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**Glossary of
Reliability
Terminology
Associated with
Automotive
Electronics**

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GLOSSARY OF RELIABILITY TERMINOLOGY ASSOCIATED WITH AUTOMOTIVE ELECTRONICS

1. INTRODUCTION:

This glossary has been compiled to assist, by serving as a reference, in the communication between the automotive electronics engineer and the reliability engineer.

2. SCOPE:

This compilation of terms, acronyms and symbols was drawn from usage which should be familiar to those working in automotive electronics reliability. Terms are included which are used to describe how items, materials and systems are evaluated for reliability, how they fail, how failures are modeled and how failures are prevented. Terms are also included from the disciplines of designing for reliability, testing and failure analysis as well as the general disciplines of Quality and Reliability Engineering. This glossary is intended to augment SAE J1213, Glossary of Automotive Electronic Terms.

3. REFERENCES:

A listing of applicable military and other organizational reference documents, from which many of these terms and definitions were drawn, is provided as a source of alternate or related definitions.

MILITARY

MIL-STD-105D	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-202E	Test Methods for Electronic and Electrical Component Parts
MIL-HDBK-217D	Reliability Prediction of Electronic Equipment
MIL-STD-280A	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms
MIL-STD-414	Sampling Procedures and Tables for Inspection by Variables for Percent Defective

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3. (Continued):

MIL-STD-756B	Reliability Models and Prediction
MIL-STD-781C	Reliability Design Qualification and Production Acceptance Tests - Experimental
MIL-STD-790B	Reliability Assurance Program for Electronic Parts Specification
MIL-STD-810C	Environmental Test Methods
MIL-STD-883B	Test Methods and Procedures for Microelectronics
MIL-STD-1313	Microelectronics Terms and Definitions
MIL-Q-9858A	Quality Program Requirements
AR-92	Quality Program Requirements
MIL-S-195001	Semiconductor Devices, General Specification for
MIC M38510D	Microcircuits, General Specifications for
MIL-STD-470	Maintainability Program Requirements for Systems and Equipments
MIL-STD-471A	Maintainability Verification/Demonstration/Evaluation
MIL-HDBK-472	Maintainability Prediction
MIL-STD-891	Contractor Parts Control and Standardization Program
MIL-STD-701	Preferred and Guidance List of Semiconductor Devices
MIL-STD-198A	Selection and Use of Capacitors
MIL-STD-199B	Selection and Use of Resistors
MIL-STD-1562	List of Standard Microcircuits
MIL-STD-976	Certification Requirements for JAN Microcircuits

EIA

Reliability Bulletin No. 1	A General Guide for Technical Reporting of Electronic Reliability Measurement
Reliability Bulletin No. 4A	Reliability Qualifications
Reliability Bulletin No. 5	Equipment Reliability Specification Guideline
Reliability Bulletin No. 10	Selection and Validation of Low Population and/or State of the Art Parts
Reliability Bulletin No. 9	Failure Mode and Effects Analyses
Reliability Bulletin No. 8	Equipment Burn-In
Engineering Bulletin No. 17	User Guidelines for Quality and Reliability Assurance of LSI Components
Engineering Bulletin No. 11	User Guidelines for Microelectronic Reliability Estimation
JEDEC Standard No. 22	Test Methods and Procedures for Solid State Devices Used in Transportation/Automotive Applications

OTHER

Glossary and Tables for Statistical Quality Control	- ASQC 1973
PROCUREMENT QUALITY CONTROL - 2nd Edition	- ASQC
Quality Systems Terminology	- ANSI/ASQC A3-1978
Terms, Symbols and Definitions for Acceptance Sampling	- ANSI/ASQC A2-1978
Definitions, Symbols, Formulas and Tables for Control Charts	- ANSI/ASQC A1-1978
How to Speak Fluent Quality	- National Semiconductor Co.

3. (Continued):

Reliability Design Handbook	RDH 376	- Reliability Analysis Center
Analysis Techniques for Mechanical Reliability	WPS-1	- Reliability Analysis Center
1987 Desk Manual		- Microelectronic Manufacturing and Testing
Glossary of Automotive Electronic Terms		- SAE HS J1213 1982
Automotive Electronics Reliability Handbook		- SAE AE-9 1987
The American Heritage Dictionary		- 2nd College Edn. 1982 Houghton Mifflin Co.

4. RELIABILITY GLOSSARY:

ACCELERATED LIFE TEST

A life test under test conditions that are more severe than usual operating conditions. It is necessary that a relationship between test severity and the probability distribution of life be ascertainable.

ACCELERATION FACTOR

- (1) The factor by which the failure rate can be increased by an increased environmental stress.
- (2) The ratio between the times necessary to obtain the same portion of failure in two equal samples under two different sets of stress conditions, involving the same failure modes and mechanisms.

ACCEPT/REJECT TEST

A test, the result of which will be the action to accept or reject something, for example, an hypothesis or a batch of incoming material.

ACCEPTABLE QUALITY LEVEL (AQL)

The maximum percent defective which can be considered satisfactory as a process average, or the percent defect whose probability of rejection is designated by α .

ACCEPTANCE NUMBER

The largest number of defects that can occur in an acceptance sampling plan and still have the lot accepted.

ACCEPTANCE SAMPLING PLAN

An accept/reject test whose purpose is to accept or reject a lot of items or material.

4. (Continued):

ACCESSIBILITY

A measure of the relative ease of admission to the various areas of an item.

ACHIEVED RELIABILITY

The reliability demonstrated at a given point in time under specified conditions of use and environment.

ACTIVATION ENERGY

- (1) The energy level at which a specific microelectronic failure mechanism becomes active (in electron-volts).
- (2) The slope of the time-temperature regression line in the Arrhenius equation (in electron-volts).

ACTIVE ELEMENT

A part that converts or controls energy, for example, transistor, diode, electron tube, relay.

ACTIVE ELEMENT GROUP

An active element and its associated supporting (passive) parts, for example, an amplifier circuit, a relay circuit, a pump and its plumbing and fittings.

AGING

The effect whereby the probability density function of strength is changed (strength is reduced) with time.

ALLOCATION

The process of assigning reliability requirements to individual units to attain the desired system reliability.

ALPHA PARTICLE INDUCED SOFT ERRORS

Integrated circuit memory transient errors due to emission of alpha particles during radioactive decay of uranium or thorium contamination in the IC packaging material.

AMBIENT

Used to denote surrounding, encompassing, or local conditions. Usually applied to environments, for example, ambient temperature, ambient pressure.

4. (Continued):

APPORTIONMENT

Synonym of Allocation.

ARITHMETIC MEAN

The arithmetic mean of n numbers is the sum of the n numbers, divided by n .

ARRHENIUS MODEL

A mathematical representation of the dependence of failure rate on absolute temperature and activation energy. The model assumes that degradation of a performance parameter is linear with time with the failure rate a function of temperature stress. The temperature dependence is taken to be the exponential function:

$$\theta_1 = \theta_2 \exp [(E/k)(1/T_2 - 1/T_1)]$$

θ_1 = mean time to failure at T_1

θ_2 = mean time to failure at T_2

T = junction temperature in K

E = activation energy in eV

k = Boltzman's constant ($8.617 \cdot 10^5$ eV/K)

ARRHENIUS ACCELERATION FACTOR

The acceleration factor F is the factor by which the time to fail can be reduced by increased temperature.

$$F = \theta_1/\theta_2 = \exp (E/k)(1/T_2 - 1/T_1)$$

ASSESSMENT

- (1) A critical appraisal, including qualitative judgments about an item, such as importance of analysis results, design criticality and failure effect.
- (2) The use of test data and/or operational service data to form estimates of population parameters and to evaluate the precision of these estimates.

ATTRIBUTE

A term used to designate a method of measurement whereby units are examined by noting the presence (or absence) of some characteristic or attribute in each of the units in the group under consideration and by counting how many units do (or do not) possess it. Inspection by attributes can be of two kinds - either the unit of product is classified simply as defective or nondefective, or the number of defects in the unit of product is counted, with respect to a given requirement or set of requirements.

4. (Continued):

ATTRIBUTE TESTING

Testing to evaluate whether or not an item possesses a specified attribute.

AUTOMATIC TEST EQUIPMENT (ATE)

Test equipment that contains provisions for automatically performing a series of pre-programmed tests.

AVAILABILITY (OPERATIONAL READINESS)

The probability that at any point in time the system is either operating satisfactorily or ready to be placed in operation on demand when used under stated conditions.

AVERAGE

A general term. It often means arithmetic mean, but can refer to s-expected value, median, mode, or some other measure of the general location of the data values.

AVERAGE OUTGOING QUALITY (AOQ)

The average quality of outgoing product after 100% inspection of rejected lots, with replacement by good units of all defective units found in inspection.

AVERAGE OUTGOING QUALITY LIMIT (AOQL)

The maximum average outgoing quality (AOQ) for a sampling plan.

BAKE-OUT

To subject an unsealed item to an elevated temperature to drive out moisture and unwanted gases prior to other process or sealing.

BATHTUB CURVE

A plot of failure rate of an item (whether repairable or not) vs. time. The failure rate initially decreases, then stays reasonably constant, then begins to rise rather rapidly. It has the shape of a bathtub. Not all items have this behavior.

BIAS

- (1) The difference between the s-expected value of an estimator and the value of the true parameter.
- (2) Applied voltage.

4. (Continued):

BINOMIAL DISTRIBUTION

The probability of r , or fewer successes in n independent trials, given a probability of success p in a single trial, is given by the cumulative binomial distribution:

$$\Pr (x \leq r) = F (r; p, n) = \sum_{x=0}^r \binom{n}{x} p^x (1-p)^{n-x}$$

BINOMIAL FUNCTION

The probability of exactly x successes in n independent trials, given a probability of success p in a single trial, is given by the binomial probability function:

$$f (x; p, n) = \binom{n}{x} p^x (1-p)^{n-x}, \quad x = 0, 1, 2, \dots, n$$

BOND

- (1) An interconnection which performs a permanent electrical and/or mechanical function.
- (2) To join with adhesives.

BOND LIFT OFF

The failure mode whereby the bonded lead separates the surface to which it was attached.

BOND STRENGTH

In wire bonding, the pull force at rupture of the bond interface.

BREADBOARD MODEL

A preliminary assembly of parts to test the feasibility of an item or principle without regard to eventual design or form. Usually refers to a small collection of electronic parts.

BURN-IN

The initial operation of an item to stabilize its characteristics, and to minimize infant mortality in the field.

4. (Continued):

CAPABILITY

- (1) A measure of the ability of an item to achieve mission objectives given the conditions during the mission.
- (2) The spread of performance of a process in a state of statistical control; the amount of variation from common causes identified after all special causes of variation have been eliminated.

C CHART

Control chart for number of nonconformities observed in some specified inspection. The units should be alike in size and in the apparent likelihood of the existence of the nonconformity, in order that the area of opportunity for nonconformity be constant from unit to unit.

CENTRAL LINE

The line on a control chart that represents the average or median value of the items being plotted. It is shown as a solid line.

CHECKOUT

Tests or observations on an item to determine its condition or status.

COEFFICIENT OF VARIATION

The standard deviation divided by the mean, multiplied by 100 and expressed as a percentage.

COMPLEXITY LEVEL

A measure of the number of active elements required to perform a specific system function.

COMPONENT

A self-contained combination of parts, subassemblies, or assemblies which perform a distinctive function in the overall operation of an equipment. Often used interchangeably with (electronic) part.

CONFIDENCE

A specialized statistical term referring to the reliance to be placed in an assertion about the value of a parameter of a probability distribution.

4. (Continued):

CONFIDENCE COEFFICIENT

- (1) A measure of assurance that a statement based upon statistical data is correct.
- (2) The probability that an unknown parameter lies within a stated interval or is greater or less than some stated value.

CONFIDENCE INTERVAL

The interval within which it is asserted that the parameter of a probability distribution lies.

CONFIDENCE LEVEL

Equals $1-\alpha$ where α = the risk (%).

CONFIDENCE LIMIT

A bound of a confidence interval.

CONSISTENCY

A statistical term relating to the behavior of an estimator as the sample size becomes very large. An estimator is consistent if it converges to the population value as the sample size becomes large.

CONSTANT FAILURE RATE

- (1) A term characterizing the instantaneous failure rate in the middle, or "useful life" period of the Bathtub Curve model of item life.
- (2) A term characterizing the hazard rate, $h(t)$, of an item having an exponential reliability function.

CONTAMINATION

A general term used to describe an unwanted material that adversely affects the physical or electrical characteristics of an item.

CONTINUOUS SAMPLING PLAN

In acceptance sampling, a plan intended for application to a continuous flow of individual units of product that involves acceptance or rejection on a unit-by-unit inspection and sampling. Continuous sampling plans are usually characterized by requiring that each period of 100% inspection be continued until a specified number of consecutively inspected units are found clear of defects.

4. (Continued):

CORRECTIVE ACTION

A documented design, material or process change to correct the true cause of a failure. Part replacement with a like item does not constitute appropriate corrective action. Rather, the action should make it impossible for that failure to happen again.

CORRELATION

A form of statistical dependence between two variables. Unless stated otherwise, linear correlation is implied.

CORRELATION COEFFICIENT

A number between -1 and +1, which indicates the degree of linear relationship between two sets of numbers. Coefficients of -1 and +1 represent perfect linear agreement between two variables, while a coefficient of zero implies none.

CORRODE

To dissolve or wear away gradually, especially by chemical action.

CORROSION

The deterioration of a substance (usually a metal) because of a reaction with its environment, or with a corroding agent.

COSMETIC DEFECT

A variation from the conventional appearance of an item such as a slight change in its color, not necessarily detrimental to service performance.

COST-EFFECTIVENESS

A measure of the value received for the resources expended.

CRACK

Evidence of a full or partial break without separation of parts.

CRAZE

A network of fine cracks in the surface.

CREEP

- (1) Elongation or fracture resulting from loads sustained over relatively long time at high temperatures.
- (2) The dimensional change with time of a material under load.

4. (Continued):

CRITICALITY

A relative measure of the consequences of a failure.

CRITICALITY ANALYSIS

A procedure by which each potential failure mode is evaluated and ranked according to the combined influences of severity and probability of occurrence.

CUMULATIVE DISTRIBUTION FUNCTION (CDF)

The probability that the random variable takes on any value less than or equal to a value x , that is,

$$\text{Cdf}(x) = \text{pr}(X \leq x)$$

The unreliability function with regard to failures

$$F(t) = \text{Pr}(T \leq t)$$

CUT SET

In a Fault Tree, any basic event or combination of basic events whose occurrence will cause the top event to occur.

DEBUGGING

The period of "shakedown operation" of a finished equipment performed prior to placing it in use. During this period, defective parts and workmanship errors are corrected under test conditions that closely simulate field operation.

DECAP

To de-encapsulate. To remove the cover or plastic encapsulant on an item.

DECREASING FAILURE RATE

- (1) A term characterizing the instantaneous failure rate in the first or "infant mortality" period of the Bathtub Curve model or product life.
- (2) A term characterizing the hazard rate $h(t)$ of an item having a Weibull reliability function with slope $B < 1$.

DEFECT

A deviation of an item from some ideal state. The ideal state is usually given in a formal specification.

4. (Continued):

DEFECT, CRITICAL

A defect that could result in hazardous or unsafe conditions for individuals using, maintaining or depending on the item.

DEFECTIVE

A unit of product which contains one or more defects.

DEGRADATION

A gradual deterioration in performance as a function of time.

DELTA LIMITS

The difference between initial and final readings usually associated with the difference between the zero time readings on a life test and the final readings. Determine how much parameters shift during the test.

DEMONSTRATED

That which has been proven by the use of concrete evidence gathered under specified conditions.

DEPENDABILITY

A measure of the item operating condition at one or more points during the mission, including the effects of Reliability, Maintainability and Survivability, given the item condition(s) at the start of the mission. It may be stated as the probability that an item will (1) enter or occupy any one of its required operational modes during a specified mission and (2) perform the functions associated with those operational modes.

DERATING

The intentional reduction of stress/strength ratio in the application of an item, usually for the purpose of reducing the occurrence of stress-related failures.

DESIGN ADEQUACY

The probability that the system will satisfy effectiveness requirements, given that the system design satisfied the design specification.

DEVICE

Any subdivision of a system; synonym for ITEM.