INTERNATIONAL STANDARD

ISO 2859-3

First edition
1991-08-01

Sampling procedures for inspection by attributes —

Part 3:
Skip-lot sampling procedures

Règles d'échantillonnage pour les contrôles par attributs —
Partie 3: Procédures d'échantillonnage successif partiel

Reference number
ISO 2859-3:1991(E)

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International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 2859-3 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*.

ISO 2859 consists of the following parts, under the general title *Sampling procedures for inspection by attributes*:

— *Part 0: Introduction to the ISO 2859 attribute sampling system*

— *Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*

— *Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

— *Part 3: Skip-lot sampling procedures*

Part 0 will be a revision of ISO 2859:1974 and Addendum 1:1977.

Annex A contains options to be agreed prior to qualification.

Annex B contains procedures for random selection at specified inspection frequencies.

Annexes A and B form an integral part of this part of ISO 2859. Annexes C and D are for information only.

Sampling procedures for inspection by attributes —

Part 3:
Skip-lot sampling procedures

1 Scope

1.1 This part of ISO 2859 specifies generic attribute skip-lot sampling procedures for reducing the inspection effort on products submitted by those suppliers who have demonstrated their ability to control, in an effective manner, all facets of quality and who consistently produce lots which meet requirements. The reduction in inspection effort is achieved by selecting at random, with a specified probability, whether a lot presented for inspection will be passed without inspection. This procedure extends to the inspection of lots the principle of random selection already applied within ISO 2859-1 to the individuals comprising a lot.

Inspection may take place at the supplier's or purchaser's locations or at an interface between operations of a production process. The skip-lot procedures are designed to be used with the attribute lot-by-lot plans described in ISO 2859-1.

NOTE 1 The skip-lot procedures specified in this part of ISO 2859 should be distinguished from Dodge's skip-lot plans. See [4], [5] and [6] in annex D.

1.2 Since every product has its own environment and characteristics, options are provided in recognition of the fact that the supplier and responsible authority select the appropriate options to meet the specific needs of the product and its environment. All choices as a result of this tailoring should be specified in a written document (see annex A).

The procedures specified are applicable to, but not limited to, the inspection of

a) end items, such as complete units or subassemblies;

b) components and raw materials;

c) services;

d) materials in process;

e) supplies in storage;

f) data or records;

g) administrative procedures.

These procedures are intended only for a continuing series of lots or batches and are not to be used for isolated lots. All lots in the series are expected to be of a similar quality and there should be reason to believe that the lots not inspected are of the same quality as the ones inspected.

This part of ISO 2859 is to be used only for characteristics inspected by attributes as designated in ISO 2859-1. Its application differs from that of reduced inspection in ISO 2859-1. With respect to the inspection of multiple characteristics, the skip-lot procedures will follow the same principles used in the associated ISO 2859-1 procedures.

The skip-lot procedures in this part of ISO 2859 can only be implemented if the ISO 2859-1 procedures are in use, on normal or reduced inspection, or a combination of normal and reduced inspection, at general inspection levels I, II or III.

Multiple sampling plans may only be used during the qualification phase associated with normal inspection. It is strongly recommended that single sampling plans with an acceptance number of zero are not used in this part of ISO 2859 (see 8.1 and clause C.4).

NOTES

2 Reduced inspection is a feature of ISO 2859-1 permitting smaller sample sizes than used in normal inspection.

3 Reduced inspection may be used while the product is in the lot-by-lot inspection state, but may not be used during the skip-lot inspection or skip-lot interrupt states.

4 Skip-lot sampling may be used instead of reduced inspection if it is more cost effective to do so (see annex C).

1.3 When specified by the purchaser, this part of ISO 2859 may be referenced in a purchasing or specification contract, inspection instruction, or other contractual documents. The responsible authority and the inspection agency are to be designated in one of the above documents. The inspection agency may be the responsible authority or an organization delegated to conduct the inspection procedures.

1.4 It is essential that the skip-lot procedures are not applied to the inspection of product characteristics that bear upon the safety of personnel.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 2859. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 2859 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.*

ISO 3534:1977, *Statistics — Vocabulary and symbols.*

3 Definitions

For the purposes of this part of ISO 2859, the definitions given in ISO 2859-1 and ISO 3534, together with the following definitions, apply.

3.1 skip-lot inspection: An acceptance sampling procedure in which some lots in a series are accepted without inspection when the sampling results for a stated number of immediately preceding lots meet stated criteria.

NOTE 5 The lots to be inspected are chosen randomly in accordance with a stated frequency called the "skip-lot frequency". A skip-lot frequency of 1 lot in 2, for example, means that the long-run average fraction of lots inspected is 50 %.

3.2 lot-by-lot inspection: Inspection of product submitted in a series of lots.

NOTE 6 A sample is selected from each lot and inspected using attribute AQL sampling procedures described in ISO 2859-1.

3.3 essentially continuous production: Production that is at a steady rate.

NOTE 7 Production is considered essentially continuous if at least 1 lot of products is submitted for inspection at a production frequency agreed to by both the supplier and the responsible authority. If no production frequency is specified, at least 1 lot shall be submitted, for example, each month. The production frequency shall be agreed between the supplier and the responsible authority. Product shipped to other parties or products of a similar nature shall or shall not be considered in the determination of "essentially continuous", as agreed by both the supplier and the responsible authority.

4 Supplier and product qualification

4.1 Supplier qualification

The supplier shall

a) have implemented and maintained a documented system for controlling product quality and design changes (for example, see ISO 9001 or ISO 9002 or ISO 9003, cited in annex D). It is assumed that this system includes inspection by the supplier of every lot produced and recording of the inspection results;

b) have instituted a system which is capable of detecting and correcting shifts in quality levels and monitoring process changes which may adversely affect quality. The supplier's personnel responsible for the application of the system shall show a clear understanding of the applicable standards, systems and procedures to be followed;

c) not have experienced an organizational change that might adversely affect quality.

4.2 Product qualification

The product shall

a) be of stable design;

b) have been manufactured on an essentially continuous basis for a period mutually agreed to by both the supplier and the responsible authority. If no period is specified, the period shall be 6 months. Whenever production is held up pending sample approval, only the time period after approval and resumption of production shall be included;

NOTE 8 Essentially continuous production is considered a stabilizing factor of the manufacturing or assembly process.

c) have been on normal or reduced inspection or a combination of normal and reduced inspection at general inspection levels I, II or III (see ISO 2859-1) during the qualification period. A product that has been on tightened inspection at any time during the qualifying period is ineligible for skip-lot inspection;

d) have been maintained at the AQL or better (see ISO 2859-1) for a period of stability mutually agreed to by both the supplier and the responsible authority. If no period is specified, the period shall be 6 months;

e) meet the following quality requirements:

1) the preceding 10 or more[1] lots have been accepted;

2) the requirements of table 1 shall be met for the preceding 10 or more consecutive lots;

3) the requirements of table 2 shall be met for each of the last 2 individual lots.

If double or multiple[2] sampling is used, only the first sample is tested in 2) and 3) above.

4.3 Example of product qualification

Suppose a qualified manufacturer produces capacitors that satisfy 4.2 a), b) and c). In addition, assume that the product is inspected to an AQL of 0,65 %; that 10 consecutive lots are accepted with a total sample size equal to 1 400 items; and that a total of 4 nonconforming items have been found in the 10 lots. Table 1 shows that the minimum cumulative sample size for 4 nonconforming items is 1 306 items. The total sample size of 1 400 exceeds this minimum cumulative sample size, so the criteria of table 1 are satisfied. Suppose the last two lots each had a sample size equal to 125 items with one nonconforming item in each sample. This satisfies the criteria of table 2, which allow 1 nonconforming item for a sample size of 125 items. The product thus meets the quality requirements of 4.2 d) and hence qualifies for skip-lot inspection.

5 Skip-lot procedures

A product that complies with 4.2 and is manufactured by a supplier who complies with 4.1 shall be eligible for skip-lot inspection.

The structure of the skip-lot procedures is outlined in figure 1. There are three basic states to the procedure.

a) State 1: lot-by-lot inspection;

b) State 2: skip-lot inspection;

c) State 3: skip-lot interrupt.

The inspection procedure for a product starts in State 1, lot-by-lot inspection. When the supplier and product qualify for skip-lot inspection (see 4.1 and 4.2), the procedure switches to State 2. Skip-lot inspection may be temporarily interrupted (see 5.5), resulting in a transfer to State 3. In State 3, the product may requalify under less stringent conditions with a resultant transfer of the procedure back to State 2 (see 5.6). Alternatively, the product may be disqualified for skip-lot inspection while the procedure is either in State 2 or State 3. In this case, the procedure switches to State 1 and the product must again satisfy the complete requirements of 4.1 and 4.2.

Throughout the skip-lot procedures, in States 1, 2 and 3, the acceptance/non-acceptance criteria applied to individual lots are those given in table II-A (single sampling) or table III-A (double sampling) in ISO 2859-1:1989 for the appropriate AQL/sample size combination on normal inspection.

5.1 Determining the initial skip-lot inspection frequency

Figure 2 is a summary of the algorithm used to determine the initial inspection frequency. Data from the last 10 or more lots shall be used to determine this frequency. These data consist of a running record of the number of items inspected and the number of nonconforming items or nonconformities found in each sample. More than 10 lots would be needed to meet the requirements specified below if the sample sizes are not large enough to satisfy minimum cumulative sample size given in table 1.

Authorized initial frequencies are

a) 1 lot inspected in 2 submitted;

b) 1 lot inspected in 3 submitted;

c) 1 lot inspected in 4 submitted.

1) More than 10 lots will be needed when the cumulative sample size requirements of table 1 have not been met in 10 lots.

2) Multiple sampling is allowed during the qualification period (State 1).

Table 1 — Minimum cumulative sample size to initiate skip-lot inspection

Nonconforming items or nonconformities	Acceptable quality level (AQL) [percent nonconforming[1] or nonconformities per hundred units]												
	0,1	0,15	0,25	0,4	0,65	1	1,5	2,5	4	6,5	10	15	25
	Minimum cumulative sample size												
0	2 600	1 740	1 040	650	400	260	174	104	65	40	26	17	10
1	4 250	2 840	1 700	1 070	654	425	284	170	107	65	43	28	17
2	5 740	3 830	2 300	1 440	883	574	383	230	144	88	57	38	23
3	7 140	4 760	2 860	1 790	1 098	714	476	286	179	110	71	48	29
4	8 490	5 660	3 400	2 120	1 306	849	566	340	212	131	85	57	34
5	9 800	6 530	3 920	2 450	1 508	980	653	392	245	151	98	65	39
6	11 090	7 390	4 440	2 770	1 706	1 109	739	444	277	171	111	74	44
7	12 360	8 240	4 940	3 090	1 902	1 236	824	494	309	190	124	82	49
8	13 610	9 070	5 440	3 400	2 094	1 361	907	544	340	209	136	91	54
9	14 850	9 900	5 940	3 710	2 285	1 485	990	594	371	229	149	99	59
10	16 080	10 720	6 430	4 020	2 474	1 608	1 072	643	402	247	161	107	64
11	17 290	11 530	6 920	4 320	2 660	1 729	1 153	692	432	266	173	115	69
12	18 500	12 330	7 400	4 630	2 846	1 850	1 233	740	463	285	185	123	74
13	19 700	13 130	7 880	4 930	3 031	1 970	1 313	788	493	303	197	131	79
14	20 890	13 930	8 360	5 220	3 214	2 089	1 393	836	522	321	209	139	84
15	22 080	14 720	8 830	5 520	3 397	2 208	1 472	883	552	340	221	147	88
16	23 260	15 500	9 300	5 820	3 578	2 326	1 550	930	582	358	233	155	93
17	24 430	16 290	9 770	6 110	3 758	2 443	1 629	977	611	376	244	163	98
18	25 600	17 070	10 240	6 400	3 938	2 560	1 707	1 024	640	394	256	171	102
19	26 760	17 840	10 700	6 690	4 117	2 676	1 784	1 070	669	412	268	178	107
20	27 930	18 620	11 170	6 980	4 297	2 793	1 862	1 117	698	430	279	186	112
n[2]	1 170	780	470	290	180	117	78	47	29	18	12	8	5

1) Percent nonconforming applies only to AQL values of 10 or less.

2) For each additional nonconforming item or nonconformity, add n to the minimum cumulative sample size for 20 nonconforming items or nonconformities. For example, at an AQL of 1 %, 22 nonconforming items or nonconformities are observed. The minimum cumulative sample size is calculated as follows:

$(2 \times 117) + 2\,793 = 3\,027$

Table 2 — Acceptance numbers to initiate, continue or resume skip-lot inspection

Sample size	Acceptable quality level (AQL)[1) [percent nonconforming[2) or nonconformities per hundred units]												
	0,1	0,15	0,25	0,4	0,65	1	1,5	2,5	4	6,5	10	15	25
	Acceptance numbers												
2								→	→	0	→	0	1
3							→	→	0	→	0	1	1
5						→	→	0	→	0	1	1	2
8					→	→	0	→	0	1	1	2	3
13				→	→	0	→	0	1	1	2	3	5
20			→	→	0	→	0	1	1	2	3	5	7
32		→	→	0	→	0	1	1	2	3	5	7	11
50	→	→	0	→	0	1	1	2	3	5	7	11	17
80	→	0	→	0	1	1	2	3	5	7	11	17	
125	0	→	0	1	1	2	3	5	7	11	17		
200	→	0	1	1	2	3	5	7	11	17			
315	0	1	1	2	3	5	7	11	17				
500	1	1	2	3	5	7	11	17					
800	1	2	3	5	7	11	17						
1 250	2	3	5	7	11	17							
2 000	3	5	7	11	17								

NOTE — These skip-lot acceptance numbers should not be confused with the lot acceptance criteria specified in ISO 2859-1 which are used to determine acceptance/non-acceptance of each lot.

1) In reduced inspection, an arrow symbol indicates move to the right, i.e. to an acceptance number zero.

2) Percent nonconforming applies only to AQL values of 10 or less.

If more than 20 lots are needed to qualify, a frequency of 1 in 2 shall be used.

If 20 or fewer lots are needed to qualify, and all of these lots satisfy the requirements of table 2, an initial frequency of 1 in 4 shall be used.

If 20 or fewer lots are needed to qualify, but 1 or more lots do not meet the requirements of table 2, an initial frequency of 1 in 3 shall be used.

The responsible authority shall approve the initial inspection frequency.

5.2 Examples of initial frequency determination

Continue the example from 4.3, and consider three cases.

5.2.1 Case 1

Assume that the product qualifies in the first 10 lots and that the lot sizes are 1 250 to 9 500. Sample sizes for these lots are either 125 or 200 and the number of nonconforming items in each sample is always 1 or 0. Thus, from table 2 for an AQL of 0,65, all 10 lots meet the requirements of that table. Hence, the initial frequency is 1 in 4.

5.2.2 Case 2

Assume that the first lot sample of 125 contains 2 nonconforming items. The table 2 criteria for the lot are therefore not met. Also assume that the product qualifies in the first 10 lots. Then, the initial frequency is 1 in 3.

5.2.3 Case 3

Assume that lots 3 and 11 are rejected, but the product qualifies at lot 21. In this case the initial frequency is 1 in 2 because more than 20 lots are needed for qualification.

5.3 Reducing the frequency of inspection

5.3.1 The authorized frequencies are

a) 1 lot inspected in 2 submitted;

b) 1 lot inspected in 3 submitted;

c) 1 lot inspected in 4 submitted;

d) 1 lot inspected in 5 submitted.

The frequency 1 lot in 5 is not available as an initial frequency.

5.3.2 The frequency of inspection may be shifted to the next lower frequency of inspection (for example, from 1 lot in 3 to 1 lot in 4) if both of the following conditions are met:

a) the data from the preceding 10 or more consecutive lots which have been inspected and accepted during the current State 2 (skip-lot inspection) since the last frequency shift, equal or exceed the requirements of table 1; and

b) the responsible authority approves the frequency shift.

When a double sampling plan is employed, only the first sample shall be used in the calculations.

Figure 3 is a flowchart that depicts the skip-lot procedures. It shows how the product qualifies (see 4.3), how the initial inspection frequencies are determined (see 5.1) and how changes in inspection frequency can occur (see 5.3). The figure also includes the interrupt procedure (see 5.5), the requalification procedure (see 5.6) and disqualification (see 5.7).

5.3.3 Continue the example from 4.3 and 5.2. Assume that case 1 occurs with the initial frequency being 1 in 4. Let the next 10 lots be accepted with a cumulative sample size of 1625 and a total of 5 nonconformities. Then, the criteria of table 1 are met because the minimum cumulative sample size for 5 nonconformities and an AQL of 0,65 is 1508. Also, suppose the sample sizes of the last 2 lots are 125 and 200 respectively and each has 1 nonconformity. Then, these lots satisfy the table 2 criteria and the frequency may be shifted to 1 in 5.

5.4 Lot selection and inspection procedures (States 2 and 3)

The lot(s) to be inspected during State 2 (skip-lot inspection) shall be selected in accordance with an established organizational procedure for random lot selection (see annex B). However, at least 1 lot shall be inspected during a period agreed to by both the supplier and responsible authority. If no period is specified, the period shall be 2 months. The average size of lots submitted during States 2 and 3 should be approximately the same as the average lot size during the qualifying period. Normal inspection at general inspection levels I, II or III, as defined in ISO 2859-1, shall be in effect.

During State 2, the lots shall be selected for inspection with a probability equal to the desired skip-lot inspection frequency. It is important that the supplier does not know which of the lots will be inspected until the lots have been offered to the inspection agency.

It is assumed that the supplier's quality assurance system includes inspection of each lot produced and recording of the inspection results. These results, for all lots produced (including those not inspected by the inspection agency), shall be made available to the inspection agency.

A running record of the number of items inspected and the number of nonconforming items or nonconformities found in each sample for all lots inspected during States 2 and 3 shall be kept in a skip-lot log.

Acceptance or rejection of lots identified by the supplier as nonconforming (instead of submission for acceptance inspection) shall not affect skip-lot status. For example, the responsible authority may agree to accept a lot as nonconforming without acceptance inspection in order to meet schedule requirements. Such a lot shall be treated as non-existent for the purposes of the procedures in this part of ISO 2859. However, if a lot is inspected by the inspection agency and later accepted as nonconforming by the responsible authority, the inspection results shall be used.