Reliability and Statistics Glossary

DEFINITIONS

Accelerated Life Test: A life test under conditions that are more severe than usual operating conditions. It is helpful, but not necessary, that a relationship between test severity and the probability distribution of life be ascertainable.

Acceleration Factor: Notation: f(t) = the time transformation from more severe test conditions to the usual conditions. The acceleration factor is f(t)/t. The differential acceleration factor is df(t)/dt.

Acceptance Number: The largest numbers of defects that can occur in an acceptance sampling plan and still have the lot accepted.

Acceptance Sampling Plant: An accept/reject test the purpose of which is to accept or reject a lot of items or material based on random samples from the lot.

Assessment: A critical appraisal including qualitative judgments about an item, such as importance of analysis results, design criticality, and failure effect.

Attribute (Inspection by): 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 two kinds: either the unit of product is classified simply as defective or not defective or the number of defects in the unit of product is counted with respect to a given requirement or set of requirements.

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

Auger Electron Spectrometer: An instrument, that identifies elements on the surface of a sample. It excites the area of interest with an electron beam and observes the resultant emitted Auger electrons.
These electrons have the specific characteristics of the near surface elements. It is usually used to identify very thin films, often surface contaminants.

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 Outgoing Quality (AOQ): The average quality of outgoing product after 100 % inspection of a rejected lot, with replacement by good units of all defective units found in inspection.

Bathtub Curve: A plot of the 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 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.

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

Confidence Interval: The interval within which it is asserted that the parameters of a probability distribution lie.

Confidence Level:
Equals 1 - α

where

α = the risk (%).

Corrective Action: A documented design, process, procedure, or materials 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.

Cumulative Distribution Function (CDF): The probability that the random variable takes on any value less than or equal to a value x, e.g.
$F(x) = CDF(x) = Pr(x \leq X)$.

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

Degradation: A gradual deterioration in performance as a function of time.

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

Duty Cycle: A specified operating time of an item, followed by a specified time of no operation.

Early Failure Period: That period of life, after final assembly, in which failures occur at an initially high rate because of the presence of defective parts and workmanship. This definition applies to the first part of the bathtub curve for failure rate (infant mortality).

EDX Spectrometer: Generally used with a scanning electron microscope (SEM) to provide elemental analysis of X-rays generated on the region being hit by the primary electron beam.

Effectiveness: The capability of the system or device to perform its function.

EOS - Electrical Overstress: The electrical stressing of electronic components beyond specifications. May be caused by ESD.

ESD - Electrostatic Discharge: The transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field. Many electronic components are sensitive to ESD and will be degraded or fail.

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Expected Value: A statistical term. If x is a random variable and F (x) it its CDF, the E (x) = xdF (x), where the integration is over all x. For continuous variables with a pdf, this reduces to E (x) = ∫ x pfd (x) dx. For discrete random variables with a pfd, this reduces to
E (x) = Σ x_np (x_n) where the sum is over all n.

Exponential Distribution: A 1 parameter distribution ($\lambda > 0$, $t \leq 0$) with: pfd (t) = lexp (-λt);
Cdf (t) 0 1 - exp (-λt); Sf (t) = exp (-λt) ;
failure rate = λ; mean time-to-failure = 1/λ. This is the constant failure-rate-distribution.

Failure: The termination of the ability of an item to perform its required function.

Failure Analysis: The identification of the failure mode, the failure mechanism, and the cause (i.e., defective soldering, design weakness, contamination, assembly techniques, etc.). Often includes physical dissection.

Failure, Catastrophic: A sudden change in the operating characteristics of an item resulting in a complete loss of useful performance of the item.

Failure, Degradation: A failure that occurs as a result of a gradual or partial change in the operating characteristics of an item.

Failure, Initial: The first failure to occur in use.

Failure, Latent: A malfunction that occurs as a result of a previous exposure to a condition that did not result in an immediately detectable failure. Example: Latent ESD failure.

Failure Mechanism: The mechanical, chemical, or other process that results in a failure.

Failure Mode: The effect by which a failure is observed. Generally, describes the way the failure occurs and tells "how" with respect to operation.

Failure Rate: (A) The conditional probability density that the item will fail just after time t, given the item has not failed up to time t; (B) The number of failures of an item per unit measure of life (cycles, time, miles, events, etc.) as applicable for the item.

Failure, Wearout: Any failure for which time of occurrence is governed by rapidly increasing failure rate.

FIT: Failure Unit; (also, Failures In Time) Failures per 109 h.

Functional Failure: A failure whereby a device does not perform its intended function when the inputs or controls are correct.

Gaussian Distribution: A 2 parameter distribution with:

$$\text{pfd (x)} = \frac{1}{\sigma\sqrt{2\pi}} \cdot e^{\frac{1}{2}\left(\frac{x-u}{\sigma}\right)^2}$$

Cdf (x) = guaf (x). SF (x) = gaufc (x). "Mean value of x" u, "standard deviation of x" = σ

Hazard Rate: Instantaneous failure rate.

Hypothesis, Null: A hypothesis stating that there is no difference between some characteristics of the parent populations of several different samples, i.e., that the samples came from similar populations.

Infant Mortality: Premature catastrophic failures occurring at a much greater rate than during the period of useful life prior to the onset of substantial wear out.

Inspection: The examination and testing of supplies and services (including when appropriate, raw materials, components, and intermediate assemblies) to determine whether they conform to specified requirements.

Inspection by Attributes: Inspection whereby either the unit of product or characteristics thereof is classified simply as defective or not defective or the number of defects in the unit of product is counted with respect to a given requirement.

Life Test: A test, usually of several items, made for the purpose of estimating some characteristic(s) of the probability distribution of life.

Lot: A group of units from a particular device type submitted each time for inspection and/or testing is called the lot.

Lot Reject Rate (LRR): The lot reject rate is the percentage of lots rejected form the lots evaluated.

Lot Tolerance Percent Defective (LTPD): The percent defective, which is to be accepted a minimum or arbitrary fraction of the time, or that percent defective whose probability of rejection is designated by **b**.

Mean: (A) The arithmetic mean, the expected value; (B) As specifically modified and defined, e.g., harmonic mean (reciprocals), geometric mean (a product), logarithmic mean (logs).

Mean Life: R(t)dt; where R(t) = the s-reliability of the item; t = the interval over which the mean life is desired, usually the useful life (longevity).

Mean-Life-Between-Failures: The concept is the same as mean life except that it is for repaired items and is the mean up-time of the item. The formula is the same as for mean life except that R(t) is interpreted as the distribution of up-times.

Mean-time-between-failures (MTBF): For a particular interval, the total functioning life of a population of an item divided by the total number of failures within the population during the measurement interval. The definition holds for time, cycles, miles, events, or other measure of life units.

Mean-Time-To-Failure (MTTF): See "Mean Life".

Mean-Time-To-Repair (MTTR): The total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time.

MTTR: = G(t)dt; where G(t) = CDF of repair time;
T - maximum allowed repair time, i.e., item is treated as no repairable at this echelon and is discarded or sent to a higher echelon for repair.

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Operating Characteristic (OC) Curve: A curve showing the relation between the probability of acceptance and either lot quality or process quality, whichever is applicable.

Part Per Million (PPM): PPM is arrived at by multiplying the percentage defective by 10 000.
Example: 0.1 % = 1.000 PPM.

Population: The totality of the set of items, units, measurements, etc., real or conceptual that is under consideration.

Probability Distribution: A mathematical function with specific properties, which describes the probability that a random variable will take on a value or set of values. If the random variable is continuous and well behaved enough, there will be a pdf. If the random variable is discrete, there will be a pmf.

Qualification: The entire process by which products are obtained from manufacturers or distributors, examined and tested, and then identified on a Qualified Product List.

Quality: A property, which refers to the tendency of an item to be made to specific specifications and / or the customer's express needs. See current publications by Juran, Deming, Crosby, et al.

Quality Assurance: A system of activities that provides assurance that the overall quality control job is, in fact, being done effectively. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with a view to having corrective measures initiated where necessary. For a specific product or service, this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production inspection, and use of the product or service.

Quality Characteristics: Those properties of an item or process, which can be measured, reviewed, or observed and which are identified in the drawings, specifications, or contractual requirements. Reliability becomes a quality characteristic when so defined.

Quality Control (QC): The overall system of activities that provides a quality of product or service, which meets the needs of users; also, the use of such a system.

Random Samples: As commonly used in acceptance sampling theory, the process of selecting sample units in such a manner that all units under consideration have the same probability of being selected.

Reliability: The probability that a device will function without failure over a specified time period or amount of usage at stated conditions.

Reliability Growth: Reliability growth is the effort, and the resource commitment, to improve design, purchasing, production, and inspection procedures to improve the reliability of a design.

Risk: α: The probability of rejecting the null hypothesis falsely.

Scanning Electron Microscope (SEM): An instrument which provides a visual image of the surface features of an item. It scans an electron beam over the surface of a sample while held in a vacuum and collects any of several resultant particles or energies. The SEM provides depth of field and resolution significantly exceeding light microscopy and may be used at magnifications exceeding 50 000 times.

Screening Test: A test or combination of tests intended to remove unsatisfactory items or those likely to exhibit early failures.

Significance: Results that show deviations between hypothesis and the observations used as a test of the hypothesis, greater than can be explained by random variation or chance alone, are called statistically significant.

Significance Level: The probability that, if the hypothesis under test were true, a sample test statistic would be as bad as or worse than the observed test statistic.

SPC: Statistical Process Control.

Storage Life (Shelf Life): The length of time an item can be stored under specified conditions and still meet specified requirements.

Stress: A general and ambiguous term used as an extension of its meaning in mechanics as that which could cause failure. It does not distinguish between those things which cause permanent damage (deterioration) and those things which do not (in the absence of failure).

Variance: The average of the squares of the deviations of individual measurements from their average. It is a measure of dispersion of a random variable or of data.

Wearout: The process of attribution which results in an increase of hazard rate with increasing age (cycles, time, miles, events, etc.) as applicable for the item.

ABBREVIATIONS

AQL   Acceptable quality level

CAR   Corrective action report/request

DIP   Dual in-line package

ECAP   Electronic circuit analysis program

EMC   Electro magnetic compatibility

EMI   Electro magnetic interference

EOS   Electrical overstress

ESD   Electrostatic discharge

FAR   Failure analysis report/request

FIT   (Failure in time) Failure unit; Failures/109 h

FMEA   Failure mode and effects analysis

FTA   Fault tree analysis

h (t)   Hazard rate

LTPD   Lot tolerance percent defective

MOS   Metal oxide semiconductor

MRB   Material review board

MTBF   Mean-time-between-failures

MTTF   Mean-time-to-failure

MTTR	Mean-time-to-repair
PPM	Parts per million
PRST	Probability ratio sequential test
QA	Quality assurance
QC	Quality control
QPL	Qualified products list
RPM	Reliability planning and management
SCA	Sneak circuit analysis
SEM	Scanning electron microscope
TW	Wearout time
Z (t)	Hazard rate
λ	Failure rate (Lambda)

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