	296	2.75	108000.	116000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	16000	-	-	-	-

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: PRESSURE REGULATOR

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	2.82	5.64	1.4	22.9
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	104	12.357	8420.	9570.		
AIRBORNE	92	3.24	28400.	32600.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	3000	10000	-	-	-	-

*See Valve, Hydraulic, General

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: RELIEF

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	712.8	1.40	3.24	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	1	1.152	868.	3400.		
AIRBORNE	194	13.172	14700.	16200.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	6	.14	42900.	75300.		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	620	10000	-	-	-	30000

PART CATEGORY:	VALVE, HYDRAULIC
DESCRIPTION:	RESTRICTOR

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	-	-	5.55	-	-	-
OPERATING						
SATELLITE	-	-	-	-	-	
GROUND	-	-	-	-	-	
GROUND, MOBILE	-	-	-	-	-	
AIRBORNE	125	6.452	19400.	21800.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	3500	-	-	-	-

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: SEQUENCER

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	*	*	2.82	5.64	1.4	22.9
<u>OPERATING</u>						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	61	3.082	19800.	23500.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	7000	-	-	-	-

*See Valve, Hydraulic, General

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: SERVO

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	16	109.67	146.	205.	69.	32300.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	0	.014	<71400.	165000.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	485	3.066	158000.	168000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	12	.038	316000.	469000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	490	-	1100	-	-	-	2200

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: SHUTTLE

ENVIRONMENT	FAIL-URES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFI-DENCE	RANGE	
					LOW	HIGH
<u>NON-OPERATING</u>						
GROUND, FIXED	*	*	146.	205.	69.	32300
<u>OPERATING</u>						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	366	5.783	63300.	67700.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS								
NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	430	-	-	-	-

*See Valve, Hydraulic, Servo

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: SHUT-OFF

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	0	214.8	<4.66	10.8	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	18	3.879	4640.	6380.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	3	.01	300000.	667000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	1000	-	-	-	64000

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: SOLENOID

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	7	820.8	8.53	14.4	-	-
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	181	4.069	44500.	49000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	5200	-	-	-	-

PART CATEGORY: VALVE, HYDRAULIC

DESCRIPTION: SPOOL, 4-WAY

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	2.82	5.64	1.4	22.9
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	146	.838	174000.	194000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	-	62000	-	-	-	-

*See Valve, Hydraulic, General

PART CATEGORY: VALVE, OIL

DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	12.4	15.8	-	32.3
OPERATING						
SATELLITE	-	-	-	-		
GROUND	12	2.844	4220.	6270.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	76	2.067	36800.	42800.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	340	-	3000	-	-	-	-

*See Valve, General

PART CATEGORY: VALVE, PNEUMATIC
DESCRIPTION: GENERAL

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	1	4.67	214.	833.	-	1810.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	21	3.164	6640.	8900.		
GROUND, MOBILE	-	-	-	-		
AIRBORNE	4661	75.97	61400.	62500.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	-	-	-	-		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	31	-	290	-	-	-	-

PART CATEGORY: VALVE, PNEUMATIC

DESCRIPTION: BLEED

ENVIRONMENT	FAILURES	PART HOURS (10^6)	FAILURE RATE IN FITS			
			BEST ESTIMATE	90% CONFIDENCE	RANGE	
					LOW	HIGH
NON-OPERATING						
GROUND, FIXED	*	*	214.	833.	-	1810.
OPERATING						
SATELLITE	-	-	-	-		
GROUND	-	-	-	-		
GROUND, MOBILE	0	.543	<1840.	4250.		
AIRBORNE	1043	4.782	218000.	227000.		
MISSILE	-	-	-	-		
SHIPBOARD	-	-	-	-		
SUBMARINE	-	-	-	-		
HELICOPTER	10	.047	213000.	328000.		

ENVIRONMENTAL FACTORS

NON-OPERATING	OPERATING							
G_F	S_A	G	G_M	A	M	S_H	S_U	H
1.0	-	-	9	1000	-	-	-	1000

*See Valve, Pneumatic, General

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SIXTH QUARTERLY PROGRESS REPORT

FOR

MANUFACTURING METHODS AND TECHNOLOGY (MM&T) MEASURE FOR FABRICATION OF LOW VOLTAGE START SEALED BEAM ARC LAMPS

1 Oct. 1977 to 31 Dec. 1977

CONTRACT NO. DAAB07-76-C-0034

U.S. Army Electronics Command
Production Division
Production Integration Branch
Ft. Monmouth, NJ 07703

Varian Associates
EIMAC Division
301 Industrial Way
San Carlos, CA 94070

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9

[redacted] Quarterly Progress Report. no. 6,
1 Oct[redacted]-31 Dec[redacted]77,

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A program is in progress to establish a production capability for the purpose of meeting estimated military needs for the X6335, a 1kW sealed beam xenon arc lamp with low voltage starting mechanism.

In accordance with the requirements of the contract, the third engineering sample is still undergoing fabrication to meet specification.

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Block 20 Continued

Improvements were made to reduce manufacturing costs and improve reliability. These included:

a. Molybdenum insert was added to improve heat transfer from anode to heatsink.

b. Anode base changed from steel to copper.

c. Stinger bearings changed to sapphire to reduce friction.

d. New mandrel machined and precision polished.

e. Test bench set-up to evaluate individual reflectors for focal point location and relative output readings.

f. Lamp with demountable electrodes designed to study electrode optimization.

g. Stinger mechanism cycle tested and evaluated.

MANUFACTURING METHODS AND TECHNOLOGY (MM&T) MEASURE FOR FABRICATION OF LOW VOLTAGE START SEALED BEAM ARC LAMPS

SIXTH QUARTERLY PROGRESS REPORT

1 Oct. 1977 to 31 Dec. 1977

"The objective of this manufacturing methods and technology project is to establish the technology and capability to fabricate Low voltage Start Sealed Beam Arc Lamps".

CONTRACT NO. DAAB07-76-C-0034

By

Roy Roberts
Tim Bell

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A

ABSTRACT

A program is in progress to establish a production capability for the purpose of meeting estimated military needs for the X6335, a 1kW sealed beam xenon arc lamp with a low voltage starting mechanism.

In accordance with the requirements of the contract, the third engineering sample is still undergoing fabrication to meet specifications.

Table of Contents

LIST OF FIGURES

1.0 PURPOSE

The objective of this program is to establish a production capability for the purpose of meeting estimated military needs for a period of two (2) years after completion of the contract, and to establish plans which may be used to meet expanded requirements.

The program is intended to demonstrate and to "prove-out" the manufacturing processes, methods and techniques that are utilized in the production of 1kW sealed beam xenon arc lamps with a low voltage starting mechanism.

The lamp initially chosen for the program was the X6257. This lamp was developed for military searchlight applications. The high voltage version of this lamp was developed initially under Contract Number DAA02-68-C-0215. The 1kW lamp was further refined on a PEM Contract Number DAAB05-71-C-2609. The low voltage starting X6257 was not developed with government funds, but was developed with Varian funds.

This contract is divided into three phases:

1. Engineering Samples, wherein modifications are being made to designs arrived at under previous development in order to improve their optical performance, safety and utility in the field and to reduce their cost. Production drawings, procedures, and tooling will also be developed. These parameters will be based on delivery of three (3) samples.
2. Confirmatory Samples, wherein the delivery of three

(3) units will be made to demonstrate that lamps can be made with production techniques and procedures to meet the specification.

3. Pilot run, wherein the delivery of thirty (30) units will be made to demonstrate the capability of meeting the planned production rate.

The engineering sample phase is needed to incorporate features which will make the lamp start more reliably, be easier to fabricate, be safer to operate, have a highly accurate mounting surface for optical reference and afford cost reduction.

During this quarter the 3rd Engineering sample underwent improvements to aid heat transfer at the anode base. Reflector location to the cathode tip on various lamp samples was evaluated to optimize candlepower readings.

2.0 GLOSSARY

LVS	Low voltage starting.
Stinger	Moveable electrode used for lamp ignition.
Mandrel	A stainless steel tool which is polished to a mirrored surface with a special elliptical contour upon which the reflector is electroformed.
EI (characteristic)	The voltage (E) across the lamp for a given current (I) passing through the lamp.
PBC	Peak beam candlepower
EMI	Electromagnetic interference

3.0 NARRATIVE AND DATA

The lamp is comprised of conventional tungsten electrodes positioned in a ceramic/metal structure with a reflector and sapphire window. The arc is located at the focal point of the reflector so that a directed beam is obtained coaxial with the electrodes. The low voltage starting mechanism includes a moveable electrode called the "stinger" which is coaxial with the anode.

The lamp is filled with up to 20 atmospheres of high purity xenon at room temperature. The lamp's spectral output is a typical high pressure xenon arc spectrum as reflected from a silver mirror and transmitted through a sapphire window. The wavelength range is about 130nm to 6500nm. The silver reflector coating was selected for maximum output in the visible and near IR bands.

The lamp operating voltage is 19.5 D.C. ±.5v. The lamp voltage is determined primarily by the interelectrode gap and the lamp pressure. The lamp acts much like a constant voltage device, that is, large changes in current result in small changes in operating voltage. Ignition is accomplished by use of the stinger. To commence the start cycle, the solenoid voltage is applied causing the stinger to move forward. The moment the stinger contacts the cathode tip, the electrical circuit is completed and current begins to flow through the choke. After approximately .5 seconds, the solenoid voltage is removed and the stinger starts to return to its deenergized position, thus breaking the circuit.

At this time, the stored energy in the choke is dumped into the arc. The stinger then draws this arc back and transfers the arc to the anode.

To further MM&T progress the following items were investigated during this report period.

a. Anode heat transfer.
b. Anode stress at braze.
c. Stinger bearings.
d. Stinger life.
e. Lamp body integrity.
f. EI characteristics, stability, EMI.
g. Lamp output (PBC)
h. Cathode placement verses arc crossover points.
i. Reflector mandrel contour.
j. De-mountable electrode lamp.
k. Stinger reliability relative to friction in bearings.
l. Stinger vibration test.

3.1 DESIGN AND ANALYSIS

The following paragraphs describe work done during this report period.

1. Signs of melting were noted in the anode tip after operating the stinger mechanism over 1000 on-off cycles. A molybdenum insert was incorporated to improve heat transfer and thereby reduce anode tip temperature. This insert has been used effectively in the previous low voltage searchlight lamps. The molybdenum insert will also lower the stress at this joint interface.
2. The anode base material was changed from carbon steel to copper in conjunction with the molybdenum insert to improve heat transfer.
3. The anode cooling fins were brazed on the copper heatsink to improve heat transfer from the anode.
4. Stinger bearings were changed from molybdenum and ceramic to sapphire bearings. This improvement offers a lower part cost and lower coefficient of friction against the tungsten stinger shaft. Also stinger parts were silver coated to reduce friction between moving parts and improve electrical conductivity.
5. Functional test of stinger assembly to 6000 cycles, (30 sec. on and 30 sec. off) completed to date.
6. Lamp number 31 of the 3rd engineering sample phase was pressure checked to 1400 psi without rupturing.
7. New elliptical reflector mandrel was machined and controlled polished.

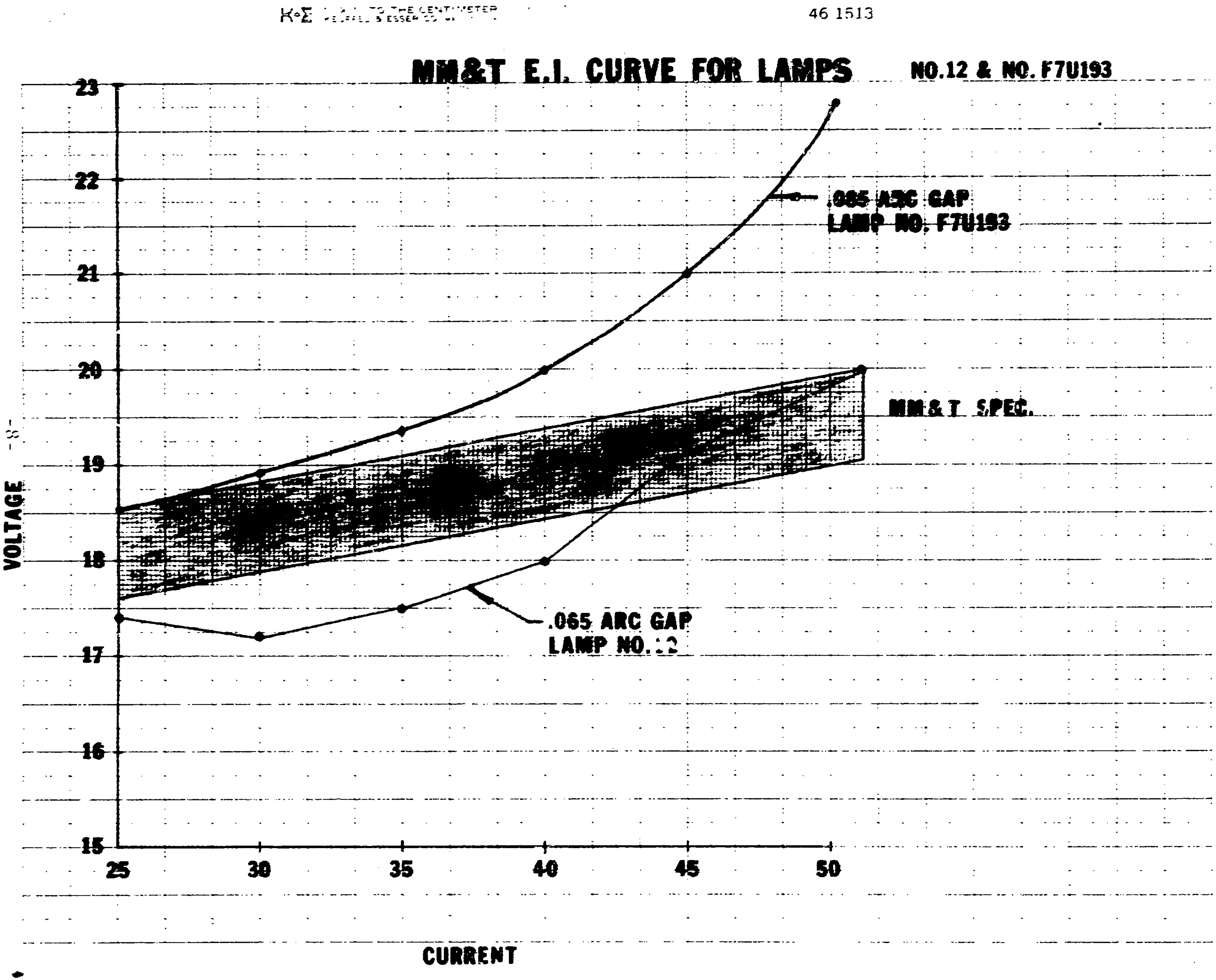
8. Voltage and current (EI) data was established on engineering samples No. 12 and F7V193. The following data (Figure 1) was generated to reflect EI characteristics for the two lamps. The steep shift in the EI occurred beyond 40 amps for engineering sample No. 12 and is attributed to anode braze deterioration which resulted in over-heating the anode.

   Figure 1 also shows a comparison between an .085 inch gap and a .065 inch gap, for the two engineering samples. The decrease in gap spacing for lamp No. 12 had shifted the EI curve closer to MM&T specifications as shown on the attached graph.

9. Peak Beam Candlepower for lamps 11 through 13 were recorded at 20 million candela instead of the 25 million candela specified in the MM&T specifications. The following areas were investigated to remedy the problem.
   - a. Cathode placement.
   - b. Reflector contour
   - c. Surface reflectances.
   - d. Cathode size and shape.
   - e. Reflector thickness.

10. Flanged elliptical reflectors were optically evaluated for beam crossover points as a possible cause for low peak beam candlepower of 20 M candelas. The theoretical beam crossover point is 2.600 inches from the reflector locating flange. The empircally recorded dimension was 3.6000 inches which severely limited the light beam filling the 5 inch diameter F/1.3 projection optics and thereby reduces PBC output.

11. The reflector mandrel contour was proven inaccurate which accounts for the low PBC output. A new mandrel was machined in efforts to solve the low PBC output problems.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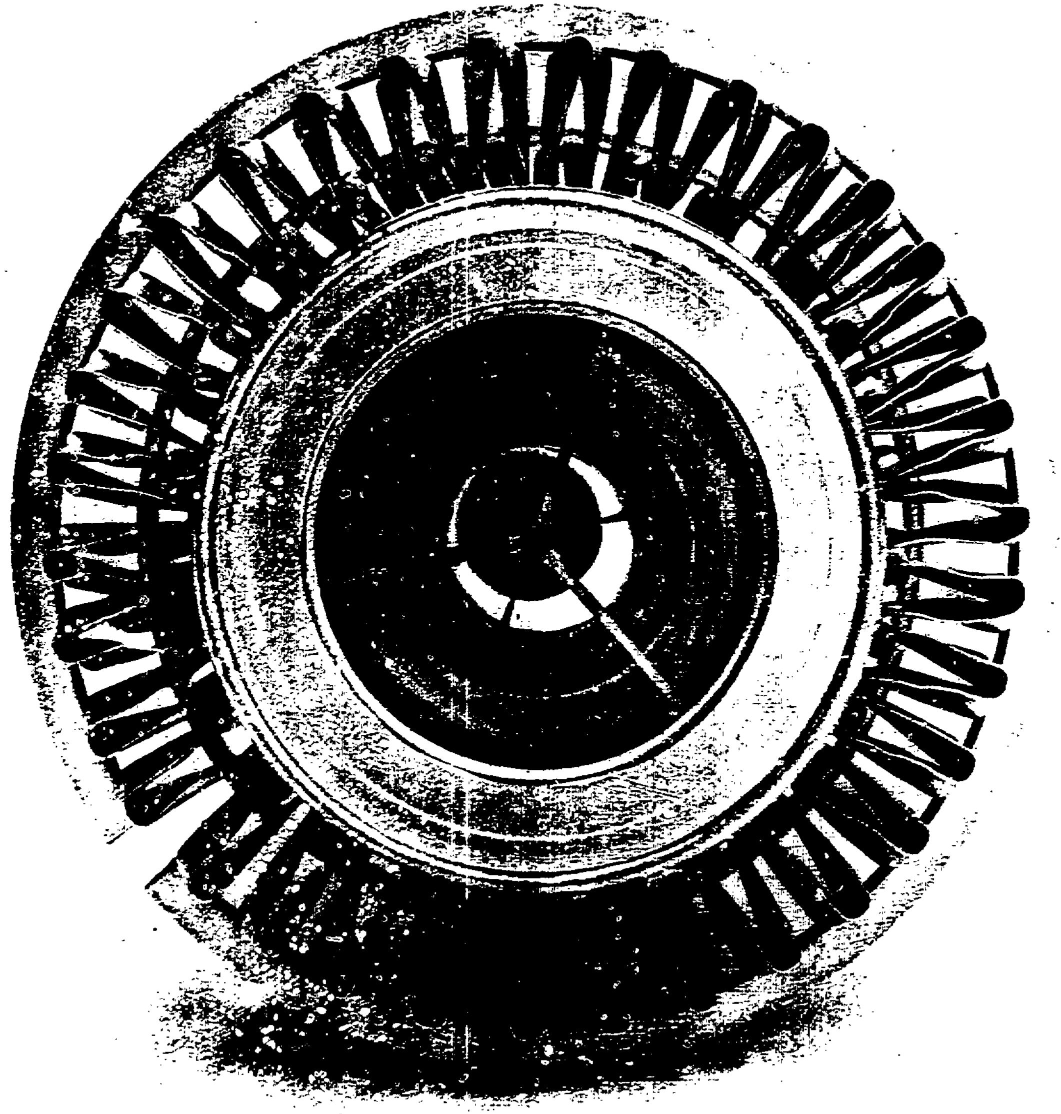
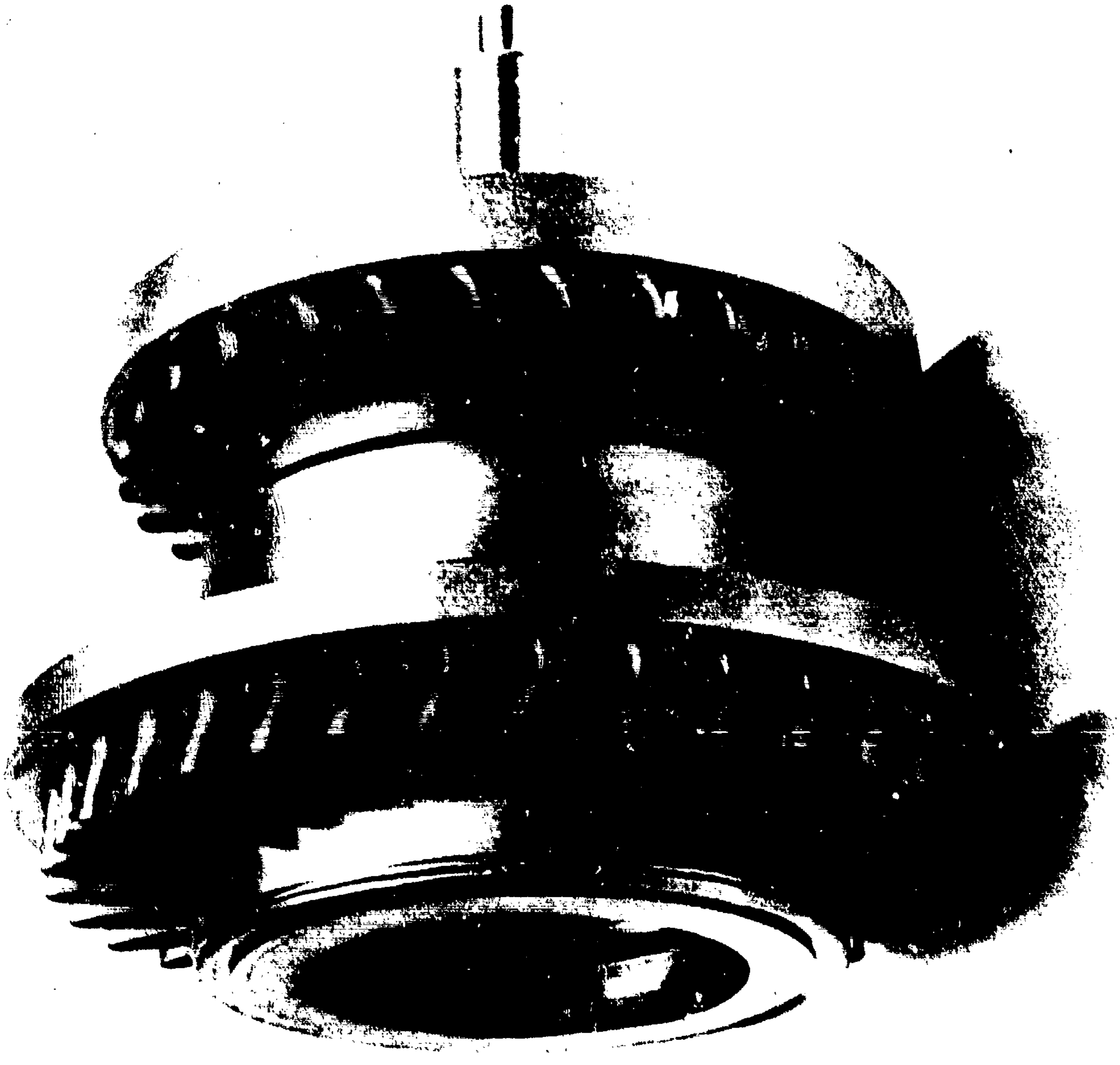
NO.12 & NO. F7U193
.065 ARC GAP
LAMP NO. F7U193
MM&T SPEC.
.065 ARC GAP
LAMP NO.12
VOLTAGE
CURRENT
23
22
21
20
19
18
17
16
15
25
30
35
40
45
50

Figure 1



MM&T Lamp Front View

Figure 2



M&T Lamp Side View

Figure 3

MM&T Lamp Rear View

Figure 4

3.2 FABRICATION AND TOOLING

Lamp body parts are being successfully brazed in sub-assemblies with pilot run tooling. Among the progress included is:

1. The molybdenum insert was successfully brazed into the copper heatsink to improve heat transfer from the tungsten anode.
2. New tooling was designed and built to accurately locate the stinger bearing centerlines. This tooling also has provisions to hold concentricity between the main body cup and the anode.
3. Machined parts for the improved stinger mechanism are completed and brazed.
4. The window assemblies were successfully brazed. The window metalizing was revised from copper plating to nickel in order to improve the joint strength.
5. Brazed sub-assemblies were made for the main body and anode cup seal rings.
6. A new flanged reflector mandrel was machined and precision polished to improve PBC output.
7. A lamp with demountable electrodes was designed and is now undergoing brazing operations. This project is totally funded by EIMAC but will be extremely valuable in electrode evaluation of this lamp as well as others.
8. Lamp sub-assemblies and additional tooling for the confirmatory run are being fabricated.
9. Braze washers for the window assembly and main body metal to ceramic seal are completed.
10. Additional sets of tooling are scheduled for manufacture after the initial tooling proves its reliability and effectiveness.

3.3 TESTING

3.3.1 Stinger Mechanism

a. A test was conducted to cycle the stinger mechanism with the lamp operating 50 sec. on and 10 sec. off The anode showed signs of melting at the tip which ended the test at approximately 1000 cycles.

b. Another test was set up to life cycle the stinger mechanism in a fully functional lamp to determine:

   1. Friction buildup as a function of time as determined by voltage increases in stinger solenoid.
   2. The effect of silver versus copper plated stinger parts. The test was conducted to 6000 cycles of 30 second intervals at 1kw of lamp power without any evidence of stinger mechanism failure.

c. Stinger vibration tests were performed to determine the resonant frequency and stinger rod amplitudes for various stinger armature and spring mechanisms. The vibration loadings were performed coincident to the lamps centerline. At a 20g's vibration loading and a cyclic frequency sweep from 20 to 80 cycles per second no significant stinger movement was noted.

3.3.2 Reflectors

A test has been established to optically verify the accuracy of the elliptical reflectors before installation in a lamp. In addition, this test determines the ideal cathode tip placement relative to the focal point for each reflector. Thus the reflector focal point location is dimensionally established for each reflector permitting the reflector location and cathode strut position to be optimally established during assembly.

3.3.3 Pressure Test

a. The lamp was subjected to a pressure test to evaluate the lamps pressure capability. The lamp body was subjected to 1400 psi of fill pressure without destruction.

3.4 CONCLUSION

Results of work accomplished during this report period indicate that major progress was made in solving problems associated with the following:

a. Heat transfer from anode.
b. Stinger mechanism reliability
c. Reflector to cathode tip location
d. Lamp body integrity

Completed lamp assemblies are reliably being brazed up to increase the number of sub-assemblies awaiting final lamp assemblies.

4.0 PROGRAM FOR NEXT INTERVAL

1. Finalize all detail drawings and assembly drawings for the MM&T lamp.
2. Investigate with an EIMAC funded de-mountable electrode lamp, the cathode and anode placement as a function of candlepower.
3. Continue to test lamps for reliability.
4. Incorporate improvements as required to optimize peak beam candlepower.

5.0 PUBLICATIONS AND REPORTS

None.

6.0 IDENTIFICATION OF PERSONNEL

The following is a list of key personnel who worked on this contract during the period October 1977 through December 1977.

Roy Roberts	199.0 Hours	
Gordon Liljegren	24.0 Hours	
Nick Picoulin	43.2 Hours	
Welton Jones	345.5 Hours	
Nick Cortese	71.2 Hours	
Alice Estrada	35.6 Hours	
Lavaughn Overton	6.0 Hours	
Vic Kristen	2.0 Hours	
Cheryl Handley	10.0 Hours	(Draftperson)
Greg Guild	211.7 Hours	"
Bob Fehringer	36.0 Hours	"
Glenn Brown	8.0 Hours	"
George Calkins	9.0 Hours	"
Paul Wierenga	16.0 Hours	"

The resume for Mr. Martin Wolfe and Ms. Alice Estrada are included in this report. Mr. Wolfe is a master technician with EIMAC and will be allocating appropriate time to the MM&T project. Ms. Estrada is a tube technician allocating appropriate time to the fabricating of braze assemblies of the MM&T project.

MARTIN E. WOLFE

Mr. Wolfe has been employed by EIMAC for thirty four years and is familiar with all areas of technology relating to lamp development. Mr. Wolfe's current responsibilities include brazing assemblies and design of brazing fixtures, and in the manufacture of xenon lamps.

Mr. Wolfe's recent experience includes new product development in the areas of cathodes, lasers, and traveling wave tubes. In addition, he assisted in developing ceramic metalizing techniques and the design and fabrication of ceramic to metal seals. This experience will be invaluable to further efforts on the MM&T lamp program.

Mr. Wolfe has also worked at a supervisory capacity in developing manufacturing methods and techniques for production workers in the vacuum industry.

ALICE R. ESTRADA

Ms. Estrada joined EIMAC in 1946 as a recent graduate of the College of San Mateo. Ms. Estrada started working in the testing department of the Vacuum Tube Division and moved progressively through the departments of the division and achieved supervisory status. This experience provided a professional background in the operation of the various types of machinery and techniques employed in the tube division.

Ms. Estrada then was assigned to the Advanced Products Model Shop as a technician, which furthered her knowledge in the areas of research and development. The techniques employed were quartz to metal seals, thin film deposition, vacuum system brazing and ionic evaporation sputtering. The major commodity areas were xenon arc lamps in pre-production development, Apollo Space Lights, Tow Lamp program, and presently on the one kilowatt low-voltage lamp. Ms. Estrada is presently making final assemblies for the xenon arc lamps initial stage to completion.

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TABLE 4-3. DEVICE FAILURE RATES FOR DEVICE USAGE (CONTINUED)

DEVICE TYPE	USAGE	TOTAL FAILURE RATE IN FITS PER DEVICE QUANTITY			
		λ_{NO}	λ_O	λ_L	λ_F
Inductive Devices***					
Coils	50	55.5	550.	3000.	1500.
Transformers	10	9.1	33.	180.	90.
Filters	200	110.	2200.	11000.	5600.
Crystal	3	117.9	600.	133332.	1332.
Electromechanical					
Accelerometer	3	89.1	157569.	120000.	709755.
Rate Gyro	5	665.	130025.	2708335.	1858860.
Switch					
Push	1	26.	271.	86400.	27870.
Thermal	2	34.2	5022.	172800.	13070.
Hydraulic					
Accumulator	1	32.5	55800.	1500.	118000.
Valve					
Relief	1	1.4	2710.	15400.	14700.
Solenoid	6	51.2	16260.	562980.	267000.
Pump, Fixed Displ.	1	380.	4220.	4180000.	109000.
Filter	1	1.4	2990.	15620.	26200.
Servoactuator	4	796.	504000.	8756000.	520000.
Ordnance					
Gas Generator	1	---- ONE SHOT DEVICE -- SEE RELIABILITY --- MODEL			
S&A Device (Redundant)	2				
Solid Rocket Motor	1				

TABLE 4-4.
SYSTEM FAILURE RATES

PART TYPE	FAILURE RATE IN FITS			
	λ_{NO}	λ_O	λ_L	λ_F
Electrical & Electronic				
Active	3609.1	65772.	736320.	330418.
Passive	688.0	66477.	921092.	120388.
TOTAL E&E	4297.1	132249.	1657412.	450906.
Electromechanical	814.3	292887.	3087535.	2609555.
Hydraulic	1262.5	585980.	13531500.	105490 .
Ordnance -------	ONE SHOT	DEVICE	---See Reliab.	Model.
TOTAL MISSILE LESS ORDNANCE	6373.9	1011116.	18276447.	4115361.

FIGURE 4-2. RELIABILITY CALCULATION

R_{NO}(5years) = $e^{-\lambda_{NO}(43800 \text{ hours})}$; R_O(5 sec.) = $e^{-\lambda_O(.001388 \text{ hours})}$

R_L(30 sec.) = $e^{-\lambda_L(.008333 \text{ hours})}$; R_F(30 sec.) = $e^{-\lambda_F(.008333 \text{ hours})}$

	R_{NO}	R_O	R_L	R_F	R_T
SERIAL ELECTRICAL & ELECTRONIC	.828438	.999999	.999986	.999996	.82842
SERIAL ELECTROMECHANICAL	.964962	.999999	.999974	.999978	.96492
SERIAL HYDRAULIC	.946204	.999999	.999887	.999991	.94609

SERIAL ORDNANCE R(5 years) = .98919 (Rocket motor) x .98521 (Gas Generator) = .97456 = R_T

REDUNDANT SAFE & ARM

$$R(5 \text{ years}) = R_1(S\&A)R_2(S\&A) + R_1(S\&A)[1-R_2(S\&A)] + R_2(S\&A)[1-R_1(S\&A)]$$

$$= (.95836)(.95836) + (.95836)(.04164) + (.95836)(.04164)$$

$$= .99827 = R_T$$

Total missile 5 year reliability is

$$R_{LC} = (.82842)(.96492)(.94609)(.97456)(.99827) = .735751$$

It is instructive to consider the relation between the non-operational and operational reliabilities. Not counting one shot devices the non-operational reliability of the missile after 5 years of storage is .75641. The operational reliability is .99981. The ratio of the unreliability (1 minus reliability) during storage to that during operation is 1282. The unreliability during storage is 1282 times the unreliability during operation. This, of course, is due to the fact that the missile will spend the overwhelming majority of its life in a non-operating condition. Similarly this points out the importance of a design to be tolerable to these conditions.

For general part types the ratio of non-operating to operating failure rates is shown in Table 4-5.

TABLE 4-5.

NON-OPERATING TO OPERATING FAILURE RATES

PART TYPE	λ_{NO} IN FITS	λ_O/λ_{NO}	λ_L/λ_{NO}	λ_F/λ_{NO}
Electrical & Electronic				
Active	3609.1	18.	204.	92.
Passive	688.0	97.	1339.	175.
TOTAL E & E	4297.1	31.	386.	105.
Electromechanical	814.3	360.	3792.	3205.
Hydraulic	1262.5	464.	10718.	836.
TOTAL MISSILES LESS ORDNANCE	6373.9	159.	2867.	646.

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APPENDIX A

HYBRID MICROELECTRONIC RELIABILITY

A.1 Non-Operating Reliability

The range of types and complexities of hybrid circuits precludes the use of a single failure rate for all devices.

The non-operating data collected for hybrid devices is shown in Table A-1 and gives an overall non-operating failure rate of 35.1 failures per billion hours.

Source A data was extracted from a major dormancy study.

Source G data represents a special laboratory test.

Source H data represents low complexity digital devices in a laboratory storage environment.

Source J data represents circuits used in warheads under field storage conditions.

Missile H data represents linear thick film devices which exhibited aluminum/gold interface problems at the wire bonds during missile storage.

Missile I data represents digital and linear devices in a depot storage environment. These are probably the more complex devices in the data.

All data represents approximate Class B quality levels.

TABLE A-1. HYBRID IC NON-OPERATING DATA

SOURCE	AMB. TEMP.	TECHNOLOGY	NO. DEVICES	STORAGE HRS. (millions)	NO. FAILURES	FAILURE RATE IN FITS
Source A	25°C	Thin Film	-	43.246	1	23.1
Source G	125°C	Thin Film	104	.09	2	20408.
	150°C	Thin Film	191	.191	3	15707.
	25°C	Thick Film	-	3.964	0	(<252.3)
	150°C	Thick Film	156	.261	2	7663.
	200°C	Thick Film	11	.011	0	(<90090.)
Source H	25°C	Thick Film	5834	38.0	0	(<26.3)
	25°C	Thick Film	36	.3	0	(<3333.3)
	25°C	Thick Film	5215	50.0	4	80.0
Source J	25°C	Thick Film	-	146.0	1	6.85
Missile H	25°C	Thick Film	62118	986.9	32	32.4
Missile I	25°C	Thick Film	2070	20.6	0	(<48.5)
	25°C	Thick Film	8280	82.4	0	(<12.1)
	25°C	Thick Film	8280	82.4	0	(<12.1)
	25°C	Thick Film	16560	164.7	13	78.9
	25°C	Thick Film	4140	41.2	9	21.8
	25°C	Thick Film	2070	20.6	0	(<48.5)
	25°C	Thick Film	2070	20.6	0	(<48.5)
	25°C	Thick Film	2070	20.6	0	(<48.5)
	25°C	Thick Film	2070	20.6	1	48.5

A.2 Hybrid Integrated Circuits Operational Prediccion Model

The MIL-HDBK-217B failure rate model for hybrid microelectronic devices is:

$$\lambda_p = \lambda_b (\Pi_T \times \Pi_E \times \Pi_Q \times \Pi_F) \times 10^{-6}$$

where:

λ_b = base failure rate
Π_T = temperature factor
Π_E = environmental factor
Π_Q = quality factor
Π_F = circuit function factor

From the I.C. chip standpoint, the hybrid model is structured to accommodate all of the monolithic chip types and the various complexity levels.

Figure A-1 gives the hybrid model and values for each parameter. The base failure rate must be calculated and a description of this calculation is given below.

A.2.1 Base Failure Rate, λ_b

The base failure rate equation is:

$$\lambda_b = \lambda_S + A_s\lambda_c + \Sigma\lambda_{RT}N_{RT} \text{ (substrate contribution)}$$

$$+ \Sigma\lambda_{DC}N_{DC} \text{ (contribution of attached components)}$$

$$+ \lambda_{PF}\Pi_{PF} \text{ (package contribution)}$$

A. Substrate Contribution

$\underline{\lambda_S}$ is the failure rate due to the substrate and film processing. It has a value of either 0.02 or 0.04 and is independent of the number of substrates. The value 0.02 applies if only thick film or only thin film substrates are used. The value 0.04 applies if both types are used.

$\underline{A_S \lambda_C}$ is the failure rate contribution due to network complexity and substrate area. The values of λ_C (complexity term) are a function of the element density, N_E/A_S. A_S is the substrate area in square inches.

To compute complexity, A_S is obtained by summing the areas of all thick film substrates resulting in a single equivalent thick film substrate. An equivalent thin film substrate is determined similarly. However, when substrates are stacked, only the area of the bottom substrate shall be used to compute A_S. If a substrate contains only one device, it shall be considered a chip and shall not be considered a substrate for purposes of failure rate prediction.

N_E is the total complexity expressed as

$$N_E = N_{LT} + N_{RT} + N_{DC}$$

where:

N_{LT} = number of internal lead terminations. Normally, this would be 2 times the number of leads, but for beam leads and flip chips, this would be one for each connection. This includes the leads from substrate to external leads.

N_{RT} = number of film resistors

N_{DC} = number of discrete chip devices (each chip counts as one device)

As a convenience in estimating the number of terminations from the schematic, the following approximations may be used (it is always more desirable to count the actual lead terminations than to use the approximation):

N_{LT} = No. of transistors	x 4
+ No. of diodes	x 2
+ No. of capacitors	x 4
+ No. of chip resistors	x 4
+ No. of conventionally packaged integrated circuit leads	x 2
+ No. of integrated circuit chip bond pads	x 2
+ No. of external hybrid package leads	x 2

For the single equivalent thick film substrate, the value for N_E is determined from the above rules. Then N_E/A_S is computed using the A_S obtained in accordance with the above rules. The value of failure rate per square inch, λ_C, is obtained from the following equations.

For thin film :

$$\lambda_{C1} = 4.7(10)^{-8}\left(\frac{N_E}{A_S}\right)^{2.082} \quad \text{for } 120 \leq \frac{N_E}{A_S} \leq 10{,}000$$

$$= .001 \quad \text{for } 10 \leq \frac{N_E}{A_S} \leq 120$$

For thick film:

$$\lambda_{C2} = 2.4(10)^{-14}\left(\frac{N_E}{A_S}\right)^{4.429} \quad \text{for } 250 \leq \frac{N_E}{A_S} \leq 2{,}000$$

$$= .001 \quad \text{for } 10 \leq \frac{N_E}{A_S} \leq 250$$

The final value of $A_S\lambda_C$ requires the use of the same A_S used to determine N_E/A_S.

This procedure is then repeated for the thin film equivalent substrate. It should be noted that when N_E is computed for stacked substrates, the elements of the upper substrates are included with the bottom substrate, even though the upper substrate uses a different resistor technology than the bottom substrate (thin film or thick film or vice versa).

$\underline{\Sigma N_{RT}\lambda_{RT}}$ is the sum of the failure rates for each resistor as a function of the required resistance tolerance.

N_{RT} is the number of film resistors of a given tolerance.

λ_{RT} is the failure rate to be used for each resistor of a given tolerance as specified in Figure A-1.

B. Attached Components Contribution.

$\Sigma \lambda_{DC} N_{DC}$ is the sum of the attached device failure rates for semiconductors, integrated circuits, capacitors and resistors, both packaged and unpackaged. The failure rate is computed by multiplying the λ_{DC} by N_{DC}, the quantity of each type. The λ_{DC} is the same for a packaged or unpackaged device. The λ_{DC} values are in Figure A-1.

C. Package Contribution.

$\lambda_{PF} \Pi_{PF}$ is the hybrid package failure rate which is a function of the package style or configuration and the materials used in its construction.

λ_{PF} is 0.01 failure/10^6 hr. This is a normalized value of base failure rate for all hybrid packages.

Π_{PF} is an adjustment factor which modifies λ_{PF} as a function of the package style and materials. Its values are in Figure A-1.

A.2.2 Π Adjustment Factors

A.2.2.1 Temperature Adjustment Factor, Π_T

Π_T adjusts the model for temperature acceleration factors. The values in Figure A-1 are derived from

$$\Pi_T = e^x$$

where $x = -3411 \left(\frac{1}{T + 273} - \frac{1}{298} \right)$ for Π_{T1} if the temperature (°C) of the package mounting base is known, and

$x = -3794 \left(\frac{1}{T + 273} - \frac{1}{318} \right)$ for Π_{T2} if the highest temperature (°C) within the hybrid package is known.

Π_T values are invalid at package mounting base temperatures above 125°C or for hot spot temperatures above 175°C.

A.2.2.2 Environmental Adjustment Factor, Π_E

Π_E accounts for the influence of environmental factors other than temperature. Refer to the environment description in the appendix.

A.2.2.3 Quality Factor, Π_Q

Π_Q accounts for effects of different quality levels. Classes A, B and C devices are those which have been subjected to, and passed all requirements, tests, and inspections specified in Methods 5004 and 5006 of MIL-STD-883, including screening, qualification, and quality conformance inspection requirements for the specified class.

A.2.2.4 Circuit Function Adjustment Factor, Π_F

Π_F adjusts the model for circuit function, (i.e., digital or linear).

FIGURE A-1. MIL-HDBK-..7B OPERATIONAL FAILURE RATE MODEL FOR HYBRID MICROELECTRONIC DEVICES

$$\lambda_p = \lambda_b (\Pi_T \times \Pi_E \times \Pi_Q \times \Pi_F) \times 10^{-6}$$

$$\lambda_b = \lambda_S + A_S \lambda_C + \sum \lambda_{RT} N_{RT} + \sum \lambda_{DC} N_{DC} + \lambda_{PF} \Pi_{PF}$$

λ_S(Substrate Failure Rate)

λ_S = .02 if only thick film or only thin film

λ_S = .04 if both thick film and thin film

A_S(Substrate Failure Rate Modifier)

A_S = Substrate Area in Square Inches.

λ_C(Complexity Term)

See next Page

λ_{RT}(Resistor Tolerance Factor)

Resistor Tolerance (±Percent)	Thin Film Resistors	Thick Film Resistors
0.1 to 1.0	0.00050	-
1.0 to 5.0	0.00025	0.00050
5.0	0.00010	0.00012

N_{RT} = # of Resistors of a Given Tolerance

λ_{DC}(Attached Devices Term)

See next page

N_{DC} = # of attached devices of a given type.

λ_{PF}(Package Failure Rate)

0.01

Π_{PF}(Package Factor)

Package Description	Π_{PF}
Package Type (≤2.25" outer seal perimeter or <0.625" diameter)	
Flat Pack (welded lid, up to 16 leads)	1.0
Flat Pack (soldered lid, up to 16 leads)	1.5
Dual-In-Line (<16 leads)	2.0
Top Hat Type (I.e. TO-3, TO-5)	
Single Substrate	1.5
Multiple Substrate	3.0
Package Type (>2.25" outer seal perimeter or >0.625" diameter)	
Flat Pack (welded lid)	2.0
Butterfly (welded lid)	2.0
Butterfly (soldered lid)	2.5
Flat Pack (soldered lid)	2.5
Dihedral (soldered lid)	3.0
Platform (soldered lid)	4.0
Modular Packages	4.0
Multilayer Ceramic Substrates	4.0
Vertical Sidewall (cold welded lid)	5.0

Note: Forrall packages with >16 leads, add 0.15 to Π_{PF} for each 4 leads >16.

Π_T(Temperature Factor)

T(°C)	Π_{T1}	Π_{T2}	T(°C)	Π_{T1}	Π_{T2}
25	1.0	.45	105	11	6.66
30	1.2	.55	110	13	7.6
35	1.5	.68	115	14	8.6
40	1.7	.83	120	16	9.7
45	2.1	1.0	125	18	11.
50	2.4	1.2	130	-	12.
55	2.8	1.4	135	-	14.
60	3.3	1.7	140	-	16.
65	3.9	2.0	145	-	17.
70	4.5	2.4	150	-	19.
75	5.2	2.8	155	-	21.
80	6.0	3.3	160	-	24.
85	6.8	3.8	165	-	26.
90	7.8	4.4	170	-	29.
95	8.8	5.1	175	-	32.
100	10.0	5.8			

Use Π_{T1} if package mounting base Temperature is known.

Use Π_{T2} if highest temperature in package is known.

Π_E(Environment Factor)

Environment	Π_E
Ground, Benign	0.2
Space Flight	0.2
Ground, Fixed	1.0
Airborne, Inhab.	4.0
Naval, Sheltered	4.0
Ground, Mobile	4.0
Naval, Unshelt.	5.0
Airborne, Uninhab.	6.0
Missile, Launch	10.0

FIGURE A-1. MIL-HDBK-217B OPERATIONAL FAILURE RATE MODEL FOR HYBRID MICROELECTRONIC DEVICES (continued)

λ_{DC} (Attached Devices Failure Rate)

Attached Device Description	λ_{DC}
Capacitor	
Ceramic, General Purpose	0.0004
Electrolytic	0.004
Inductors	0.0001
Resistor Chips	0.0002
Diode, Silicon*	
Logic Switch	0.0048
Small Signal (<500ma)	0.0081
Power Rectifier (>500ma)	0.012
Zener (volt. reg)	0.022
Thyristor	0.05
Varactor; Step Rec; Tunnel	0.19
Detector	0.18
Mixers	0.22
Transistor, Silicon*	
NPN, Logic Switch	0.0053
NPN, Linear	0.011
NPN, Power (>1W)	0.051
PNP, Logic Switch	0.0077
PNP, Linear	0.017
PNP, Power (>1W)	0.081
FET, Logic Switch	0.021
FET, Linear	0.063
Unijunction	0.10
Monolithic Microcircuits	
Bipolar digital devices (TTL & DTL types not included below)	**
Bipolar & MOS linear, bipolar beam lead, bipolar ECL and all other MOS devices.	***

*For JAN TX or TXV multiply by 0.2. For NON-JAN/Commercial multiply by 5.

**Use monolithic models, assuming 25°C, Class B (JAN)MIL-M-38510 Quality Level, Π_E = 1.0 and Π_L = 1.0.

***Same as above and multiply by 2.

λ_C (Complexity Term)

$\frac{N_E}{A_S}$	λ_{C1} Thin F.	λ_{C2} Thick F.	$\frac{N_E}{A_S}$	λ_{C1} Thin F.	λ_{C2} Thick F.
10 to			1500	.19	2.8
120	.0010	.0010	2000	.35	10.0
150	.0016	.0010	2500	.56	-
200	.0029	.0010	3000	.82	-
250	.0046	.0010	3500	1.1	-
300	.0068	.0022	4000	1.5	-
350	.0093	.0044	4500	1.9	-
400	.012	.0080	5000	2.4	-
450	.016	.014	5500	2.9	-
500	.020	.022	6000	3.6	-
550	.024	.033	6500	4.1	-
600	.029	.048	7000	4.8	-
650	.034	.069	7500	5.5	-
700	.039	.096	8000	6.3	-
750	.045	,13	8500	7.1	-
800	.052	,17	9000	8.0	-
850	.059	.23	9500	9.0	-
900	.067	.29	10000	10.0	-
950	.074	.37			
1000	.083	.46			

$N_E = N_{LT} + N_{RT} + N_{DC}$

N_{LT} = # of Internal Lead Terminations

N_{RT} = # of Film Resistors

N_{DC} = # of Discrete Chip Devices

Π_Q (Quality Factor)

Level or Class	A	B	C
Π_Q	.5	1	30

Π_F (Circuit Function Factor)

Function	Π_F
Digital	0.8
Linear	1.0
Linear/Digital Combination	1.1

APPENDIX B

ORDNANCE DEVICE RELIABILITY

B.1 Solid Propellant Rocket Motors

The reliability of solid propellant motors is a one-shot reliability and is not considered dependent on the operational time of the unit. The motors, however, do demonstrate definite aging trends in ballistic parameters during long term storage.

The reliability prediction for solid propellant motors therefore is a single probability of success for the total life cycle of the unit. Table B-1 gives the reliability estimates for various classes of motors. The reliability of the ignition system is not included in this prediction but presented separately in Section B.2.

Two general propellant compositions are considered: Double Base and Composite. Also each propellant composition is divided into single thrust and dual thrust motors.

The estimates for the motors are considered conservative.

TABLE B-1. PROPELLANT UNIT RELIABILITY
(excludes ignition systems)

	Reliability			
	50% Confidence		90% Confidence	
Classification	5 yrs.	10 yrs.	5 hrs.	10 yrs.
Double Base, Single Thrust	.930	.925	.795	.790
Double Base, Dual Thrust	.952	*	.850	*
Composite, Single Thrust	.992	.924	.972	.790
Composite, Dual Thrust	.944	*	.827	*
All Motors	.994	.964	.981	.890

*No data available at 10 years.

B.2 Igniter and Safe and Arm Devices

The reliability of igniters and safe and arm devices is a one-shot reliability and is not considered dependent on the operational time of the unit. These units do demonstrate definite aging trends in ballistic and functional parameters during long term storage. In addition, random type failures have also been experienced.

The reliability prediction model for the total life cycle of the device is:

$$R_{LC}(t) = [R\ (t)\ \text{aging}] \times [R\ (t)\ \text{random}]$$

where: $R_{LC}(t)$ is the life cycle reliability of the unit

$R(t)$ aging is the aging component of the unit's reliability

$R(t)$ random is the random failure component of the unit's reliability and is equal to $e^{-\lambda t}$.

λ is the random failure rate

t is the total storage time of the unit.

Tables B-2 and B-3 contain values for the equation parameters for Igniters and Safe and Arm Devices respectively.

TABLE B-2. IGNITER RELIABILITY PREDICTION MODEL

$$R(t)_{igniter} = [R(t)_{aging}] \times [R(t)_{random}]$$

$$R(t)_{random} = \exp(-\lambda t)$$

Classification	R(t) Aging				λ	
	50% confidence		90% confidence		50% Confidence	90% Confidence
	t = 5 yrs.	t = 10 yrs	t = 5 yrs.	t = 10 yrs.		
Solid Rocket Motor Pyrogen Igniters	.998	.986	.994	.954	65×10^{-9}	129×10^{-9}
Solid Rocket Motor Pyrotechnic Igniters	.995	.991	.984	.969	65×10^{-9}	129×10^{-9}
Gas Generator Igniters	.997	.979	.991	.934	65×10^{-9}	129×10^{-9}

* Extrapolated

TABLE B-3. SAFE AND ARM DEVICE RELIABILITY PREDICTION MODEL

$$R(t)_{S\&A\ device} = [R(t)_{aging}] \times [R(t)_{random}]$$

$$R(t)_{random} = \exp(-\lambda t)$$

Classification	R(t) aging				λ	
	50% confidence		90% confidence		50%confidence	90% confidence
	t = 5 yr.	t = 10 yr.	t = 5 yr.	t = 10 yr.		
Inertial S&A	.992	.976	.975	.923	58×10^{-9}	91×10^{-9}
Manual S&A	1.000	1.000	1.000	1.000	58×10^{-9}	91×10^{-9}
Motor Driven S&A	.964	.954*	.948	.912*	15×10^{-9}	35×10^{-9}

*Extrapolated from 1 through 8 year data.

B.3 Solid Propellant Gas Generators

The reliability of solid propellant gas generators is a one-shot reliability and is not considered dependent on the operation time of the unit. The motors, however, do demonstrate definite aging trends in ballistic parameters during long term storage.

The reliability prediction for solid propellant gas generators therefore is a single probability of success for the total life cycle of the unit. Table B-4 gives the reliability estimates for gas generators. The reliability of the ignition system is not included in this prediction but presented separately in Section B.2

The estimates for the gas generators are considered conservative.

TABLE B-4. GAS GENERATOR RELIABILITY PREDICTION (excludes ignition systems)

50% Confidence		90% Confidence	
5 Yrs.	10 Yrs.	5 Yrs.	10 Yrs.
.991	.925	.972	.775

B.4 Miscellaneous Ordnance Devices

The reliability of ordnance devices is a one-shot reliability and is not considered dependent on the operation time of the unit. The units do exhibit a random failure characteristic in storage however.

The reliability prediction for the ordnance device for the unit's total life cycle is:

$$R_{LC}(t) = e^{-\lambda_p t}$$

where λ_p is the device storage failure rate
t is the total storage hours

Table B-5 presents failure rate values for the various ordnance devices.

Failure rates for explosive bellows, explosive bolts, explosive motors and explosive timers are considered conservative.

FIGURE B-5. MISCELLANEOUS ORDNANCE DEVICE FAILURE RATES

λ_p (Device Failure Rate)

Device	λ_p
Electric Igniters	$.019 \times 10^{-6}$
Explosive Actuators	$.063 \times 10^{-6}$
Explosive Bellows*	$.015 \times 10^{-6}$
Explosive Bolts*	$.061 \times 10^{-6}$
Explosive Motors*	$.042 \times 10^{-6}$
Explosive Switches	$.005 \times 10^{-6}$
Explosive Timers*	$.035 \times 10^{-6}$
Zero Impulse Bolt*	$.926 \times 10^{-6}$
Pin Puller*	$.535 \times 10^{-6}$
Surface Fuse	3.390×10^{-6}
Energy Generator	1.863×10^{-6}

*Estimates considered conservative.

APPENDIX C

VACUUM TUBE RELIABILITY

C.1 Non-Operating Reliability

The failure rate models are presented in Figure C-1. Note, for a number of the tube types, a decreasing failure rate with time is indicated and described by a Weibull model.

For some tubes, the analysis indicated a significant decrease in failure rate with storage length for a large majority of the data. This suggested that the devices were failing very early in storage and no significant increase in failure occurred as time increased. The data was fit to a Weibull failure distribution in the form:

$$\lambda(t) = e^{(\beta-1)Lnt - Ln\alpha}$$

where $\lambda(t)$ is the hazard rate or instantaneous failure rate per billion hours.

β = shape parameter

α = scale parameter

t = storage hours in billions

A fairly high correlation was made to this function, with the β (shape) parameter less than one, again suggesting that the majority of the failures were occurring early in storage.

C.2 Electronic Vacuum Tube Operational Prediction Model

The MIL-HDBK-217B failure rate model for electronic vacuum tubes is:

$$\lambda_p = \lambda_b \Pi_E \times 10^{-6}$$

where λ_b = base failure rate in million hours

Π_E = environmental factor

The values for these parameters are shown in Tables C-1 and C-2. The base failure is valid provided tubes are replaced before wearout.

FIGURE C-1 ELECTRONIC VACUUM TUBE NON-OPERATING FAILURE RATE MODELS AND PARAMETERS

TUBE TYPE	FAILURE RATE MODEL	λ_b	α	β
Receiving	$\lambda = \lambda_b$	12	-	-
Klystron, Low Power	$\lambda = \lambda_b$	78	-	-
Klystron, High Power	$\lambda(t) = e^{(\beta-1)Lnt - Ln\alpha}$	-	1.0106	0.269
TWT, Low Power & High Power	$\lambda(t) = e^{(\beta-1)Lnt - Ln\alpha}$	-	1.0243	0.314
Magnetron, Low Power & High Power	$\lambda(t) = e^{(\beta-1)Lnt - Ln\alpha}$	-	1.0467	0.310
Gridded Tubes, Low Power, High Power	$\lambda(t) = e^{(\beta-1)Lnt - Ln\alpha}$	-	1.0194	0.254
Amplitrons	$\lambda(t) = e^{(\beta-1)Lnt - Ln\alpha}$	-	0.9854	0.214

λ = failures per billion hours

t = storage time in billion hours

TABLE C-1. BASE FAILURE RATES FOR TUBES

TUBE TYPE	λ_b (f./10^6 hr.)
RECEIVER	
Triode, Tetrode, Pentode	5
Power Rectifier	10
KLYSTRON	
Low Power (e.g., local oscillator)	30
High Power	
VA853	200
VA842	50
L3403	150
L3035	85
SAC42A	110
L3250	110
Z5010	190
ZM3038A	350
If high power type not included above:	
Peak Power <10 Megawatts	200
Peak Power ≥10 Megawatts	400
MAGNETRON	
Peak Power <10 Kilowatts	200
Peak Power ≥10 Kilowatts	450
TWT	
Peak Power <100 watts	30
Peak Power ≥100 watts, <10,000 watts	100
Peak Power ≥10,000 watts	200
CROSSED FIELD AMPLIFIER	
QK681	180
TRANSMITTING	
Triode	75
Pentode	100
CRT	15
THYRATRON	50

TABLE C-2. ENVIRONMENTAL FACTOR FOR TUBES

ENVIRONMENT	G_B	S_F	G_F	A_I	N_S	G_M	A_U	N_U	M_L
π_E	0.5	0.5	1.0	6.5	6.5	10	10	10	80

APPENDIX D

LASER OPERATIONAL PREDICTION MODELS

D.1 Laser Operational Prediction Models

The MIL-HDBK-217B general failure rate model for lasers is:

$$\lambda_{LASER} = \lambda_{MEDIA} + \lambda_{PUMP} + \lambda_{COUPLING}$$

The models and failure rates apply to the laser peculiar items only, i.e., those items wherein the lasing action is generated and controlled. In addition to the laser peculiar items, there are other assemblies used with lasers that contain electronic parts and mechanical devices (pumps, valves, hoses, etc.). The failure rates for these parts should be determined with the same procedures as used for other electronic and mechanical devices in the equipment or system of which the laser is a part.

The laser failure rate models have been developed at the "functional," rather than "piece part," level because the available data were not sufficient for "piece part" model development.

Because each laser family can be designed using a variety of approaches the failure rate models have been structured on three basic laser functions which are common to most laser families, but may differ in the hardware implementation of a given function. These functions are the lasing media, laser pumping mechanism (or pump), and the coupling method.

Examples of media-related hardware and influence factors are the solid state rod, gas, gas pressure, vacuum integrity, gas mix, outgassing, and tube diameter. The electrical discharge, the flashlamp, and energy level are examples of pump-related hardware and influence factors. The coupling function contributors are the "Q" switch, mirrors, windows, crystals, substrates, coatings, and level of dust protection provided.

The λ_{PUMP} term in the λ_{LASER} equation is zero for helium/neon, argon ion CO_2 sealed and CO_2 flowing lasers because the pumping mechanisms for these lasers contain no laser peculair items. Pumping is accomplished with electrical parts and circuitry. Failure rates for these parts are not included in this section but they should be included in the reliability analysis of the system equipment containing the laser. Also, some of the terms in the above general λ_{LASER} equation have modifying factors depending upon the laser type. These factors are shown in the following sub-sections.

D.1.1 Helium/Neon Argon Ion Lasers

The failure rate model for helium/neon and argon ion lasers is presented in Figure D-1.

The predominant failure mechanism is related to the gas media as reflected in λ_{MEDIA}. However for argon ion lasers, when the tube is refilled periodically (preventive maintenance) the mirrors (part of $\lambda_{COUPLING}$) can be expected to deteriorate after approximately 10^4 hours of operation if in contact with the discharge region.

D.1.2 Carbon Dioxide, Sealed Lasers

The failure rate model for carbon dioxide sealed lasers is presented in Figure D-2.

The overfill percentage in the Gas Overfill Factor, Π_O, is based on the percent increase over the optimum CO_2 partial pressure which is normally in the range of 1.5 to 3 Torr for most sealed CO_2 lasers. The equation for Π_O is:

$$\Pi_O = -0.01\ (\%\ \text{overfill}) + 1$$

the equation for the ballast factor, Π_B, is

$$\Pi_B = (1/3)\frac{\%\ \text{Vol. Inc.}}{100}$$

The number of active optical surfaces, Π_{OS}, is determined from Figure D-5.

D.1.3 Carbon Dioxide, Flowing Lasers

The failure rate model for carbon dioxide, flowing lasers is presented in Figure D-3.

The failure rate contribution of the lasing media, λ_{MEDIA}, approaches zero for carbon dioxide, flowing lasers. This is because this type of laser is much less susceptible to leaks and long term gas decomposition than a sealed system. The flowing gas also acts as a purge in removing contamination and precluding its entrapment. Therefore, except for tube breakage (which has rarely been observed) optics deterioration appears the predominant failure mechanism and this is accounted for under $\lambda_{COUPLING}$.

The failure rate contribution of the laser coupling hardware, $\lambda_{COUPLING}$, is a function of the laser beam average power output, P, in kilowatts. The $\lambda_{COUPLING}$ values shown are valid only for power levels up to one kilowatt. Beyond this range other glass failure mechanisms begin to predominate and alter the $\lambda_{COUPLING}$ values. It should also be noted that CO_2 flowing laser optical devices are the primary source of failure occurrence. A preventive maintenance program on optical devices would greatly extend laser life; however, procedures must be tailored to the individual design of each system. Typical optical cleaning methods are as follows:

1. Use dry, pressurized air and a camel hair brush to remove dust, particulates, etc.
2. Rub with high quality lens tissue using moisture from breath (if necessary).
3. Flush with distilled water and a mild laboratory detergent (if necessary).
4. Cautions -
   a. Use of special gloves for handling recommended.
   b. Careful use of 20 to 30 percent alcohol solutions with sterile cotton swabs (change swabs frequently).

The number of active optical surfaces, Π_{OS} is determined from Figure D-5.

D.1.4 Solid State Nd:YAG Rod Lasers and Ruby Red Laser

The failure rate model for solid state neodymium doped yttrium-aluminum-garnet (Nd:YAG) rod laser and ruby red laser is presented in Figure D-4.

The failure rate contribution of the lasing media, λ_{MEDIA}, is 0.1 for Nd:YAG lasers. For the ruby red laser, λ_{MEDIA} is a function of the repetition rate (Π_{REP}) and the energy density (F) is measured in Joules per cm.^{2}/pulse over the cross-sectional area of the laser rod and its value is determined from the actual design parameter of the laser rod utilized.

Repetition rates for military solid state lasers are generally in the 1 to 20 pps range. Repetition rates other than shown have not been observed and corresponding Π_{REP} values certified.

The failure rate contribution of pumping mechanism, λ_{PUMP}, is highly affected by the flashlamp or flash tube contribution. It is expressed as a function of the environmental factor (Π_E) and the failure rate contribution of the flashlamp or flashtube ($\lambda_{PUMP\ HOURS}$). The value for $\lambda_{PUMP\ HOURS}$ is calculated from Figure D-6 for Xenon flashlamps or Figure D-7 for Krypton flashlamps.

It should be noted that although sealed systems tend to be reliable once compatible materials have been selected and proven, extreme care must still be taken to prevent the entrance of particulates during manufacturing, field flashlamp replacement, or routine maintenance/repair. Contamination is the major cause of solid state laser malfunction, and special provisions and vigilance must continually be provided to maintain the cleanliness level required. Coupling cleanliness factor, Π_C, values can vary from 1 up to 60.

The number of active optical surfaces, Π_{OS}, is determined from Figure D-5.

FIGURE D-1. MIL-HDBK-217B OPERATIONAL FAILURE RATE MODEL FOR HELIUM/NEON LASERS AND ARGON ION LASERS

$$\lambda = (\Pi_E \lambda_{MEDIA} + \Pi_E \lambda_{COUPLING}) \times 10^{-6}$$

λ_{MEDIA} & $\lambda_{COUPLING}$

Laser Type	λ_{MEDIA}	$\lambda_{COUPLING}$
Helium/Neon	84	.1
Argon Ion	457	6.

Π_E (Environmental Factor)

Environment	Π_E
Ground, Benign	.2
Space Flight	.2
Ground, Fixed	1.
Airborne, Inhabited	5.
Naval, Sheltered	5.
Ground, Mobile	5.
Naval, Unshelt.	5.
Airborne, Uninhab.	8.
Missile, Launch	8.

FIGURE D-2. MIL-HDBK-217B OPERATIONAL FAILURE RATE MODEL FOR CARBON DIOXIDE, SEALED LASERS

$$\lambda_{CO_2\ SEALED} = (\Pi_E \Pi_O \Pi_B \lambda_{MEDIA} + \Pi_E \Pi_{OS} \lambda_{COUPLING}) \times 10^{-6}$$

λ_{MEDIA}

$\lambda_{MEDIA} = 69I - 450$

I = Current (ma) through discharge tube

$(10ma \leq I \geq 150\ ma)$

$\lambda_{COUPLING}$

$\lambda_{COUPLING} = 10.$

Π_E (Environmental Factor)

Environment	Π_E
Ground, Benign	.2
Space Flight	.2
Ground, Fixed	1.
Airborne, Inhabited	5.
Naval, Sheltered	5.
Ground, Mobile	5.
Naval, Unsheltered	5.
Airborne, Uninhab.	8.
Missile, Launch	8.

Π_{OS} (Number of active Optical Surfaces)

See Figure 2.2-5

Π_O (Gas Overfill Factor)

CO_2 Overfill Percent	Π_O
0	1.00
25	0.75
50	0.50

Π_B (Ballast Factor)

Percent of Ballast Volumetric Increase	Π_B
0	1.0
50	0.58
100	0.33
150	0.19
200	0.11

FIGURE D-3. MIL-HDBK-217B OPERATIONAL FAILURE RATE MODEL FOR CARBON DIOXIDE, FLOWING LASERS

$$\lambda_{CO_2\ FLOWING} = (\Pi_E \lambda_{MEDIA} + \Pi_E \Pi_{OS} \lambda_{COUPLING}) \times 10^{-6}$$

λ_{MEDIA}

$\lambda_{MEDIA} = 0$

$\lambda_{COUPLING}$

Power (kilowatts)	$\lambda_{COUPLING}$
.01	3
.1	30
1.0	300*

*Does not apply for power levels over 1.0 kilowatts.

Π_E (Environmental Factor)

Environment	Π_E
Ground, Benign	.2
Space Flight	.2
Ground, Fixed	1.
Airborne, Inhabited	5.
Naval, Sheltered	5.
Ground, Mobile	5.
Naval, Unsheltered	5.
Airborne, Uninhab.	8.
Missile, Flight	8.

Π_{OS} (Number of active Optical Surfaces)

See Figure 2.2-5

FIGURE D-4. MIL-HDBK-217B OPERATIONAL FAILURE RATE MODEL FOR SOLID STATE Nd:YAG ROD LASERS AND RUBY RED LASERS

$$\lambda = (\Pi_E \lambda_{MEDIA} + \lambda_{PUMP} + \Pi_E \Pi_C \Pi_{OS} \lambda_{COUPLING}) \times 10^{-6}$$

λ_{MEDIA} (Nd:YAG Rod Laser)

$\lambda_{MEDIA} = 0.1$

λ_{MEDIA} (Ruby Red Laser)

$\lambda_{MEDIA} = (\Pi_{REP}) \ (43.5 \ F^{2.52})$

F = Energy density in Joules per cm^2/pulse over the cross sectional area of the laser beam.

Π_{REP} (Repetition Rate Factor)

Repetition or Pulse Rate (Pulses per sec.)	Π_{REP}
1	3600
5	18000
10	36000
15	54000
20	72000

λ_{PUMP}

$\lambda_{PUMP} = \Pi_E \lambda_{PUMP\ HOURS}$

$\lambda_{PUMP\ HOURS}$

Lamp	See Figure
Xenon	B-6
Krypton	B-7

$\lambda_{COUPLING}$

$\lambda_{COUPLING} = 16.3$

Π_C (Coupling Cleanliness Factor)

	Π_C
Rigorous cleanliness procedures, equipment, and trained maintenance personnel. Plus bellows provided over optical train.	1
Minimal precautions during opening, maintenance, repair, and testing. Plus bellows provided over optical train.	30
Minimal precautions during opening, maintenance, repair, and testing. No bellows provided over optical train.	60

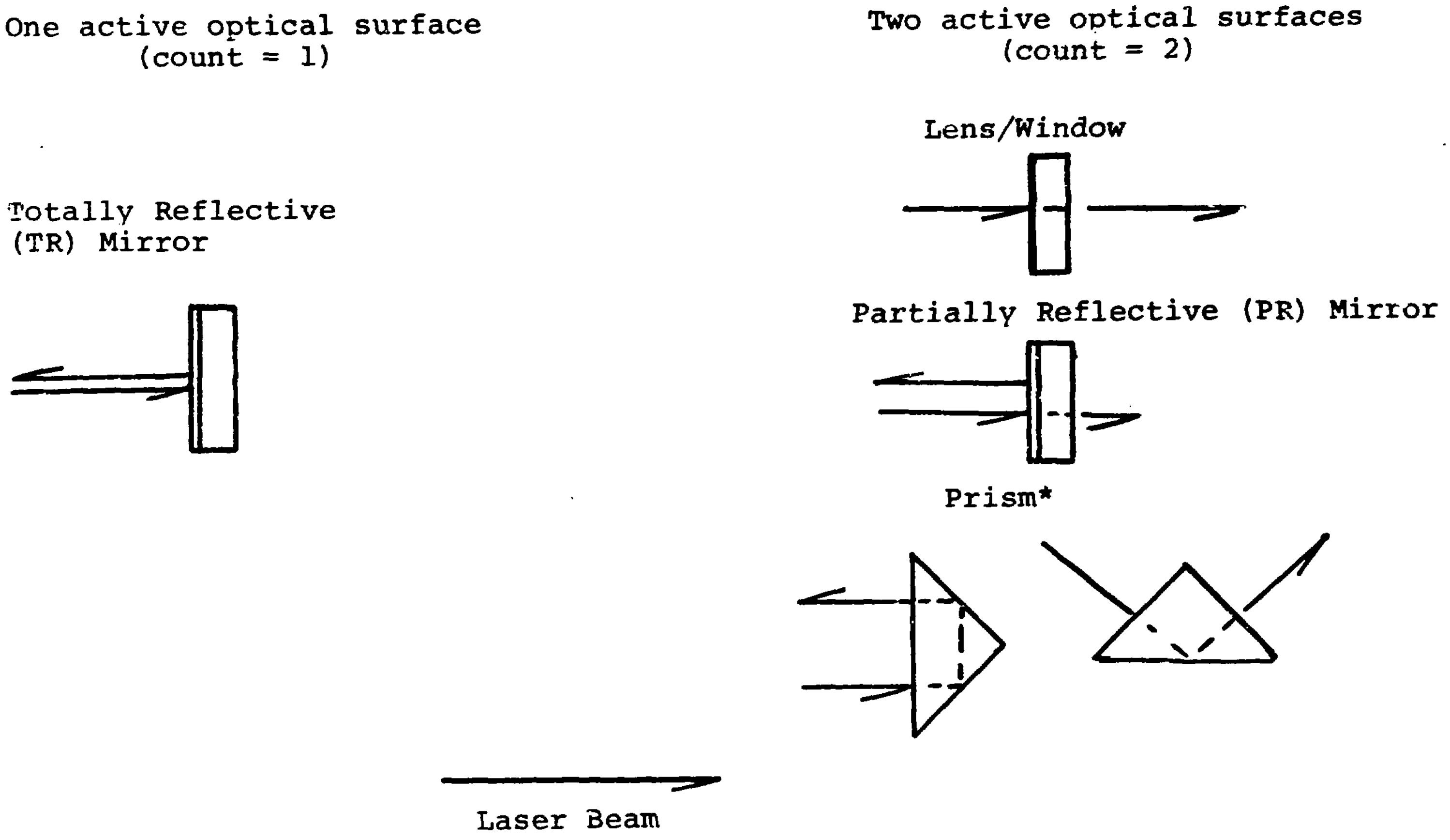
Π_E (Environmental Factor)

Environment	
Ground, Benign	.2
Space Flight	.2
Ground, Fixed	1.
Airborne, Inhabited	5.
Naval, Sheltered	5.
Ground, Mobile	5.
Naval, Unsheltered	5.
Airborne, Uninhab.	8.
Missile, Launch	8.

Π_{OS} (Number of Active Optical Surfaces)

See Figure B -5

FIGURE D-5. EXAMPLES OF ACTIVE OPTICAL SURFACES AND COUNT



*Prism has only 2 active surfaces, because interior surfaces are not subject to external particulate contamination.

Only active optical surfaces are counted. An active optical surface if one with which the laser energy or beam interacts. Internally reflecting surfaces are not counted.

FIGURE D-6. DETERMINATION OF $\lambda_{\substack{PUMP\\HOURS}}$ FOR XENON FLASHLAMPS

$$\lambda_{\substack{PUMP\\HOURS\\XENON}} = (\Pi_{REP}) \left[2000 \left(\frac{E_j}{dL \quad T} \right)^{8.58} \right] (\Pi_{COOL})$$

where:

$\lambda_{\substack{PUMP\\HOURS\\XENON}}$ is the failure rate contribution of the xenon flashlamp or flashtube* in failures/million operating hours. The flashlamps evaluated herein are linear types used for military solid state laser systems.

Π_{REP} is the pulse or repetition factor used to convert from failures per 10^6 pulses to failures/million hours.

Repetition or Pulse Rate (Pulses per second)	Π_{REP}
1	3600
5	18000
10	36000
15	54000
20	72000

E_j is the flashlamp or flashtube input energy per pulse in joules and its value is determined from the actual or design input energy parameter except that for input energy levels equal to or less than 30 joules, $E_j = 30$.

d is the flashlamp or flashtube inside diameter in millimeters, and its value is determined from the actual design parameter of the flashlamp utilized.

L is the flashlamp or flashtube arc length in inches, and its value is determined from the actual design parameter of the flashlamp utilized.

T is the truncated pulse width in microseconds, and its value is determined from the actual design parameter of the pulse forming network (PFM) used to pulse the flashlamp or flashtube. Pulse tails do not affect reliability, and the maximum value of T is 100 microseconds for any truncated pulse width exceeding 100 microseconds. For shorter duration pulses, pulse width is to be measured at 10 percent of the maximum current amplitude.

Π_{COOL} is the cooling factor due to various cooling media immediately surrounding the flashlamp or flashtube.

Cooling Media	Π_{COOL}
Gas, Air	1.0
Gas, Inert	1.0
Liquid, Deionized Water	0.1
Liquid, Water-Glycol	0.1
Liquid, Fluorocarbon	0.1

Note: Typical values for Xenon flashlamps in military Nd:YAG rangefinders and designators are $E_j = 40$ joules, d = 4 millimeters, L = 2 inches, and T = 100 microseconds. The repetition rate ranges from 1 to 20 pps, and the lamps are normally liquid cooled.

FIGURE D-7. DETERMINATION OF $\lambda_{\substack{\text{PUMP}\\\text{HOURS}}}$ FOR KRYPTON FLASHLAMPS

$$\lambda_{\substack{\text{PUMP}\\\text{HOURS}\\\text{KRYPTON}}} = (\ 625\ )\left(10^{(0.9\frac{P}{L})}\right)(\ \Pi_{\text{COOL}})$$

$\lambda_{\substack{\text{PUMP}\\\text{HOURS}\\\text{KRYPTON}}}$ is the failure rate contribution of the krypton flashlamp or flashtube in failures/million operating hours. The flashlamps evaluated herein are the continuous wave (CW) type and are most widely used for commercial solid state applications. They are approximately 7mm in diameter and 5 to 6 inches long. Average power is typically 4 KW.

P is the average input power in kilowatts, and its value is determined from the actual design parameter for the flashlamp utilized.

L is the flashlamp or flashtube arc length in inches, and its value is determined from the actual design parameter of the flashlamp utilized.

Π_{COOL} is the cooling factor due to various cooling media immediately surrounding the flashlamp or flashtube.

Cooling Media	Π_{COOL}
Gas, Air	1.0
Gas, Inert	1.0
Liquid, Deionized Water	0.1
Liquid Water-Glycol	0.1
Liquid, Fluorocarbon	0.1

APPENDIX E

ENVIRONMENTAL FACTORS

E.1 Environmental Factors

The environmental factors are in the form of K-factors. The ground, fixed non-operating failure rate is the base failure rate and can be multiplied by the appropriate environmental factor to estimate the failure rate for the specific environment.

These modifiers are based on MIL-HDBK-217B data.

ENVIRONMENTAL DESCRIPTION

Environment	Nominal Environmental Conditions
Ground, Benign (G_B)	Nearly zero environmental stress with optimum engineering operation and maintenance.
Space, Flight (S_F)	Earth orbital. Approaches Ground, Benign conditions without access for maintenance. Vehicle neither under powered flight nor in atmospheric reentry.
Ground, Fixed (G_F)	Conditions less than ideal to include installation in permanent racks with adequate cooling air, maintenance by military personnel and possible installation in unheated buildings.
Ground, Mobile (and Portable) (G_M)	Conditions more severe than those for Ground, Fixed, mostly for vibration and shock. Cooling air supply may also be more limited, and maintenance less uniform.
Naval, Sheltered (N_S)	Surface ship conditions similar to Ground, Fixed, subject to occasional high shock and vibration.
Naval, Unsheltered (N_U)	Nominal surface shipborne conditions but with repetitive high levels of shock and vibration.
Airborne, Inhabited (A_I)	Typical cockpit conditions without environmental extremes of pressure, temperature, shock and vibration.
Airborne, Uninhabited (A_U)	Bomb-bay, tail, or wing installations where extreme pressure, temperature, and vibration cycling may be aggravated by contamination from oil, hydraulic fluid, and engine exhaust. Classes I and Ia equipment of MIL-E-5400 should not be used in this environment.
Missile, Launch (M_L)	Severe conditions of noise, vibration, and other environments related to missile launch, and space vehicle boost into orbit, vehicle re-entry and landing by parachute. Conditions may also apply to installation near main rocket engines during launch operations.

ENVIRONMENTAL FACTORS

<u>Applicability</u>

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
All Microelectronics	CLASS C	0.2	0.2	1.0	4.0	4.0	4.0	6.0	5.0	10.0
	CLASS B	0.2	0.2	1.0	4.0	4.0	4.0	6.0	5.0	10.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
All Semi-conductors except Microwave	JAN	0.2	0.2	1.0	5.0	5.0	5.0	5.0	8.0	8.0
	JANTX	0.2	0.2	1.0	5.0	5.0	5.0	5.0	8.0	8.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Microwave Semiconductors	JAN	0.1	0.1	1.0	5.0	5.0	5.0	5.0	8.0	20.0
	JANTX	0.1	0.1	1.0	5.0	5.0	5.0	5.0	8.0	20.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
All Vacuum Tubes	MIL-STD	0.5	0.5	1.0	6.5	6.5	10.0	10.0	10.0	80.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Resistors, Fixed Composition	MIL-STD	0.5	0.5	1.0	2.0	2.5	3.5	3.8	4.0	7.5
	HI-REL	0.5	0.5	1.0	2.0	2.5	3.5	3.8	4.0	7.5

ENVIRONMENTAL FACTORS

Applicability

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Resistors, Fixed Film, MIL-R-39017 MIL-R-22684	MIL-STD	0.2	0.2	1.0	1.3	1.6	2.4	2.8	3.0	7.0
	HI-REL	0.2	0.2	1.0	1.3	1.6	2.4	2.8	3.0	7.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Resistors, Fixed Film, MIL-R-55182 MIL-R-10509	MIL-STD	0.4	0.4	1.0	2.0	3.0	4.0	4.4	4.8	7.2
	HI-REL	0.4	0.4	1.0	2.0	3.0	4.0	4.4	4.8	7.2

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Resistors, Power Film, MIL-R-11804	MIL-STD	0.2	0.2	1.0	1.3	1.5	2.4	2.7	3.0	7.0
	HI-REL	0.2	0.2	1.0	1.3	1.5	2.4	2.7	3.0	7.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Resistors, Fixed, Wirewound MIL-R-39005 MIL-R-93	MIL-STD	0.2	0.2	1.0	2.5	3.0	3.3	3.8	5.0	11.7
	HI-REL	0.2	0.2	1.0	2.5	3.0	3.3	3.8	5.0	11.7

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Resistors, Fixed Wirewound, MIL-R-39007 MIL-R-26 MIL-R-39009 MIL-R-18546	MIL-STD	0.3	0.3	1.0	2.0	2.3	3.3	3.7	4.0	10.0
	HI-REL	0.3	0.3	1.0	2.0	2.3	3.3	3.7	4.0	10.0

ENVIRONMENTAL FACTORS

Applicability

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Thermistor MIL-T-23648	BEAD	0.2	0.2	1.0	2.5	3.0	5.0	4.0	3.4	12.0
	DISK	0.2	0.2	1.0	2.5	3.0	5.0	4.0	3.4	12.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_U	G_M	N_U	A_U	M_L
Resistors, Variable, Wirewound MIL-R-39015 MIL-R-27208	MIL-STD	0.3	0.3	1.0	2.0	2.3	2.7	3.3	4.0	20.0
	HI-REL	0.3	0.3	1.0	2.0	2.3	2.7	3.3	4.0	20.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_U	G_M	N_U	A_U	M_L
Resistors, Precision, Wirewound Potentiometer MIL-R-12934	MIL-STD	0.2	0.2	1.0	2.0	2.0	2.0	2.4	3.0	5.0
	HI-REL	0.2	0.2	1.0	2.0	2.0	2.0	2.4	3.0	5.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_U	G_M	N_U	A_U	M_L
Resistors, Semi- precision, WW Potentiometer MIL-R-19 MIL-R-39002 WW Power Potentiometer MIL-R-22	MIL-STD	0.2	-	1.0	2.5	3.0	3.3	-	-	-
	HI-REL	0.2	-	1.0	2.5	3.0	3.3	-	-	-

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_U	G_M	N_U	A_U	M_L
Resistors, Variable Non- Wirewound Trimmers MIL-R-22097	MIL-STD	0.3	-	1.0	2.0	2.7	3.3	4.2	5.0	26.7
	HI-REL	0.3	-	1.0	2.0	2.7	3.3	4.2	5.0	26.7

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_U	G_M	N_U	A_U	M_L
Resistors, Composition (Low Precision) Potentiometer MIL-R-94	MIL-STD	0.1	-	1.0	5.0	5.0	5.0	5.5	6.0	10.0
	HI-REL	0.1	-	1.0	5.0	5.0	5.0	5.5	6.0	10.0

ENVIRONMENTAL FACTORS

Applicability

Capacitors,
Paper & Plastic Film
MIL-C-39022
MIL-C-14157
MIL-C-19978

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.5	0.5	1.0	2.0	2.0	2.0	4.5	7.5	10.0
HI-REL	0.5	0.5	1.0	2.0	2.0	2.0	4.5	7.5	10.0

ENVIRONMENTAL FACTORS

Capacitors,
Mica
MIL-C-39001
MIL-C-5

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.3	0.3	1.0	1.5	1.5	1.5	3.5	6.0	7.5
HI-REL	0.3	0.3	1.0	1.5	1.5	1.5	3.5	6.0	7.5

ENVIRONMENTAL FACTORS

Capacitors,
Mica
MIL-C-10950

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.3	0.3	1.0	1.5	1.5	1.5	4.4	6.0	7.5

ENVIRONMENTAL FACTORS

Capacitors,
Glass
MIL-C-23269

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.3	0.3	1.0	1.5	1.5	1.5	3.5	6.0	7.5
HI-REL	0.3	0.3	1.0	1.5	1.5	1.5	3.5	6.0	7.5

ENVIRONMENTAL FACTORS

Capacitors,
Ceramic
MIL-C-11015
MIL-C-39014

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.5	0.5	1.0	2.0	2.0	2.0	4.0	5.5	7.5
HI-REL	0.5	0.5	1.0	2.0	2.0	2.0	4.0	5.5	7.5

ENVIRONMENTAL FACTORS

Capacitors,
Tantalum
Electrolytic
(Solid)
MIL-C-39003

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.5	0.5	1.0	2.0	2.0	2.0	4.5	7.5	10.0
HI-REL	0.5	0.5	1.0	2.0	2.0	2.0	4.5	7.5	10.0

ENVIRONMENTAL FACTORS

Capacitors,
Tantalum
Electrolytic
(Non-Solid)
MIL-C-39006
MIL-C-3965

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
MIL-STD	0.5	0.5	1.0	3.0	3.0	3.0	7.0	10.0	15.0
HI-REL	0.5	0.5	1.0	3.0	3.0	3.0	7.0	10.0	15.0

ENVIRONMENTAL FACTORS

Applicability

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Capacitors, Aluminum Oxide MIL-C-39018 Aluminum Dry Electrolytic MIL-C-62	MIL-STD	0.5	0.5	1.0	6.0	6.0	6.0	10.0	15.0	20.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Capacitors, Variable, Ceramic MIL-C-81	MIL-STD	0.3	-	1.0	2.0	2.0	2.0	6.0	12.5	17.5

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Capacitors, Variable, Piston Type MIL-C-14409	MIL-STD	0.3	0.3	1.0	3.0	3.0	3.0	16.7	26.7	40.0

ENVIRONMENTAL FACTORS

		G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
All Inductive Devices	L-STD	0.5	0.5	1.0	2.5	2.5	1.5	2.5	3.5	5.0
	HI-REL	0.5	0.5	1.0	2.5	2.5	1.5	2.5	3.5	5.0

ENVIRONMENTAL FACTORS

	G_B	S_F	G_F	A_I	N_S	G_M	N_U	A_U	M_L
Lasers	0.2	0.2	1.0	5.	5.	5.	5.	8.	8.