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Reinforcement fibres — Sampling plans applicable to received batches

Fibres de renfort — Méthodes d'échantillonnage pour le contrôle de réception de lots

INTERNATIONAL ISO

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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 1886 was prepared by Technical Committee ISO/TC 61, *Plastics*.

This third edition cancels and replaces the second edition (ISO 1886:1980), of which it constitutes a technical revision.

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Introduction

As indicated in the title, this International Standard is designed for received batches and not for inspection during manufacturing of a product. In the latter case, the manufacturer should have the necessary facilities available and a good knowledge of the product, thus allowing him to assure the quality through an appropriate control system.

For checking received batches, the customer has only limited information about a given product.

The sampling plans described hereafter are intended as "normal" plans, and require a certain number of results for the assessment of a batch to a given confidence level.

Other sampling plans, i.e. reduced or tightened plans, can be considered, depending on the product type, the application for which the product is intended, the test method and the degree of inspection required.

The choice of sampling plan and the extent of sampling depends on

— the knowledge of the product acquired by the customer during product qualification, plus information from routine inspections of received batches;

— the degree of confidence that the customer is prepared to accord the inspections undertaken by the manufacturer.

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Reinforcement fibres — Sampling plans applicable to received batches

1 Scope

This International Standard specifies two methods of sampling — by attributes or by measurements (variables) — applicable to batches of reinforcement materials (in particular textile glass, carbon fibre and aramid fibre) in various forms (e.g. package, roll, bulk material). For both methods, this International Standard includes tables with acceptance and rejection criteria based on a given number of acceptable quality levels (AQLs) that are usually applied to the various reinforcement materials.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 472:1988, *Plastics — Vocabulary.*

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.*

ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent nonconforming.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 472, ISO 2859-1, ISO 3534 and ISO 3951 apply, plus the following definitions, some of which are versions of definitions already published in ISO 3534, for instance, but reworded to suit the particular context of this International Standard.

3.1 sampling plan: A series of rules established to obtain, through the selection of a sample and its subsequent analysis, an evaluation which is as reliable as possible of the quality of a received batch, so as to determine, using criteria defined in the product specification, if this batch is acceptable.

For the purposes of this International Standard, two main sampling methods are considered: by attributes and by measurements (variables).

3.2 elementary unit: The smallest normally commercially available entity of a given product.

The description (form, dimensions, mass, etc.) of the elementary unit will normally be defined in the product specification. This unit may be supplied in one of several forms:

— package (single yarn, folded or cabled yarn, roving, etc.);

— roll (mat, woven fabric, veil, etc.);

— the smallest physical entity in a bulk product (e.g. chopped fibres, milled fibres).

NOTE 1 For a given product, the dimensions, mass or volume of the elementary unit may change, as fabrication techniques evolve, without necessarily causing any modification in the product properties or the way in which these properties vary throughout the elementary unit. As an example, while some years ago a bobbin of yarn had a weight of 2 kg, the same item can now be supplied as a 10 kg bobbin. In both cases, it is the bobbin which must be considered as the elementary unit.

3.3 case: The smallest conveniently handleable unit (i.e. a carton or other container), which may contain one or more elementary units of the same type and quality.

3.4 batch (dispatched or received batch): A definite quantity of product made up of elementary units of the same type and produced under conditions assumed to be constant.

A batch may constitute all or part of any particular order.

The cases making up a batch may be handleable individually, or several may by assembled together on a pallet. All the cases constituting a batch are dispatched to, or intended for, a single customer and accompanied by a single dispatch note.

NOTE 2 In addition to the concept of a shipped batch, the user of this International Standard should be aware of the concept of a production batch. The latter concept generally applies only when production takes place in discontinuous runs. This is the case with carbon fibres, for instance, which must therefore be indentified by indicating the production batch on each case. For continous production (most textile-glass items, for example), the production-batch concept does not apply. Nevertheless, each case should, in principle, be marked with a production date. If, within a particular shipped batch, there are widely separated production dates, manufacturer and customer may agree to consider sampling each production run separately.

3.5 acceptability quality level (AQL): The maximum percent nonconforming (or the maximum number of nonconformities per 100 units) that, for purposes of sampling inspection, can be considered satisfactory as a process average.

The AQL will normally be defined, for each property, in the product specification. It may not be the same for all properties. In addition, properties subject to a lower limit and an upper limit may have a different AQL for each limit.

3.6 sample: A given number of elementary units which have been selected at random with a view to performing a test either directly on these units or on one or more specimens taken from the units.

NOTE 3 Where necessary, an additional sampling stage may be carried out on these elementary units to give a laboratory sample (e.g. a single piece of fabric or a given amount of chopped fibres). Instructions for the preparation of this laboratory sample will normally be given in the test method concerned.

3.7 inspection by attributes (counting nonconformities): A method of inspection that, for every selected elementary unit, determines either

— the presence or absence of one or more qualitative characteristics; or

— the conformance or not of a property with one or more limits defined in the manufacturer's specification.

The number of nonconforming units is then compared to the AQL given in the product specification to determine whether the batch should be accepted or rejected (see example 1, subclause 7.1).

3.8 inspection by measurements (variables): A method of inspection that consists of measuring one or more quantitative characteristics for each elementary unit in a batch or in a sample taken from the batch. Each quantitative characteristic must be measurable on a continuous scale. If more than one characteristic is measured, it requires only one characteristic to be unsatisfactory for the batch to be unacceptable.

This method of inspection using measurements is only applicable to characteristics that obey a normal (i.e. Gaussian) distribution law.

For the purposes of this International Standard, the measurement results obtained for each elementary unit are used to calculate the mean for the sample and the standard deviation. From these data, the lower quality statistic Q_L and/or the upper quality statistic Q_U are calculated, using the formulae given in example 2 (see 7.2.1), and Q_L and/or Q_U then compared with the acceptability constant k (see table 2). A graph may also be plotted as an aid in assessing the quality of the batch sampled.

Inspection by measurements may be applied to one or more properties with

— one limit, either lower or upper (see 7.2.1, example 2);

— two limits, either with different AQLs or with the same AQL.

In the case of two limits with different AQLs, batch acceptance calculations are carried out first for one limit, then for the other (see 7.2.2). In the case of two limits with the same AQL, the batch acceptance decision is based on a graphical treatment of the results (see 7.2.3, example 3).

3.9 operating characteristic curve: Each sampling plan is characterized by an operating characteristic curve which indicates, for a given AQL, the probability P_a of a batch being accepted, depending on the actual (i.e. measured) level p of nonconformities, in percent, in the batch.

The graph shown in figure 1 is an example, taken from ISO 3951, for a sample of 15 units and an AQL of 1,5 % (the "s" method). If the product supplied contains 4 % nonconformities, about 62 % of the batches submitted would be expected to be acceptable using this sampling plan.

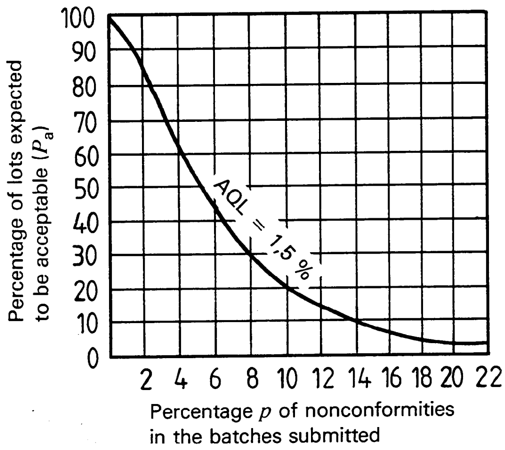

Figure 1 — Example of an operating characteristic curve

Operating characteristic curves of this kind allow an estimate to be made of the risk β to the customer in accepting batches with a nonconformity level greater than the AQL. Conversely, the risk α to the manufacturer of having a batch rejected which contains less nonconformities than the AQL can also be estimated.

Manufacturer's and customer's risks can be assessed using the operating characteristic curve. For example, it can be seen in figure 1 that the horizontal line corresponding to P_a = 10 % cuts the operating characteristic curve at a nonconformity level of 13,38 %. This means that, in 10 % of the cases, the customer may have to accept with this sampling plan a batch containing in practice 13,38 % nonconformities.

As for the manufacturer, there is a 5 % probability of him having a batch rejected by a customer although it contains only 1,09 % nonconformities.

4 Choice of sampling plan

4.1 General

From the various possibilities described in ISO 2859-1 and ISO 3951, this International Standard specifies, for both methods of inspection, the normal inspection level (i.e. level II in the two International Standards mentioned above), corresponding to a confidence level of 95 %. Other inspection levels, corresponding to higher or lower confidence levels, may be use, however. In these cases, the above-mentioned two International Standards shall be consulted.

For inspection by measurements, this International Standard only includes the "s" method, which is based on the actual standard deviation measured on the sample.

4.2 Attributes or measurements?

When a batch is to be sampled, the method of inspection, i.e. by attributes or by measurements, must be decided first.

a) Inspection by attributes is simpler, especially as far as the decision, taken after sampling, as to the acceptability of the received batch is concerned. This method of inspection can be used with one or several qualitative parameters and does not require any knowledge of the distribution law governing the results. It does require, however, a greater number of elementary units in the sample than does inspection by measurements.

b) Inspection by measurements cannot be used if the law governing the distribution of the results is not a Gaussian one. However, inspection by measurements requires, for a given AQL, a smaller number of elementary units compared with inspection by attributes. Indeed, the use of the results themselves and their distribution provides much more information on the quality of the batch. Inspection by measurements is thus particularly suitable for use with destructive testing, complex test procedures or products for which quality is a critical factor. When this inspection method is used in conjunction with quality-control charts, it is also a good way of detecting shifts in quality.

The choice of sampling plan must thus take into consideration

— the type of test which will be conducted and its cost;

— the distribution of the measured values.

It should be noted that it is possible to use inspection by measurements for certain parameters and inspection by attributes for others. In addition, it must be pointed out that the product specification should, in principle, indicate the inspection method that is most appropriate for the product concerned.

4.3 Severity of inspection

For a given inspection level (for the purposes of this International Standard, this is the normal level, which is related to a confidence level of 95 %): sampling can be characterized either by normal inspection severity or by tightened or reduced severity. For the qualification of a product, or in cases of dispute, the minimum inspection level shall be the normal level. If a decrease in quality is observed over several lots, or if the severity of the inspection

procedure needs to be improved for any other reason, then the tightened level of inspection shall be applied.

For regular deliveries of a reputable product well known to the customer, however, sampling can be carried out at the reduced level. By the same token, it is possible to use the "σ" method rather than the "s" method when the standard deviation of the property measured is accurately known.

The full sampling plans (see ISO 2859-1 and ISO 3951) shall be consulted if the normal plan is inapplicable, or if it is applicable but for some reason cannot be carried out.

4.4 Remarks

4.4.1 Before carrying out an inspection procedure (i.e. sampling plus the inspection itself), it is necessary for manufacturer and customer to agree what the following terms represent in practice for a given product:

a) the dispatched batch;

b) an elementary unit;

c) the sample (i.e. how many elementary units);

d) an individual result, the mean of the results and the standard deviation.

4.4.2 The decision regarding batch acceptance will depend solely on the individual results for each of the elementary units. These results may, if several specimens have been taken from each elementary unit, in fact each be the mean of several measurements.

If, for any reason, the distribution of the results obtained for a particular elementary unit needs to be taken into consideration, this distribution shall be considered as an additional parameter and a tolerance specified for it.

4.4.3 The sampling plan must form part of a coherent system which requires

a) that the product specification include the following information:

- the properties guaranteed,
- the inspection method used (by attributes or by measurements) for each property,
- the required quality level (AQL) for each property (the AQL will not necessarily be the same for each property),
- any departures from the normal sampling plan or from the standard sampling method;

b) that the test method specify, in addition to the test procedure itself:

- the number of specimens to be taken from each elementary unit in the sample,
- the place where the specimen(s) is/are to be taken in each elementary unit,
- the way in which the individual result for each elementary unit is to be expressed.

5 Sampling

Tables 1 and 2 specify the number of elementary units to be taken, which will depend on the number of elementary units in the dispatched batch. The tables also specify the batch acceptance and rejection criteria to be applied for AQLs between 0,65 % and 6,5 %.

For reduced or tightened sampling plans, ISO 2859-1 (attributes) and ISO 3951 (variables) shall be consulted in order to obtain the sample size from the tables of sample size versus batch size, and also the acceptance criteria for different AQLs.

Table 1 — Inspection by attributes (normal inspection) (Level II of ISO 2859-1)

Number of elementary units in batch	Sample size and corresponding code letter		Acceptance criteria as per following AQLs											
			0,65		1,0		1,5		2,5		4,0		6,5	
			A	R	A	R	A	R	A	R	A	R	A	R
2 to 8	2	A	⇩		⇩		⇩		⇩		⇩		0	1
9 to 15	3	B									0	1	⇧	
16 to 25	5	C							0	1	⇧		⇩	
26 to 50	8	D	⇩		⇩		0	1	⇧		⇩		1	2
51 to 90	13	E			0	1	⇧		⇩		1	2	2	3
91 to 150	20	F	0	1	⇧		⇩		1	2	2	3	3	4
151 to 280	32	G	⇧		⇩		1	2	2	3	3	4	5	6
281 to 500	50	H	⇩		1	2	2	3	3	4	5	6	7	8
501 to 1 200	80	J	1	2	2	3	3	4	5	6	7	8	10	11
1 201 to 3 200	125	K	2	3	3	4	5	6	7	8	10	11	14	15
3 201 to 10 000	200	L	3	4	5	6	7	8	10	11	14	15	21	22

Key:

⇧ & ⇩: Use the criteria specified for the sampling plan immediately above or below the arrow.

A: Batch is acceptable if the number of nonconforming units is equal to or less than the number given.

R: Batch is unacceptable if the number of nonconforming units is equal or greater than the number given.

NOTE — For batches of more than 10 000 elementary units, sampling shall be the subject of an agreement between manufacturer and customer.