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An American National Standard

Standard Practice for Factors and Procedures for Applying the MIL-STD-105 Plans in Life and Reliability Inspection[1]

This standard is issued under the fixed designation E2555; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

~~ε^1 NOTE—Section 3.1.2 was corrected editorially in March 2019.~~

1. Scope

1.1 This practice presents a procedure and related tables of factors for adapting Practice E2234 (equivalent to MIL-STD-105) sampling plans to acceptance sampling inspection when the item quality of interest is life length or reliability. Factors are provided for three alternative criteria for lot evaluation: mean life, hazard rate, and reliable life. Inspection of the sample is by attributes with testing truncated at the end of some prearranged period of time. The Weibull distribution, together with the exponential distribution as a special case, is used as the underlying statistical model.

1.2 A system of units is not specified by this practice.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E456 Terminology Relating to Quality and Statistics

E2234 Practice for Sampling a Stream of Product by Attributes Indexed by AQL

2.2 *Other Documents:*

MIL-STD-105E Sampling Procedures and Tables for Inspection by Attributes[3]

3. Terminology

3.1 *Definitions:*

3.1.1 The terminology defined in Terminology E456 applies to this practice unless modified herein.

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[1] This practice is under the jurisdiction of ASTM Committee E11 on Quality and Statistics and is the direct responsibility of Subcommittee E11.40 on Reliability.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] MIL-STD-105E is also commonly referred to as "MIL-STD-105." It is virtually identical in content to its predecessor, MIL-STD-105D. These documents are out of print.

3.1.2 *acceptance quality limit (AQL), n*—quality limit that is the worst tolerable process average when a continuing series of lots is submitted for acceptance sampling. **E2234**

3.1.2.1 *Discussion—*

This definition supersedes that given in MIL-STD-105E.

3.1.2.2 *Discussion—*

A sampling plan and an AQL are chosen in accordance with the risk assumed. Use of a value of AQL for a certain defect or group of defects indicates that the sampling plan will accept the great majority of the lots or batches provided the process average level of percent defective (or defects per hundred units) in these lots or batches are no greater than the designated value of AQL. Thus, the AQL is a designated value of percent defective (or defects per hundred units) for which lots will be accepted most of the time by the sampling procedure being used. The sampling plans provided herein are so arranged that the probability of acceptance at the designated AQL value depends upon the sample size, being generally higher for large samples than for small ones, for a given AQL. The AQL alone does not identify the chances of accepting or rejecting individual lots or batches but more directly relates to what might be expected from a series of lots or batches, provided the steps indicated in this refer to the operating characteristic curve of the plan to determine the relative risks.

3.1.3 *consumer's risk, n*—probability that a lot having specified rejectable quality level will be accepted under a defined sampling plan.

3.1.4 *double sampling plan, n*—a multiple sampling plan in which up to two samplings can be taken and evaluated to accept or reject a lot.

3.1.5 *hazard rate, n*—differential fraction of items failing at time t among those surviving up to time t, symbolized by $h(t)$.

3.1.5.1 *Discussion—*

$h(t)$ is also referred to as the instantaneous failure rate at time t. It is related to the probability density and cumulative distribution functions by $h(t) = f(t) / (1 - F(t))$.

3.1.6 *limiting quality level (LQL), n*—quality level having a specified consumer's risk for a given sampling plan.

3.1.7 *lot, n*—a definite quantity of a product or material accumulated under conditions that are considered uniform for sampling purposes.

3.1.7.1 *Discussion—*

The lot for sampling may differ from a collection of units designated as a batch for other purposes, for example, production, shipment, and so forth.

3.1.8 *multiple sampling plan, n*—a sampling plan in which successive samples from a lot are drawn and after each sample is inspected a decision is made to accept the lot, reject the lot, or to take another sample, based on quality level of the combined samples.

3.1.8.1 *Discussion—*

When the quality is much less or much more than the AQL, the decision can be made on the first sample, which is smaller than that of a single sampling plan with equivalent acceptance quality level. For samples that are close to the AQL in quality, additional samples are required and the total sample size will be larger than the corresponding single sampling plan.

3.1.9 *sample, n*—group of items, observations, test results, or portions of material taken from a large collection of items, observations, test results, or quantities of material that serves to provide information that may be used as a basis for making a decision concerning the larger collection. **E2234**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *acceptance number, n*—the maximum number of failed items allowed in the sample for the lot to be accepted using a single or multiple sampling plan.

~~3.2.2 *hazard rate, n*—differential fraction of items failing at time t among those surviving up to time t, symbolized by $h(t)$.~~

~~3.2.2.1 *Discussion—*~~

~~$h(t)$ is also referred to as the instantaneous failure rate at time t. It is related to the probability density and cumulative distribution functions by $h(t) = f(t) / (1 - F(t))$.~~

3.2.2 *mean life, n*—average time that items in the lot or population are expected to operate before failure.

3.2.2.1 *Discussion*—

This metric is often referred to as mean time to failure ~~(MTTF) or mean time before failure (MTBF).~~(MTTF).

3.2.3 *rejection number, n*—the minimum number of failed items in the sample that will cause the lot to be rejected under a given sampling plan.

3.2.4 *reliable life (ρ_r), n*—life beyond which some specified proportion, *r*, of the items in the lot or population will survive.

3.2.5 *test truncation time (t), n*—amount of time sampled items are allowed to be tested.

3.2.6 *Weibull distribution, n*—probability distribution having cumulative distribution:

$$\text{function } F(t) = 1 - \exp\left(-\left(\frac{t-\gamma}{\eta}\right)^{\beta}\right),\ t > \gamma \text{ and probability density}$$

$$\text{function } f(t) = \frac{\beta}{\eta}\left(\frac{t-\gamma}{\eta}\right)^{\beta-1} \exp\left(-\left(\frac{t-\gamma}{\eta}\right)^{\beta}\right)$$

3.2.6.1 *Discussion*—

The Weibull distribution is widely used for modeling product life. It can take a wide variety of shapes and also the characteristics of other types of distributions based on the value of its parameters. γ is called the location, minimum life, or threshold parameter and defines the lower limit of the distribution (Fig. 1). η is called the scale or characteristic life parameter and is equal to the 63.2 percentile of the distribution, minus γ (Fig. 2). β is the shape parameter (Fig. 3). The exponential distribution is the special case where $\gamma = 0$ and $\beta = 1$.

4. Significance and Use

4.1 The procedure and tables presented in this practice are based on the use of the Weibull distribution in acceptance sampling inspection. Details of this work, together with tables of sampling plans of other forms, have been published previously. See Refs (**1-3**).[4] Since the basic computations required have already been made, it has been quite easy to provide these new factors. No changes in method or details of application have been made over those described in the publications referenced above. For this

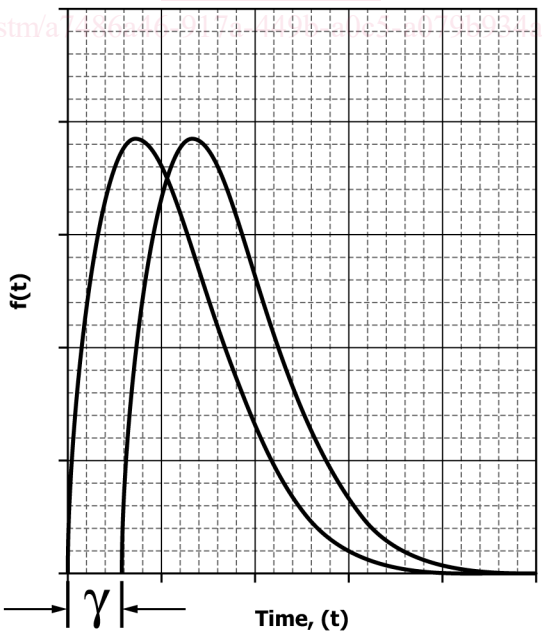

FIG. 1 Effect of the Parameter γ on the Weibull Probability Density Function, *f(t)*

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.