Designation: B602 – 21

Standard Guide for Attribute Sampling of Metallic and Inorganic Coatings[1]

This standard is issued under the fixed designation B602; 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.

1. Scope

1.1 This guide gives sampling plans that are intended for use in the inspection of metallic and inorganic coatings for conformance to ASTM standard specifications.

1.2 The plans in this guide, except as noted, have been selected from some of the single sampling plans of MIL-STD-105D. The specific plans selected are identified in Tables 1-3 of this guide. The plan of Table 4, which is used for destructive testing, is not from the Military Standard. This standard does not contain the Military Standard's requirement for tightened inspection when the quality history of a supplier is unsatisfactory.

1.3 The plans are based on inspection by attributes, that is, an article of product is inspected and is classified as either conforming to a requirement placed on it, or as nonconforming. Sampling plans based on inspection by variables are given in Guide B762. Variables plans are applicable when a test yields a numerical value for a characteristic, when the specification imposes a numerical limit on the characteristic, and when certain statistical criteria are met. These are explained in Guide B762.

1.4 The plans in this guide are intended to be generally suitable. There may be instances in which tighter or looser plans or ones that are more discriminating are desired. Additional plans that may serve these needs are given in Guide B697. Also, Guide B697 describes the nature of attribute sampling plans and the several factors that must be considered in the selection of a sampling plan. More information and an even greater selection of plans are given in MIL-STD-105D, MIL-STD-414, ANSI/ASQC Z1.9-1979, Refs (**1-7**)[2], and in Guide B697.

1.5 *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.*

1.6 *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:*[3]

B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings

B762 Guide of Variables Sampling of Metallic and Inorganic Coatings

2.2 *ANSI Standard:*[4]

ANSI/ASQC Z1.9-1979 Sampling Procedures and Tables for Inspection by Variables for Percent Non-Conformance

2.3 *Military Standards:*[5]

MIL-STD-105D Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-414 Sampling Procedures and Tables for Inspection by Variables for Percent Defective

3. Terminology

3.1 *Definitions:*

3.1.1 *destructive test, n*—test that destroys the tested article or makes it nonconforming to a requirement.

3.1.2 *inspection lot, n*—collection of articles of the same kind that is submitted to inspection for acceptance or rejection as a group.

3.1.3 *nondestructive test, n*—test that neither destroys the tested article nor makes it nonconforming to a requirement.

3.1.4 *sample, n*—articles randomly selected from an inspection lot whose quality is used to decide whether or not the inspection lot is of acceptable quality.

[1] This guide is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.10 on Test Methods.

Current edition approved Oct. 1, 2021. Published November 2021. Originally approved in 1975. Last previous edition approved in 2016 as B602 – 88(2016). DOI: 10.1520/B0602-21.

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

[3] 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.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

TABLE 1 Level I—Sampling Plan for Nondestructive Tests[A]

Inspection Lot Size	Sample Size	Acceptance Number	AQL, %	50/50 Point, %	LQL, %	AOQL,%
1 to 20[B]	all	0	...	...	...	...
21 to 280	20	0	0.26	3.4	11.0	1.8
281 to 1 200	80	1	0.44	2.1	4.8	1.1
1 201 to 3 200	125	2	0.65	2.1	4.3	1.1
3 201 to 10 000	200	3	0.68	1.8	3.3	0.97
10 001 to 35 000	315	5	0.83	1.8	2.9	1.0
Over 35 000	500	7	0.80	1.5	2.4	0.90

[A] Taken from MIL-STD-105D, Single Sampling Plan, Level II, AQL = 0.65, Normal Inspection.
[B] The smallest lots are 100 % inspected, and so there is no sampling risk. For this reason, there are no AQL, etc.

TABLE 2 Level II—Sampling Plan for Nondestructive Tests[A]

Inspection Lot Size	Sample Size	Acceptance Number	AQL, %	50/50 Point, %	LQL, %	AOQL,%
1 to 8[B]	all	0	...	...	...	...
9 to 90	8	0	0.64	8.3	25	4.6
91 to 280	32	1	1.1	5.2	12	2.6
281 to 500	50	2	1.7	5.3	10	2.7
501 to 1 200	80	3	1.7	4.6	8.2	2.4
1 201 to 3 200	125	5	2.1	4.5	7.4	2.5
3 201 to 10 000	200	7	2.0	3.9	5.9	2.2
10 001 to 35 000	315	10	2.0	3.4	4.9	2.1
Over 35 000	500	14	1.9	2.9	4.0	1.9

[A] Taken from MIL-STD-105D, Single Sampling Plan, Level II, AQL = 1.5, Normal Inspection.
[B] The smallest lots are 100 % inspected, and so there is no sampling risk. For this reason, there are no AQL, etc.

TABLE 3 Level III— Sampling Plan for Nondestructive Tests[A]

Inspection Lot Size	Sample Size	Acceptance Number	AQL, %	50/50 Point, %	LQL, %	AOQL,%
1 to 5[B]	all	0	...	...	...	...
6 to 50	5	0	1.0	12.9	37	7.4
51 to 150	20	1	1.8	8.2	18	4.2
151 to 280	32	2	2.6	8.2	16	4.3
281 to 500	50	3	2.8	7.3	13	3.9
501 to 1 200	80	5	3.3	7.1	11	4.0
1 201 to 3 200	125	7	3.2	6.1	9.4	3.6
3 201 to 16 000	200	10	3.1	7.3	7.7	3.3
16 001 to 35 000	315	14	2.9	4.7	6.4	3.0
Over 35 000	500	21	3.0	4.3	5.6	2.9

[A] Taken from MIL-STD-105D, Single Sampling Plan, Level II, AQL = 2.5, Normal Inspection.
[B] The smallest lots are 100 % inspected, and so there is no sampling risk. For this reason, there are no AQL, etc.

TABLE 4 Sampling Plan for Destructive Test[A]

Inspection Lot Size	Sample Size	Accept-ance Number	AQL,%	50/50 Point, %	LQL,%
1 to 25	2	0	2.5	29	68
26 to 1 200	13	1	2.8	13	27
1201 to 35 000	32	2	2.6	8.3	16
Over 35 000	55	3	2.5	6.6	12

[A] AOQLs are not given because destructive tests cannot be used to screen rejected lots. This plan is not found in MIL-STD-105D.

4. Significance and Use

4.1 Sampling inspection permits the estimation of the overall quality of a group of product articles through the inspection of a relatively small number of product items drawn from the group.

4.2 The selection of a sampling plan provides purchasers and sellers a means of identifying the minimum quality levels that are considered to be satisfactory.

4.3 Because sampling plans will only yield estimates of the quality of a product, the results of the inspection are subject to error. Through the use of sampling plans, the risk of error is known and controlled.

5. General

5.1 In sampling inspection, a relatively small number of articles (the sample) is selected randomly from a larger number of articles (the inspection lot) and is inspected for conformance to the requirements placed on the articles. Based on the results, a decision is made either to accept or reject the inspection lot. Sampling is used, rather than inspection of every article in a lot, to reduce cost. Also, some test methods are destructive, in which cases sampling inspection must be used to avoid destroying the lot.

5.2 There is always a risk that a sample will not be representative of the lot from which it is drawn. The larger the sample, the smaller this risk, but, the larger the cost of inspection. So the selection of a sampling plan involves the

balancing of the costs of inspection against the consequences of accepting an undesirable number of nonconforming articles. If every article in an inspection lot conforms to its requirements, every article in the sample will conform also. Such lots will always be accepted. If only a few articles in an inspection lot are nonconforming, the chances are that the sample will indicate that the lot is acceptable; but there is a small chance that the sample will indicate that the lot is unacceptable. The larger the proportion of nonconforming articles in an inspection lot, the more likely it will be that the sample will indicate that the lot is unacceptable. In the extreme case of every article in an inspection lot being nonconforming, a sample will always indicate that the lot is unacceptable.

5.3 For a given sampling plan, the chance of accepting an inspection lot that contains nonconforming items is often described in terms of the Acceptance Quality Level (AQL) and the Limiting Quality Level (LQL). The AQL is the quality level that is considered to be acceptable. The LQL is the quality level that is considered to be barely tolerable. A sampling plan is selected that will accept most submitted inspection lots of AQL quality and reject most lots of LQL quality. In this test method the AQL given for a sampling plan is the quality level of lots (expressed as the percentage of nonconforming articles) that have a 95 % chance of being accepted. The LQL is the quality level of lots that have a 10 % chance of being accepted or, in other words, a 90 % chance of being rejected. Also given with each sampling plan in this guide, is the quality level of an inspection lot that has a 50 % chance of being accepted. This is called the 50/50 point.

5.4 If all of the articles in a rejected inspection lot are inspected, and if nonconforming articles are removed and replaced with conforming articles, and then if the now 100 % conforming lot is resubmitted, the average quality level for a series of lots taken as a whole will be better because of the addition of the 100 % conforming lot. When the incoming lots are of a good quality level, the average quality level of a series of lots will be even better when the rejected lots are screened and resubmitted. When incoming lots are of a poor quality level, the average quality of a series of lots will again be good because many of the incoming lots will be rejected and upgraded. At intermediate quality levels of incoming lots, the average quality level of a series of lots will not be as good as in either of the above cases. The poorest average quality level that can result from the use of a given sampling plan when screening of rejected lots is done is called the Average Outgoing Quality Limit (AOQL). If corrective action is taken by the supplier so that there is a low rejection rate of initially supplied lots, the average quality level will be better than the AOQL (Note 1). This 100 % inspection of rejected lots cannot, of course, be used if the inspection test method is destructive. Screening of rejected lots will substantially increase the cost of inspection if the incoming lots are much worse than AQL quality. Screening is to be used only when required by the purchaser.

NOTE 1—The AOQLs given for Tables 1-3 are strictly correct only when the sample is small with respect to the lot. If the sample is consistently a significant part of the lot, the correct AOQL will be smaller than the tabulated value. The correct values are obtained by multiplying the tabulated values by:

$$1 - \text{sample size/lot size}$$

5.5 This guide contains four sampling plans. Three are intended to be used when the inspection methods are nondestructive. One of these (Table 2) is considered to be standard and is the one that is followed unless the user of this method specifies either a higher quality level (Table 1) or a lower one (Table 3). The fourth plan is intended to be used when the inspection methods are destructive. This last plan utilizes smaller samples and so reduces the cost of inspection but with a sacrifice in the ability to distinguish between acceptable and unacceptable lots.

6. Ordering Information

6.1 Unless otherwise specified by the purchaser, the sampling plan given in Table 2 will be used for nondestructive testing, and the plan given in Table 4 for destructive testing.

6.2 When either a nondestructive or a destructive test can be used to inspect an article for conformance to a particular requirement, the purchaser should specify which test is to be used. When a test is neither clearly nondestructive nor destructive (see Note 2, 8.3), the purchaser should specify which it is considered to be.

7. Formation of Inspection Lot

7.1 An inspection lot shall be formed from articles that are of the same kind, that have been produced to the same specification, and that have been coated by a single supplier at one time or at approximately the same time under essentially identical conditions.

8. Sampling

8.1 *General*—A sample shall be selected from the inspection lot. If the test method to be used is nondestructive, the sample size shall be that directed in 8.2. If the test method is destructive, the sample size shall be that directed in 8.3.

8.2 *Nondestructive Tests*—For nondestructive testing, the size of the sample shall be that specified for the sampling plan level that is required by the purchaser. The sampling plans are given for Level I in Table 1, for Level II in Table 2, and for Level III in Table 3. If the purchaser does not specify the level, Level II shall be used.

8.3 *Destructive Tests*—For destructive testing, the size of the sample shall be that specified in Table 4.

NOTE 2—The nature of a destructive test can be such that the tested article can be reclaimed, for example by stripping and reapplying the coating. Other tests can destroy the coating in nonessential locations, in which case the item can still be functional. In these instances the purchaser needs to decide and state whether the tests are to be considered destructive or nondestructive.

NOTE 3—The plan given for destructive tests uses smaller samples than the plans given for nondestructive tests. There may be cases in which destruction of even these smaller quantities is undesirable. For example, the articles may be expensive or the inspection lot may be small. Often in such cases test specimens are coated along with the articles and are used to represent them in the destructive tests. The permission to use test specimens and the requirements covering them and their use should be set forth in the applicable coating specification, purchase order, or other governing document.

8.4 The sample shall be drawn from the inspection lot randomly, that is, in a manner that assures each article an equal chance of being selected regardless of other considerations such as its location in the inspection lot, its appearance, its quality, its location on a fixture during coating, and its chronological relationship to the other articles. Random sampling procedures are given in the Annex of this guide.

9. Inspection and Lot Disposition

9.1 Each article in the sample shall be inspected as directed in the applicable coating standard. If the number of articles that do not conform to a particular requirement is equal to or less than the acceptance number of the sampling plan, the inspection lot is acceptable with respect to that requirement, otherwise the inspection lot is not acceptable (Note 4). Inspection lots that are unacceptable with respect to one or more requirements shall be rejected.

NOTE 4—The acceptability of an inspection lot is determined with respect to each requirement independently from all other requirements. The acceptance number applies to each requirement in turn; it is not added. For example, if a sample of 50 articles drawn in accordance with Table 2 is found to contain two defectives with respect to thickness and a third one with respect to appearance, the inspection lot is acceptable because although three articles were defective no more than two, the acceptance number, were defective with respect to a single requirement.

10. Resampling

10.1 When required by the purchaser, inspection lots that are rejected for nonconformance to a requirement where conformance can be determined by a nondestructive test may be 100 % inspected by the seller and resubmitted for acceptance after the seller has removed all nonconforming articles and replaced them with conforming articles. The same sampling plan that was used when the lot was first inspected shall be used for the reinspection of the screened lot. The resubmitted lot shall be inspected only for the characteristics for which it was rejected.

11. Keywords

11.1 inspection; inspection sampling; sampling procedures

ANNEX

(Mandatory Information)

A1. DRAWING OF SAMPLES

A1.1 Random Sampling

A1.1.1 If the articles in a lot are thoroughly mixed, sorted, or arranged without bias as to quality (for example, barrel electroplated articles), a sample drawn anywhere from the lot will meet the requirement of randomness. If the articles are not so mixed, and if it is thought to be impractical to mix them, bias will result if the entire sample is drawn from a single or a few layers. Other bias in sampling, such as taking articles from the same place on a plating rack, taking articles from the output of one electroplating bath and not others, and taking articles that appear to be conforming or to be nonconforming, must be avoided. Bias can be avoided by numbering the articles, randomly selecting a group of numbers equal to the sample size, and inspecting the articles with the selected numbers. A method for doing this is described in the following.

A1.1.2 When random numbers are used to select a sample, each article in the lot is identified by a different number. This may be done by placing the units in racks or trays where the positions in the racks are numbered. If the units have serial numbers, the serial numbers can be used. Random numbers may be obtained from books pertaining to statistics. A table of random numbers (Table A1.1) has been included in this Annex. Some pocket calculators are designed to generate random numbers.

A1.1.3 As an example assume that a sample of 13 articles is to be selected from an inspection lot of 80 articles. The articles are numbered 1 through 80. A pencil is allowed to fall blindly at some number in Table A1.1. Starting at this point, a coin is tossed to decide whether to go up or down the column; heads, up; tails, down. If the pencil falls on column 10, line 11, and the coin is tails, the decision is to read down the column until 13 numbers are chosen. Take the first two digits in each group of five digits. The selection of random numbers is made as follows: the 85s are rejected because they are over 80, and the second 06 is rejected because it has already appeared. The sample then consists of articles numbered 31, 20, 8, 26, 53, 65, 64, 46, 22, 6, 41, 67, and 14.

A1.2 Constant-Interval Sampling

A1.2.1 When product items are arranged in an order without regard to quality, such as articles in a tray, a sample can be drawn by using the constant-interval procedure. Here, a constant interval is maintained between the items drawn for the sample. For example, every 9th, 19th, or 24th unit is selected. The first item drawn from the lot can be determined from the table of random numbers. All other items are then drawn at a constant interval following the first item. The constant interval is determined by dividing the lot size by the sample size and by rounding the quotient down to the nearest whole number.

A1.2.2 As an example assume that a lot of 3000 items is to be visually examined for freedom from such defects as blisters, pits, nodules, porosity, and staining. In accordance with Table 3, a sample of 135 items is to be drawn. The constant interval is 24 (3000 divided by 125). A random number from 1 to 24 is selected either from a table (see A1.1.2) or by another appropriate method. After the first item is taken, the remaining items in the required sample are drawn by selecting every 24th