SAMPLE

Reliability Report

Mean-Time-Between-Failure Prediction
Telcordia SR332

for

Telecommunications System

Broadband Subscriber Management System

Prepared by:

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Description of Equipment

This Mean-Time-Between-Failure Prediction has been performed for the Telecommunications System. This equipment consists of a System chassis with plug-in circuit board modules. Each sub-level unit includes it's associated circuit boards, enclosures, and cables. The following describes the equipment with it's components.

Assembly	Part Number
CE3	
FE1	
ENET 6U	
T1 PKT	
OC3 SMF	
OC3 MMF	
ATM DS3	
DS3 PKT	
ETH-3U	
DC Power Supply	
AC Power Supply	

Assumptions and Conditions

This calculation relates to operational hours, as opposed to elapsed hours, so this should be reflected in the overall reliability if required.

Models provided by the Telcordia SR332, Issue 3, Specification for Reliability Prediction were used, except where manufacturer's failure rate data was available.

Environment = Ground Benign, Controlled (G_B)

Model = Serial, redundant paths do not exist.

Calculation Method = Limited Stress, Method I, Case 3

Component Quality Level = II

Temperature rise of components - See Appendix B.

Electrical Stress - See Appendix B.

Omitted Items

Device	Reason for omission
Assembly hardware	Stationary mechanical devices are omitted

Summary of Results

1.0 MTBF Predictions

Reliability predictions are presented below for the entire system, sub-assembly units and each circuit board per Telcordia SR-332.

Table I and II, shows the overall System results for DC and AC power supply configurations.

Table III shows the results for each individual circuit board.

Table 1.1

DC System Level Results

Telcordia Method, Ground Benign (G_B) at 25°C

Assembly	Part Number	MTBF (hours)	MTBF (years)	Failure Rate (FIT*)
CE3		653,168	74.6	1531
FE1		683,995	78.1	1462
ENET 6U		692,521	79.1	1444
T1 PKT		1,358,696	155	736
OC3 SMF		1,497,006	171	668
CHASSIS		1,290,404	147	775
DC Power Supply		751,880	85.8	1330
System Total		125,850	14.4	7946

*FIT is Failures in 10^9 hours.

Table 1.2

AC System Level Results

Telcordia Method, Ground Benign (G_B) at 25°C

Assembly	Part Number	MTBF (hours)	MTBF (years)	Failure Rate (FIT*)
CE3		653,168	74.6	1531
FE1		683,995	78.1	1462
ENET 6U		692,521	79.1	1444
T1 PKT		1,358,696	155	736
OC3 SMF		1,497,006	171	668
CHASSIS		1,290,404	147	775
AC Power Supply		751,880	85.8	1330
System Total		125,850	14.4	7946

*FIT is Failures in 10^9 hours.

Table 1.3
Individual Assembly Results
Telcordia Method, Ground Benign (G_B) at 25ºC

Assembly	Part Number	MTBF (hours)	MTBF (years)	Failure Rate (FIT*)
CE3		653,168	74.6	1531
FE1		683,995	78.1	1462
ETH-3U		3,649,635	417	274
ATM DS3		1,497,006	171	668
DS3 PKT		2,252,252	257	444
T1 PKT		692,521	79.1	1444
OC3 MMF		1,358,696	155	736
ENET 6U		3,584,229	409	279
OC3 SMF		1,355,014	155	738
ZIATECH, 6311 DC PS		751,880	85.8	1,330
ZIATECH, 6301 AC PS		751,880	85.8	1,330

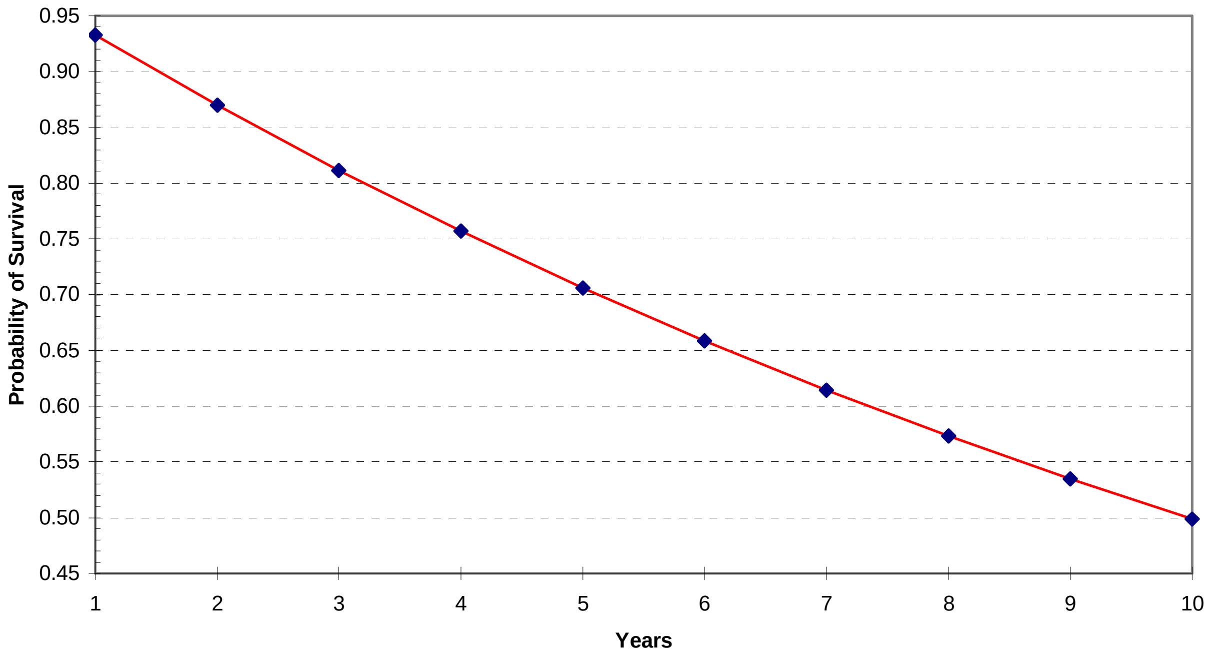
*FIT is Failures in 10^9 hours.

1.1 Reliability Function Plot - Probability of Survival

The following graphs show the Probability of Survival, that is the percentage of Failure Free product, as a function of time.

The graph applies to both AC and DC System configurations.

Reliability Function
DC and AC Configurations
Telcordia Method, Ground Benign (G_B) at 25ºC



We can expect that 93.2% of product will survive year one without failure, whereas, 49.8% of the product will survive 10 years failure free.

2.0 Margin Analysis

Margin analysis where operating temperature is varied between low and high limits. MTBF and Failure Rate are presented graphically over the range of temperature.

The following graphs apply to both AC and DC System configurations.

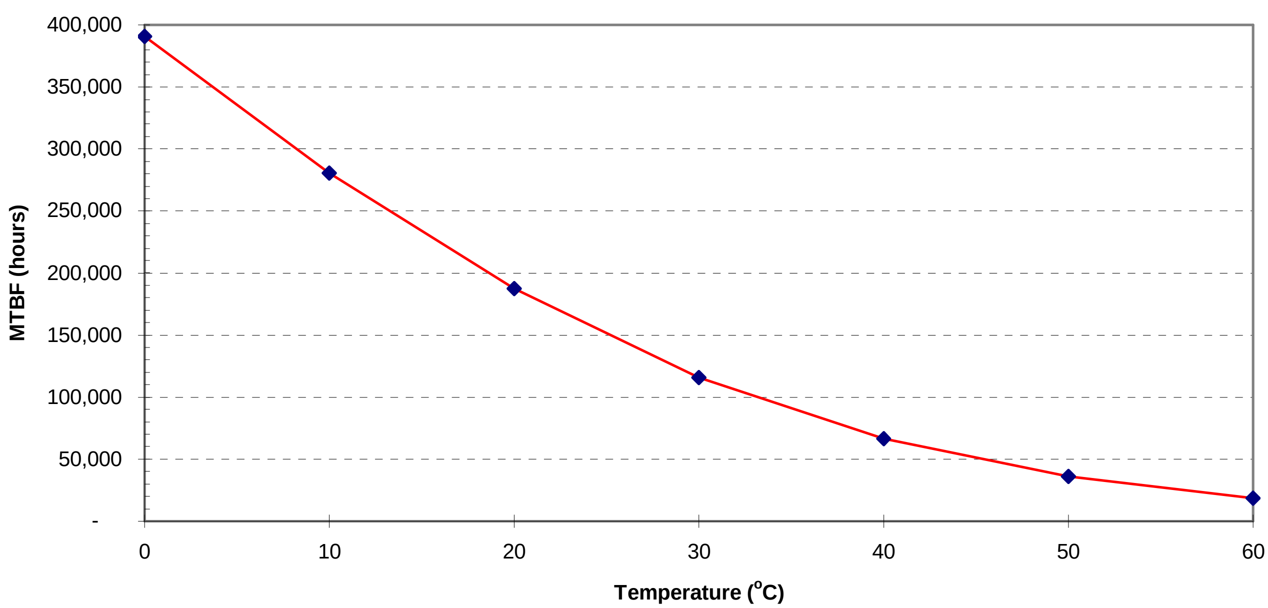
Table 2.0
DC and AC Configurations
MTBF & Failure Rate
Telcordia Method, Ground Benign (G_B)

Temperature (^oC)	MTBF (hours)	MTBF (years)	Failure Rate (FIT*)
0	142,944	16.3	6,996
10	98,145	11.2	10,189
20	63,126	7.2	15,841
30	38,436	4.4	26,017
40	22,479	2.6	44,486
50	12,821	1.5	77,997

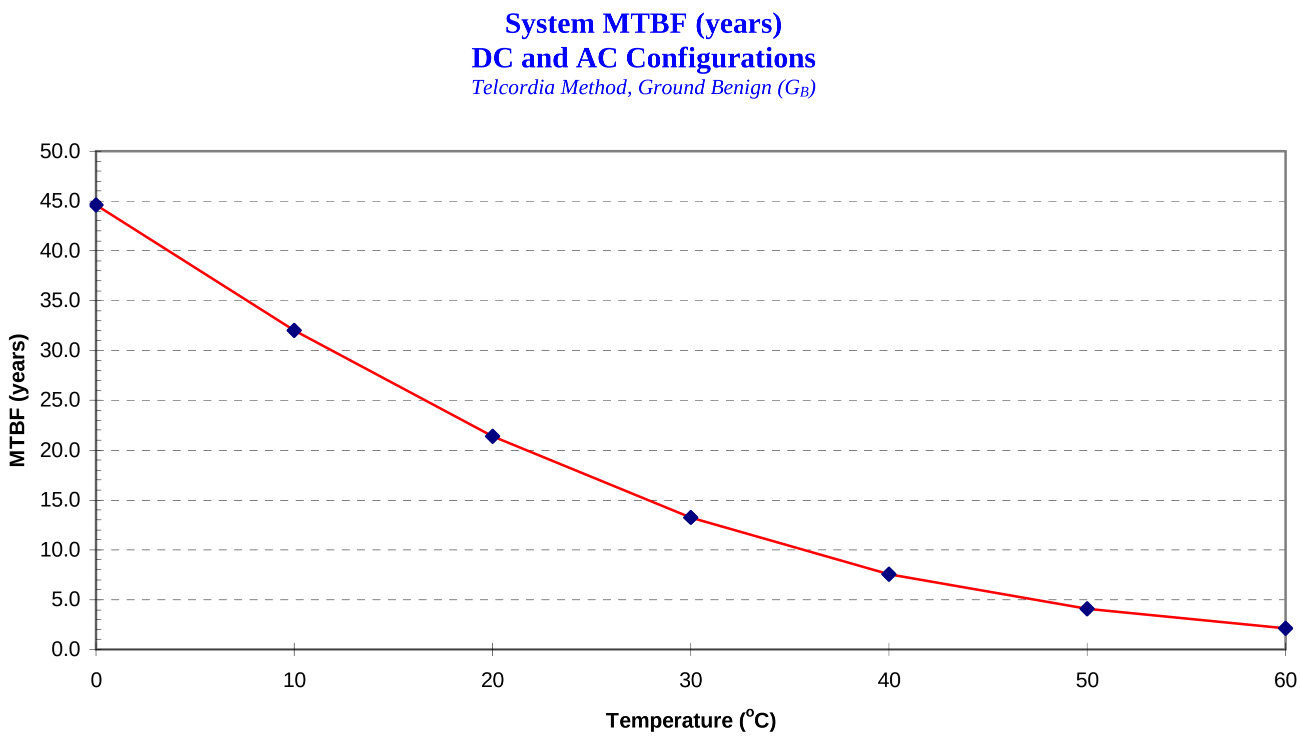
*FIT is Failures in 10^9 hours.

2.1 MTBF vs. Temperature

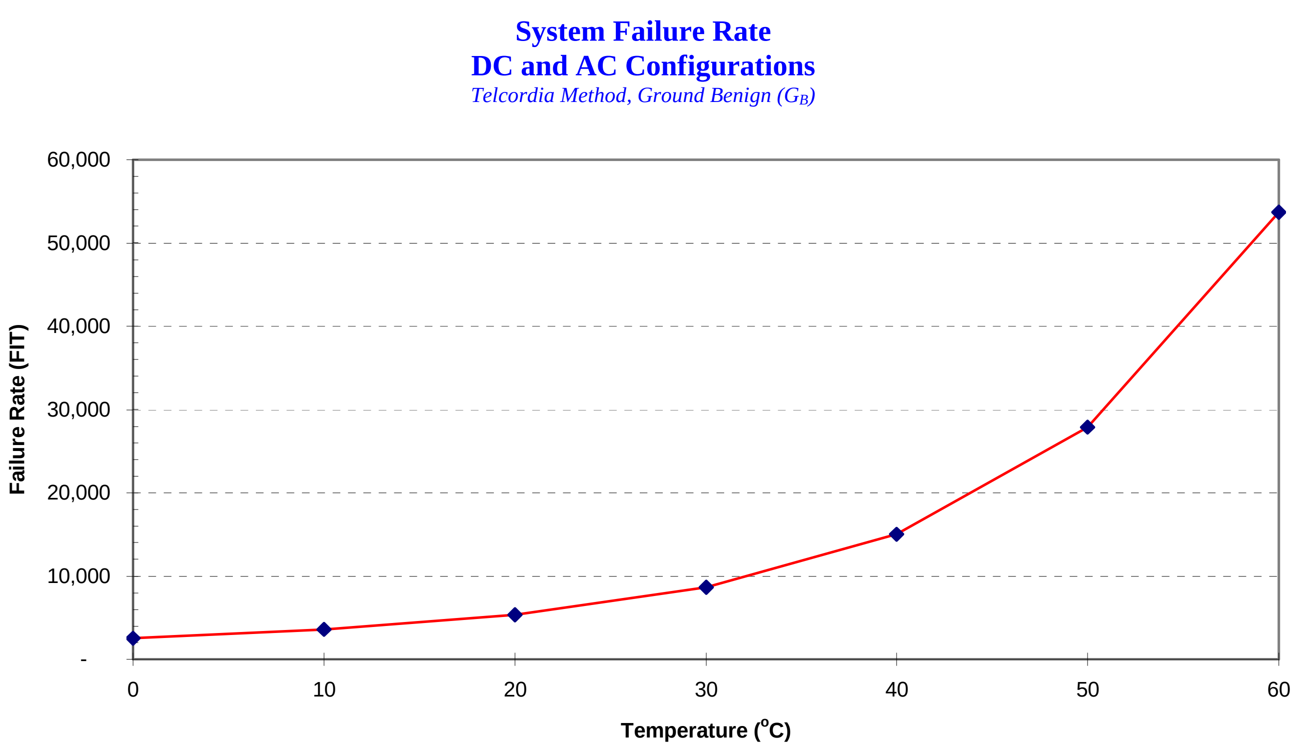
System MTBF (hours)
DC and AC Configurations
Telcordia Method, Ground Benign (G_B)



2.1 MTBF vs. Temperature (continued)



2.2 Failure Rate vs. Temperature



3.0 Revision History

A. Initial release, 6/13/2000.
B. Updated, 4/25/2002.
C. Updated, 11/18/10.
D. Miscellaneous corrections.
E. Telcordia Issue 4 update, pages 12-16, 9/5/19.

Appendix A

An Overview of Reliability

Why You Need Reliability Prediction

In today's very competitive electronic products market, a commitment to product quality and reliability is a necessity: customers have high expectations for the reliability of the products they buy, and the companies that don't meet those expectations lose. You already know the advantages to your company of building reliable products: when the products you sell operate reliably, your reputation grows, your costs shrink, and your business prospers.

The most successful companies meet these market demands for quality by using design for reliability principles: integrate reliability considerations into the entire product design process, right from the start. This way reliability is designed into the product, not patched on later, when problems arise. The companies that practice design for reliability find that it results in fewer design changes and iterations, lower manufacturing costs, lower warranty and service costs, more profit, and, most importantly, happy customers.

An important element of the design for reliability process is reliability prediction, which allows you to predict product failure rates.

Uses of Reliability Prediction

Reliability predictions provide a quantitative basis for evaluating product reliability. The information a reliability prediction gives can be used to guide your design decisions throughout the development cycle.

Feasibility Study: When an initial design concept is proposed, a reliability prediction can give you an idea of the feasibility of the design as far as reliability is concerned. Even though these early stage predictions are based on limited design information, and thus are approximate at best, they can give direction to your design decisions; many of these early design decisions may be critical to the success of the product. In addition, it can really pay to discover potential problems early, on paper, before time and money is spent on detailed design and development.

You will usually start with a reliability requirement, which may be given by your customer, or dictated by competitive products. You might have a requirement of a 20,000 hour MTBF for a product. If your predicted value is 3,500 hours, the current design concept may not be feasible; at this point you can modify the design concept, or revise the requirement. If your predicted value is 50,000 hours, this can give you confidence in your design concept, at least as far as reliability is concerned.

Compare Design Alternatives: As your design moves through the early stages into more detailed design, you will make many decisions on design alternatives. Reliability predictions, along with other factors such as performance and cost, can be used as a basis for your decisions. For instance, you may be able to implement a given circuit function in a number of ways, all performing and costing about the same; if one alternative is estimated to be much more reliable than the others, it would stand out.

Find Likely Problem Spots: At the detailed design level, reliability predictions can help you identify likely problem areas. As part of the prediction process, you will go over your parts lists, do stress analysis, and note part quality levels; this detailed examination can expose overstressed parts and misapplied parts. The predicted failure rates will point you to parts, or part groups, which are high contributors to the product failure rate; these problem areas can then be addressed and improved.

Trade-Off System Design Factors: There are many factors that determine the overall value of a product; functional performance, cost, size, weight, reliability, and other parameters must all be integrated for a successful design. The design process will thus involve many trade-offs among these factors; reliability predictions can offer a quantitative measure of reliability to guide your trade-off decisions.

Track Reliability Improvement: As you progress through the design, reliability predictions can offer evidence of improving reliability, allowing designers, management, and customers to track progress toward reliability goals.

Ways to Improve Reliability

As you design your product, you can improve reliability by using the following ideas; note that reliability predictions allow you to quantitatively measure the effects of improvement steps.

Reduce Part Count: In general, reducing part count will increase reliability. You can use innovative design ideas, and more highly integrated functional parts, to reduce the number of parts without affecting circuit performance; part count reduction can also lead to lower cost and less board space required.

Part Selection: The quality and reliability of the components you select for your product is very important; select suppliers that produce high quality, high reliability parts.

Derating: Part failure rates generally decrease as applied stress levels decrease. Thus, derating, or operating the part at levels below it's ratings (for current, voltage, power dissipation, temperature, etc.) can increase reliability. Part derating can be achieved by circuit design (minimize applied part stress), part selection (use part with ratings well above given applied stress), and thermal design (reduce part operating temperature).

Burn-In: Burn-in is operation in your factory, at elevated temperature, to accelerate the rate of infant mortality failures; burn-in allows you to weed out failure prone devices in your factory, rather than in the field. Note that burn-in can be done at the part, board, or system level.

Redundancy: Product reliability may also be enhanced by using redundant design techniques.

How Reliability Can Pay Off

To give you an idea of how the reliability of your product can impact your company's fortunes, consider an example. We will assume: the typical customer operates your product for 300 hours per month; your product warranty is for 1 year; an exponential reliability function. We will tabulate the expected failures of field units in one year, based on product MTBF in hours.

MTBF	Failure Free	Failure
5,000	48.7%	51.3%
10,000	69.8%	30.2%
20,000	83.5%	16.5%
40,000	91.4%	8.6%

Note that at 5,000 hours MTBF, over half of the units can be expected to fail in the one year period. When you consider that every failure costs you repair dollars, and also represents a potentially unhappy customer, you can see how your business literally depends on your product's reliability.

Ways to Do Reliability Prediction

You can use various reliability prediction techniques, depending on your knowledge of the details of your design. An early estimate can be made by comparing your product with products of similar function or complexity, of known reliability; generally, this will be a crude estimate at best, as the many differences in design details between the products are not accounted for.

As more details of your design are known, more accurate methods become available. These methods utilize part failure rate models, which predict the failure rates of parts based on various part parameters, such as technology, complexity, package type, quality level, and stress levels.

Two of the better known failure rate prediction methods are MIL-HDBK-217, and Bellcore. These handbooks offer documented procedures for predicting electronic product reliability, providing a standard basis for comparing reliability numbers.

Limitations of Reliability Prediction

To use quantitative reliability prediction methods such as MIL-HDBK-217 and Bellcore wisely, you should be aware of their limitations. Like all engineering models, the failure rate models are approximations to reality. The failure rate models are based on the best field data that could be obtained for a wide variety of parts and systems; this data is then analyzed and massaged, with many simplifying assumptions thrown in, to create usable models. Then, when you use the model, you make more assumptions for the design parameters you enter, such as stress and temperature.

<u>Thus you should not treat a reliability prediction number for your product as an absolute prediction of it's field failure rate</u>. It is generally agreed that these predictions can be very good when used for relative comparisons, such as comparing design alternatives, or comparing products. Note also that reliability predictions do not account for substandard quality control for purchased parts, bad workmanship, poor product level quality control, overstressed field operation, etc.

Many people get caught up in the numbers game, manipulating the reliability prediction numbers for one purpose or another; you will be best served if you use reliability prediction as one of the tools that can guide you to more reliable products.

Description of Methodology

The parts count method is a technique for developing an estimate or prediction of the average life, the Mean-Time-Between-Failures (MTBF), of an assembly. It is a prediction process whereby a numerical estimate is made of the ability, with respect to failure, of a design to perform its intended function. Once the failure rate is determined, MTBF is easily calculated as the inverse of the failure rate, as follows:.

$$MTBF = \frac{1}{FR_1 + FR_2 + FR_3 + ...FR_n}$$

where FR is the failure rate of each component of the system up to n, all components.

The general procedure for determining a board level (or system level) failure rate is to sum individual failure rates for each component. For MIL-HDBK-217, the summation is then added to a failure rate for the circuit board, which includes the affect of solder joints. Component failure rates are provided by MIL-HDBK-217, "Military Handbook, Reliability Prediction of Electronic Equipment", as standard part failure rate models or directly from the manufacturers.

The failure rates presented apply to equipment under normal operating conditions, i.e., with power on and performing its intended function in its intended environment. Consideration is given to various environments, component quality, and thermal aspects.

Reliability Standards

There are several methods and standards that provide the basic core mathematical models for reliability calculations. The standards and a description of each follows.

MIL-HDBK-217

MIL-HDBK-217 is the original standard for reliability calculations. It provides reliability math models for nearly every conceivable type of electronic device. Used by both commercial companies and the defense industry, MIL-HDBK-217 provides detailed reliability equations. MIL-HDBK-217, which is updated regularly, is currently at Revision F Notice 2.

This standard uses a series of models for various categories of electronic, electrical and electro-mechanical components to predict failure rates which are affected by environmental conditions, quality levels, stress conditions and various other parameters. These models are fully detailed in MIL-HDBK-217.

Parts Count

A section of MIL-HDBK-217, known simply as the Parts Count section, provides simpler reliability math models for the various part types. Most of the part parameters requested in the main body of MIL-HDBK-217 (also known as the Part Stress section) are automatically defaulted to average values in the Parts Count section. Parts Count reliability calculations are normally used early in a design when detailed information is not available, or when a rough estimate of reliability is all that is required.

Bellcore

The Bellcore reliability standard, Reliability Prediction Procedure for Electronic Equipment, TR-332, Issue 6, Dec. 97, is a very popular standard for commercial companies. It was originally developed at AT&T Bell Laboratories, and was based on MIL-HDBK-217. Bell Labs modified the equations from MIL-HDBK-217 to provide results which better represented what their equipment was experiencing in the field. They also added the ability to take into account burn-in testing, as well as field and laboratory testing. Bell Communications Research, formed in the divestiture of the former Bell System on January 1, 1984, was the controlling organization of the Bellcore reliability standard.

Telcordia

The Bellcore TR-332 was replaced by the Telcordia Special Report SR-332, Reliability Prediction Procedure for Electronic Equipment, currently at Issue 4, March 2016. The document is prepared by Telcordia Network Infrastructure Solutions (NIS), a divison of Ericsson Inc. It replaced SR-332 Issue 3, January 2011 and February 2001 update.

Mechanical

The Handbook of Reliability Prediction Procedures for Mechanical Equipment, NSWC-94/L07, provides models for various types of mechanical devices including springs, bearings, seals, motors, brakes, clutches, and much more. This relatively new standard is the only one of its kind - providing detailed reliability math models for mechanical devices. This latest issue date of this mechanical standard is March 1994.

CNET

The CNET reliability standard from France T,l,com is the French reliability standard for telecommunications equipment. CNET, developed in 1983, was originally based on MIL-HDBK-217. The most recent revision of the document, RDF 93, provides many enhancements.

The Equations

A sample calculation for integrated circuits taken from MIL-HDBK-217 is as follows:

Failure Rate = (C1 * PiT + C2 * PiE) * PiQ * PiL

Each factor in this equation is dependent upon a certain part parameter. The end result of this equation is the failure rate of the integrated circuit.

Failure Rate & MTBF

For this discussion, we will assume that the resulting failure rate is shown in failures per million hours. This is simply the number of failures that you would expect to have in a million hours of operation of your equipment. Failure rates for many basic devices are well below 1 failure per million hours, so these values may seem insignificant. But if you have hundreds of parts in your design and have a thousand systems operating in the field, you can see that the failure rates will quickly add up. MTBF, or Mean Time Between Failures, is the inverse of the failure rate and is the average time between failures. It is calculated from the failure rate as follows:

MTBF = 1,000,000/Failure Rate

You can choose the units in which the failure rate is shown. Another common unit used, besides failures/million hours, is failures per billion hours which is sometimes known as FITs.

Environmental Factors

Environmental Conditions and Multiplier Factors (π_E)

ENVIRONMENT	SYMBOL	π_E	NOMINAL ENVIRONMENTAL CONDITIONS
Ground, Fixed, Controlled	G_B	1	Vibration/shock stresses: Low Atmospheric variations: Low Temperature cycling stresses: Low Application examples: Central office, data center, environmentally controlled vaults, environmentally controlled remote shelters, and environmentally controlled customer premise areas.
Ground, Fixed, Uncontrolled (Limited)	G_L	1.2	Vibration/shock stresses: Low to Moderate Atmospheric variations: Low to Moderate Temperature cycling stresses: Moderate to High Factor assumes a ruggedized enclosure provides protection. Application examples: Weather-protected remote terminals, outdoor equipment, and radio tower equipment.
Ground, Fixed, Uncontrolled (Moderate)	G_F	1.5	Vibration/shock stress: Moderate to High Atmospheric variations: Low to Moderate Temperature cycling stresses: Moderate to High Factor assumes a ruggedized enclosure provides protection. Application examples: Remote terminals and outdoor equipment in manholes, and near direct path of railroad, highway, and air traffic.
Ground, Mobile (both vehicular mounted and portable)	G_M	2	Vibration/shock stress: Extreme Atmospheric variations: Low to Moderate Temperature cycling stresses: High (Variations due to transport and different locations) Application examples: Equipment that can be in rapid motion relative to the ground, including cell phones and hand-held devices, portable operating equipment, and test equipment.

Airborne, Commercial	A_C	3	Vibration/shock stress: Extreme Atmospheric variations: High Temperature cycling stresses: High (Variations due to transport and different locations at different altitudes) Application example: Passenger compartment of commercial aircraft.
Space-based, Commercial (low earth orbit)	S_C	See MIL-217 or other applicable standards	Vibration/shock stress: Extreme Atmospheric variations: High Temperature cycling stresses: High (Variations due to transport and different locations at different altitudes) Application example: Communication satellites.

Device Quality Levels and Factor π_Q

QUALITY LEVEL 0 — This level shall be assigned to commercial-grade, reengineered, remanufactured, reworked, salvaged, or gray-market components that are procured and used without device qualification, lot-to-lot controls, or an effective feedback and corrective action program by the primary equipment manufacturer or its outsourced lower-level design or manufacturing subcontractors. However, steps must have been taken to ensure that the components are compatible with the design application. **Quality Factor π_Q = 6**
QUALITY LEVEL I — This level shall be assigned to commercial-grade components that are procured and used *without* thorough device qualification or lot-to-lot controls by the equipment manufacturer. However, **(a)** steps must have been taken to ensure that the components are compatible with the design application and manufacturing process; and **(b)** an effective feedback and corrective action program must be in place to identify and resolve problems quickly in manufacture and in the field. **Quality Factor π_Q = 3**
QUALITY LEVEL II — This level shall be assigned to components that meet requirements (a) and (b) of Quality Level I, plus the following: **(c)** purchase specifications must explicitly identify important characteristics (electrical, mechanical, thermal, and environmental) and acceptable quality levels (i.e., AQLs, Defects Per Million [DPMs], etc.) for lot control; **(d)** devices and device manufacturers must be qualified and identified on approved parts/manufacturer's lists (device qualification must include appropriate life and endurance tests); **(e)** lot-to-lot controls, either by the equipment manufacturer or the device manufacturer, must be in place at adequate AQLs/DPMs to ensure consistent quality. **Quality Factor π_Q = 1**
QUALITY LEVEL III — This level shall be assigned to components that meet requirements (a) through (e) of Quality Levels I and II, plus the following: **(f)** device families must be requalified periodically; **(g)** lot-to-lot controls must include early life reliability control of 100% screening (temperature cycling and burn-in), which, *if the results warrant it*, may be reduced to a "reliability audit" (i.e., a sample basis) or to an acceptable "reliability monitor" with demonstrated and accepted cumulative early failure values of less than 200 ppm out to 10,000 hours; **(h)** where burn-in screening is used, the Percent Defective Allowed (PDA) shall be specified and shall not exceed 2%; and **(i)** an ongoing, continuous reliability improvement program must be implemented by both the device and equipment manufacturers. **Quality Factor π_Q = 0.8**

Appendix B

Assembly and Component Failure Data

MTBF Prediction Report

P/N Detail, Sorted by TFR

ASSM, FE1

P/N:

Environment: GB,GC - Ground Benign, Controlled, Temperature: 25°C

Category	P/N	Description	Mfgr. P/N	Ref. Des.	Qty.	FR, Unit	TFR	T Rise (C)	Stress (%)
IC	160-0107	PROC.,PENT,SPGA321,233MHZ	FV8050366-233	U3	1	337.2754	337.2754	62.0	na
Capacitor	110-0127	CAP, 68UF, 6.3V	TAJC686K006R	C117-C174	29	318.8816	10.9959	2.0	79.4
Connector	140-0108	CONN, 352009-1	352009-1	U4	1	225.2175	225.2175	na	na
IC	170-0107	SRAM 256X18	GVT71256E18T-7.5	U10-U26	17	184.4402	10.8494	3.0	na
transistor	157-0105	NCHAN-MOSFET	MMSF5N02HD	M1,M2,M3,M4	4	70.0813	17.5203	10.0	50.0
Fan	218-0101	FAN/ HEATSINK, INTEL PROC.	109P4412H8026	U3	1	50.0000	50.0000	na	na
IC	155-0111	3.3V 18-BIT BIDIREC BFFR/LTCH/REGISTER	IDT74FCT163501CPV	U31,U32,U33,U34	4	41.4066	10.3517	5.0	na
Resistor	100-0123	RES 10 OHM 0805 1/4W	MCR10EZHF10R0	R115-R272,	91	35.7589	0.3930	2.0	50.0
Resistor	100-0124	RES 0805 33.2, 1%, 1/4W	CRCW080533R2FT	R1-R248	84	33.0082	0.3930	2.0	50.0
Capacitor	110-0114	CAP 0.1U SMD0805	CC0805HX7R104K	C1-C66	130	23.2715	0.1790	2.0	10.0
Connector	140-0119	CONN, J1 ASSEMBLY	352068-1	J1,J4	2	20.8623	10.4311	na	na
Resistor	100-0106	RES 10K 0805	9C08052A1002F	R35-R270	49	19.2548	0.3930	2.0	50.0
Resistor	100-0105	RES_0805_1K	9C08052A1001F	R16-R342	46	18.0759	0.3930	2.0	50.0
Resistor	100-0111	RES 22 0805	9C08052A22ROJL	R9-R179	44	17.2900	0.3930	2.0	50.0
Capacitor	110-0118	CAP POLAR 10UF 16V	TAJC106K016R	C141,C142,C166	3	11.7886	3.9295	2.0	50.0
IC	155-0114	16-Bit Non-Inverted Registered XCVR	PI74LPT16952VC	U28,U36	2	10.4277	5.2138	5.0	na
IC	155-0110	3.3V 16-BIT REGISTER	IDT74FCT163374CPV	U7	1	9.2029	9.2029	5.0	na
IC	158-0106	SP232ACN (16PIN SOIC)	SP232ACN (16PIN SOIC)	U2	1	8.4147	8.4147	5.0	na
LED	115-0102	LED_BI_10MA_GG	553-0122-300	D1,D2,D3,D4,D5	5	5.3319	1.0664	3.0	na
Resistor	100-0116	RES 50 0805	9C08052A49R9F	R96-R104,R335-R337	12	4.7155	0.3930	2.0	50.0
Resistor	100-0110	RES 220 OHM 0805	9C08052A2200F	R4,R106-R114	10	3.9295	0.3930	2.0	50.0
IC	155-0112	3.3V & 5V PLL Clock Generators	IDT74FCT388915T-133PY	U29,U30	2	3.5085	1.7542	5.0	na
Connector	157-0112	POWER IC, MIC5158BM	MIC5158BM	U5	1	2.1522	2.1522	10.0	na
Capacitor	110-0108	CAP 0.001U SMD0805	C0805C102K5RAC	C105-C114,C143,C144	12	2.1481	0.1790	2.0	10.0
Connector	140-0104	POSTS 2X5 W SHROUD	103308-1	P1,P2	2	1.8966	0.9483	na	na
Resistor	100-0117	RES 511 0805	9C08052A5110FK	R32,R84,R339,R340	4	1.5718	0.3930	2.0	50.0
Resistor	100-0103	RES ZERO OHM 0805	9C08052A0R00JL	R31,R85,R343,R344	4	0.8206	0.2051	2.0	0.0
IC	175-0105	PAL	EPM7128SQC100-7	U1,U37,U38,U40-U48	12	0.7956	0.0663	3.0	na
IC	175-0101	PLA	EPF10K30BC356-3	U6	1	0.6007	0.6007	3.0	na
IC	175-0123	1024-Bit Serial EEPROM	NM93C46ALM8	U39	1	0.2325	0.2325	3.0	na
IC	175-0104	PLA	EPM7064STC44-7	U8,U9	2	0.1326	0.0663	3.0	na

MTBF Prediction Report

P/N Detail, Sorted by TFR

DS3 PACKET

P/N:

Environment: GB,GC - Ground Benign, Controlled, Temperature: 25°C

Category	P/N	Description	Mfgr. P/N	Ref. Des.	Qty.	FR, Unit	TFR	T Rise (C)	Stress (%)
IC	155-0113	IC,BUS SWITCHS,10 BIT,SO24-9,TSSOP24	IDT74FST3384PG	U58-,U63	6	82.3231	13.7205	5.0	na
Oscillator	150-0104	OSC 44.736mHz VECTRON	HGTCCR44.736	Y1	1	60.0000	60.0000	na	na
Transistor	157-0113	IRL-3103S	IRL-3103S	M3	1	25.7434	25.7434	25.0	50.0
IC	155-0117	DS3/E3/STS-1 Line Interface	78P7200-IH	U30	1	25.4128	25.4128	25.0	na
IC	158-0103	DS3 FRAMER - BROOKTREE	BT8330EPJC	U29	1	25.4128	25.4128	25.0	na
IC	158-0105	DSCC4	PEB20534H52-V20	U52	1	25.4128	25.4128	25.0	na
IC	170-0104	IC, CLK BUFFER, 24 PIN, SOIC	CY7B9910-2SC	U39	1	15.5602	15.5602	3.0	na
Inductive	130-0101	IND_180MA_6P8UH	NL322522T-6R8J	L2	1	14.9323	14.9323	2.0	na
Inductive	130-0102	IND_450MA_OP47UH	NL322522T-R47J	L1	1	14.9323	14.9323	2.0	na
IC	157-0104	DUAL 4 INPUT MUX	MC7153D	U70	1	13.8825	13.8825	5.0	na
IC	157-0109	QUAD OR	MC74F32D	U10	1	13.5515	13.5515	5.0	na
IC	157-0111	IC,QUAD TRI STATE BFFR, 5V,16PIN, SOP	MC74F125D	U76	1	12.3970	12.3970	3.0	na
Resistor	100-0146	RES, 0805, 33.2	CRCW080533R2	R38-R286	31	12.1816	0.3930	2.0	50.0
Inductive	130-0106	CMODE_CHOKE	23Z428SM	L6,L7	2	11.0027	5.5014	2.0	na
Connector	140-0119	CONN, J1 ASSEMBLY	352068-1	J1	1	10.4311	10.4311	na	na
IC	155-0119	FAST CMOS BUF/CLK DRV	74FCT810CTSO20-2	U2	1	8.4644	8.4644	5.0	na
IC	175-0107	EPROM 93C46 (5 VOLT PART)	AT93C46-10SC	U40	1	7.3076	7.3076	5.0	na
IC	155-0128	IC, 5-Tap Silicon Delay Line	DS1000Z-25	U79,U80	2	6.5497	3.2749	3.0	na
Inductive	130-0103	TRANSF_ MINI	ST5045	T1,T2	2	6.4096	3.2048	3.0	na
Resistor	100-0110	RES 220 OHM SMD0805	9C08052A2200F	R4-R67	16	6.2873	0.3930	2.0	50.0
Capacitor	110-0108	CAP .001U SMD0805	C0805C102K5RAC	C47-C169	29	5.1913	0.1790	2.0	10.0
Capacitor	110-0114	CAP .1U SMD0805	CC0805HX7R104K	C11-C165	29	5.1913	0.1790	2.0	10.0
Capacitor	110-0105	CAP__TANT_4P7UF	AVX_TAJD475M050R	C41,C42,C44,C46,C126	5	4.9393	0.9879	3.0	10.0
Capacitor	110-0125	CAP TANT 22UF 25V	TPSD226025R0200	C70,C156,C157	3	4.2056	1.4019	3.0	20.0
Resistor	100-0103	RES_0805_ZERO_OHM	9C08052A0R00JL	R47-R275	11	4.1575	0.3780	0.0	0.0
LED	115-0104	LED, BI 10MA GY	553-0132-300	CR2	1	3.1992	3.1992	3.0	na
Resistor	100-0106	RES_0805_10K	9C08052A1002F	R19-R82	11	2.9266	0.2661	2.0	20.0
Capacitor	110-0104	CAP__TANT_1UF_50V	AVX_TAJC105M050R	C10,C163	2	1.9757	0.9879	3.0	10.0
Resistor	100-0105	RES_0805_1K	9C08052A1001F	R39,R40,R83,R84, R285,R361	6	1.5963	0.2661	2.0	20.0
Resistor	100-0114	RES_0805_422	9C08052A4220F	R1,R193,R194,R198,- R200	6	1.5963	0.2661	2.0	20.0