

TECHNICAL REPORT

**ISO/TR
12662**

First edition
1997-07-15

Certification scheme for prestressing steels

Procédure de certification des armatures de précontrainte

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Reference number
ISO/TR 12662:1997(E)

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 12662, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

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Printed in Switzerland

The reason for publishing this Technical Report is to promote world trade with prestressing steel by reducing the differences between the certification schemes which could make the certified prestressing steels acceptable all over the world without additional certification. Then the product specifications too will need further harmonization.

This document is being issued in the Technical Report (type 2) series of publications (according to subclause G.3.2.2 of part 1 of the ISO/IEC Directives, 1995) as a “prospective standard for provisional application” in the field of prestressed steels because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this Technical Report (type 2) will be carried out not later than three years after its publication with the options of: extension for another three years; conversion into an International Standard; or withdrawal.

Annex A of this Technical Report is for information only.

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Certification scheme for prestressing steels

1 Scope

This Technical Report gives rules which may be applied for a certification scheme for continuous production of prestressing steels, in order to verify their conformity with requirements specified in product standards such as ISO 6934.

2 Normative references

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

ISO 377:—¹⁾, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing.*

ISO 6934-1:1991, *Steel for the prestressing of concrete — Part 1: General requirements.*

ISO 6934-2:1991, *Steel for the prestressing of concrete — Part 2: Cold drawn wire.*

ISO 6934-3:1991, *Steel for the prestressing of concrete — Part 3: Quenched and tempered wire.*

ISO 6934-4:1991, *Steel for the prestressing of concrete — Part 4: Strand.*

ISO 6934-5:1991, *Steel for the prestressing of concrete — Part 5: Hot-rolled steel bars with or without subsequent processing.*

ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing.*

ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition.*

ISO/IEC Guide 62:1996, *Guidelines for third-party assessment and registration of a supplier's quality system.*

ISO/IEC Guide 65:1996, *General requirements for the acceptance of certification bodies.*

1) To be published. (Revision of ISO 377-1:1989)

3 Definitions

For the purposes of this Technical Report, the following definitions apply.

3.1 certification: Assessment and regular surveillance by a certification body of the quality system and compliance of the products with a product standard using sampling and testing of the product supported by statistical analysis.

3.2 certification body: Impartial body, governmental or non-governmental, possessing the necessary competence and responsibility to carry out conformity certification according to given rules of procedures and management and accredited by a national or international body to perform these tasks.

3.3 factory production control: Permanent internal control of production exercised by the manufacturer.

3.4 quality system: Organizational structure, procedures, processes and resources needed to implement quality management. [2]

NOTES

- 1 The quality system should only be as comprehensive as needed to meet the quality objectives.
- 2 For contractual or mandatory quality assessment purposes, demonstration of the implementation of identified quality system elements may be required.
- 3 The quality system includes factory production control.

3.5 quality manual: Document stating the quality policy and describing the quality system of an organization. [2]

NOTE — The quality manual forms part of the quality system documentation.

3.6 technical file: Document outlining manufacturing processes and methods.

3.7 provisional certification: Certification for manufacture which may be granted during a first stage by the certification body for a product family and a limited period of time after the initial assessment.

3.8 full certification: Certification for manufacture which is granted by the certification body for a product family either after the initial assessment or after the satisfactory completion of the provisional certification, when applicable.

3.9 product family: Group of related products.

Table 1 gives examples of product families.

3.10 standard properties: Those properties which are contained in a product standard and form part of the routine internal control requirements for every inspection lot.

3.11 special properties: Those properties which are contained in a product standard and do not form part of the routine internal control requirements, e.g. stress relaxation and fatigue resistance.

3.12 independent testing: Testing which is carried out by an independent testing laboratory on samples selected by the certification body.

NOTE — When agreed with the certification body, independent testing for special properties may be carried out in the producer's testing laboratory under the supervision of the certification body.

3.13 testing laboratory: Laboratory which measures, examines, tests, calibrates or otherwise determines the characteristics or performance of materials or products.

3.14 inspection body: Impartial body having the organization, staffing, competence and integrity to perform, according to specified criteria, functions such as assessing, recommending for acceptance and subsequent audit of

producer's quality control operations and selection and evaluation of products on site or in factories or elsewhere, according to specific criteria.

3.15 external supervision: Continuous surveillance, judgement and assessment of the quality system by a certification body which consists of periodic audits of the factory and of sampling and testing of both standard and special properties.

3.16 characteristic value: Value having a prescribed probability of not being attained in a hypothetical unlimited test series. (Based on [3].)

Table 1 — Examples of product families

Type of prestressing steel	Surface configuration	Products in the product family ¹⁾
Cold-drawn wire	Plain	4 - 1770 5 - 1770 6 - 1770
	Indented	4 - 1770 5 - 1770 6 - 1770
	Plain	4 - 1670 5 - 1670 6 - 1670 7 - 1670
	Indented	4 - 1670 5 - 1670 6 - 1670 7 - 1670
	Plain	7 - 1570 10 - 1570 12,2 - 1570
	Indented	7 - 1570 10 - 1570 12,2 - 1570
	Plain	9 - 1470 10 - 1470 12,2 - 1470
	Indented	9 - 1470 10 - 1470 12,2 - 1470
Quenched and tempered wire	Plain	6 to 16 - 1570 ²⁾
	Ribbed	6,2 to 16 - 1570 ²⁾
	Grooved or indented	7,1 to 12,6 - 1420 ²⁾
2- or 3-wire strand	Plain	5,2 - 1960 5,8 - 1910 6,2 - 1910 7,5 - 1860
		5,2 - 1770 7,5 - 1770
7-wire strand	Plain	9,5 - 1860 11,1 - 1860 12,7 - 1860 15,2 - 1860
		9,3 - 1720 10,8 - 1720 12,4 - 1720 15,2 - 1720

Table 1 — Examples of product families (continued)

Type of prestressing steel	Surface configuration	Products in the product family ¹⁾
7-wire compacted strand	Plain	12,7 - 1860 15,2 - 1820 18,0 - 1700
19-wire strand	Plain	17,8 - 1860 19,3 - 1860 20,3 - 1810 21,8 - 1810
Bars	Plain	15 to 40 - 1030 ³⁾
	Ribbed	15 to 40 - 1030 ³⁾
	Plain	15 to 40 - 1080 ³⁾
	Ribbed	15 to 40 - 1080 ³⁾
	Plain	15 to 40 - 1180 ³⁾
	Ribbed	15 to 40 - 1180 ³⁾
	Plain	15 to 40 - 1230 ³⁾
	Ribbed	15 to 40 - 1230 ³⁾
1) The nominal diameter, in mm, and tensile strength, in N/mm ² , are successively indicated. 2) For the diameters, see ISO 6934-3. 3) For the diameters, see ISO 6934-5.		

4 Certification for production

4.1 General

Assessment of the quality system, testing and external supervision should be carried out by a certification body acting either with its own resources or using inspection bodies or testing laboratories authorized by it.

The products to be certified should be grouped into suitable product families, using table 1 as a guideline. This grouping should be accepted by the certification body.

If the product standard specifies properties for which this Technical Report does not give test frequencies, the latter should be decided by the certification body.

If this Technical Report gives test frequencies for properties which the product standard does not specify, these properties should not be tested.

4.2 Certification procedure

Full certification for production of material meeting the requirements of the product standard will be given for a product family after the following steps have been taken:

- application submitted by the producer to a certification body accompanied by a technical file and a quality manual;
- initial assessment by the certification body leading to the issue of either a provisional or a full certificate;
- when a provisional certificate is issued — transfer to a full certification after verification of the long-term quality level.

The certification procedure is illustrated by figure 1.

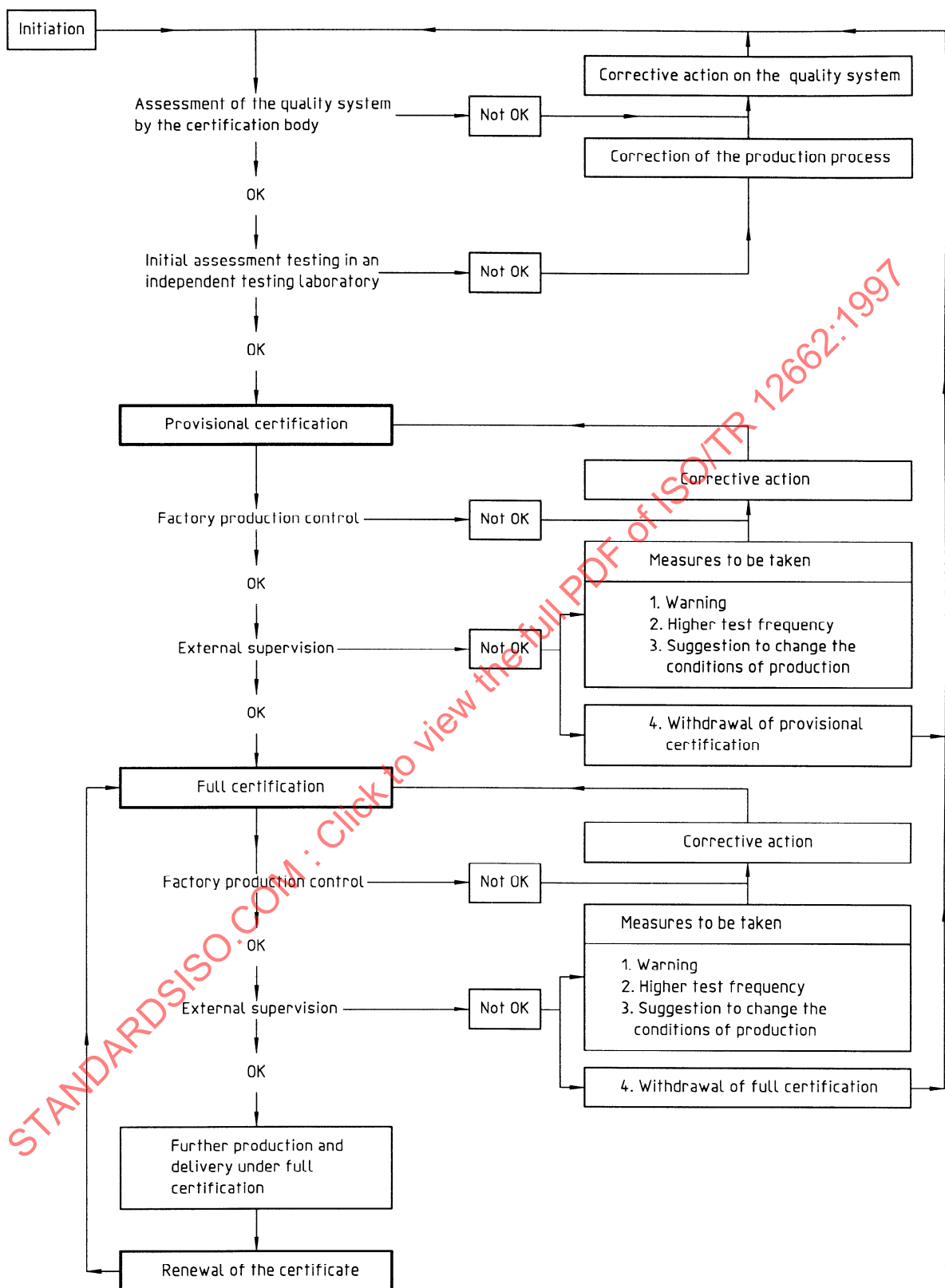


Figure 1 — Illustration of the certification procedure

4.3 Maintenance of full certification

Certification for production will be maintained subject to

- a) continuation of the production of the product families after granting of full certification;
- b) implementation of corrective actions on any non-compliance to meet the requirements;
- c) satisfactory result of external supervision.

4.4 Duration of certification

Full certification is granted in general for a maximum of 3 years.

4.5 Renewal of the certificate

At the end of the period of full certification, the renewal of the certificate will only be subject to compliance with the requirements of 4.3.

4.6 Documentation and product identification

The certification body will provide instructions concerning the use of the certification symbols. These should be used by the producer on the delivery technical documentation after provisional or full certification has been granted. They will include the means of identification of the certification body (a logo or a number), the certificate number, and a statement included in the delivery technical document of the information on the product label. The certificate number will be retained by the producer as long as certification is granted.

5 Initial assessment

5.1 General

The purpose of initial assessment is to ensure that the producer is in a position to supply products of a consistent quality in accordance with the requirements specified in the product standard.

The initial assessment applies to the manufacture of each product family.

Initial assessment consists of the following individual stages:

- a) audit of the quality system (see 5.2);
- b) testing of test pieces (see 5.3);
- c) evaluation of the test results (see 5.4).

The certification body which carries out the initial assessment may take into account previous independent testing results provided that the tested products have been manufactured under the conditions described in the technical file and the corresponding tests have been carried out within the last two years in an independent testing laboratory.

NOTE — When the producer's quality system is certified according to ISO 9002 by a certification body complying with ISO/IEC Guide 65 and ISO/IEC Guide 62, the certification body which carries out the initial assessment may only verify the validity of the certificate.

5.2 Audit of the quality system

The certification body should establish that the producer operates a quality system which satisfies the requirements of ISO 9002 and should confirm this in an assessment report.

5.3 Testing of test pieces

5.3.1 General

Testing to determine the properties of the products of the same product family that are the subject of the product standard is only to be undertaken if the report of the audit of the quality system is satisfactory and the producer has sufficient experience in the manufacture of the product concerned. The material should be produced on the plant proposed for the continuous production. The tests should cover each product family for which certified production is intended.

The factory where there has been no previous production of the type of prestressing steel (see, for example, table 1) which is to be included in the certification should be treated as a new producer.

For a new producer, the initial assessment described in this subclause and the sampling rate for internal control should be extended to a maximum of the double numbers of tests. A producer who ceases any stage of manufacture of a prestressing steel type for a significant period of time should renew initial assessment when recommencing production.

NOTE — The significant period of time is determined for individual cases, account being taken of the following, amongst other factors:

- a) major change in the quality system;
- b) changes in production technology.

5.3.2 Extent of testing and sampling

For each product family, one size should be tested.

For each product family, the material from which the samples are taken should come from two different heats. The samples to be taken per heat should permit the determination of the special properties and for standard properties, witness testing in the producer's testing laboratory and testing by an independent testing laboratory, with a retest on results where necessary.

The samples should be taken in the presence of the certification body as random samples from the production material presented for testing. Care should be taken to ensure that the samples genuinely reflect the properties of the material to be tested. Two samples should be taken from each of four units of production from each of the two heats, i.e. a total of 16 samples. Tests for standard properties should be carried out on the full product cross-section. Any sample preparation should be in accordance with ISO 377 and ISO 14284.

Standard properties should be assessed by both the producer and an independent testing laboratory. Special properties should be assessed by an independent testing laboratory (also see 3.12).

For a product family, the type and number of tests to be carried out are given in table 2.

Table 2 — Independent testing to be carried out

Stage	Frequency and material concerned	Type and number of tests		
		Standard properties	Special properties	
			Stress-relaxation	Fatigue resistance
Initial assessment	Once, for each product family	16 tests (2 × 4 per heat)	2 tests (1 per heat)	6 tests (3 per heat)
During provisional certification ^{1) 2)}	Every six months, for each product type (wire, 2- or 3-wire strand, 7-wire strand, 7-wire compacted strand, bars)	8 tests	1 test	3 tests
After full certification ²⁾	Yearly, for one size of every product type	8 tests	1 test	3 tests
1) When applicable.				
2) The tests should be carried out for every product type on samples coming from the same heat or inspection lot.				

5.4 Evaluation of the test results

5.4.1 The results (individual values and/or if applicable statistical parameters related to the mean and dispersion) of the tests are to be collated in a test report.

5.4.2 The results should be evaluated for compliance with the requirements of the product standard.

5.4.3 In the case of fatigue tests, the product should be deemed to comply with the product standard if all test specimens fulfil the relevant requirements.

If one valid test specimen fails, one further series of three specimens should be selected if possible from the heat which includes the failure. If one or more of these specimens fails, the material should be deemed not to comply with the product standard, and an investigation should be carried out.

Where two or more valid test specimens of those initially selected fail to endure the specified number of cycles, the material represented should be deemed not to comply with the product standard, and an investigation should be carried out.

NOTE — In the case of any failure, the test should be considered invalid if it initiated from a defect unique to the test specimen or in an area adjacent to the testing machine grips, in this case another single test should be carried out.

5.4.4 If applicable, the witnessed test results and those obtained in the independent testing laboratory are compared by appropriate methods.

6 Provisional certification

NOTE — The stage of provisional certification does not have to be applied. The certification body may directly issue a full certificate (see clause 7).

6.1 General

Once the initial assessment has been completed, a provisional production certificate with a certificate number is granted to the producer.

Full certification will normally be expected to be given in a period of 6 to 12 months, after granting the provisional certification.

6.2 Extent of testing

In order to verify the maintenance of the long-term quality level, the producer should manufacture the product that is the object of the certification with external supervision. During this period, external supervision should be carried out more frequently than that described in clause 9.

During this period, the type and number of tests which should be carried out every six months by an independent testing laboratory for a certified product per each product type (see table 1) are given in table 2 (see also 3.12).

6.3 Evaluation

At the end of the period specified in 6.1, all results of internal control and external supervision should be evaluated separately and be compared with each other. The long-term quality level determined by appropriate statistical methods should correspond to the requirements of the product standard.

7 Full certification

Once the properties have been evaluated positively by the certification body, a full approval to produce is granted to the producer. This permits the producer to use the certificate number or to continue to use it when a provisional certificate has been initially granted.

In order to verify the maintenance of the long-term quality level, the producer should manufacture the product that is the object of the certification with external supervision. During this period, external supervision should be carried out according to clause 9.

8 Factory production control

8.1 General

Factory production control by the manufacturer is intended to ensure and demonstrate that the product delivered by the manufacturer complies with the requirements of the product standard and that the level of quality remains consistent. It is also used to ensure that, where necessary, measures can be taken to improve product compliance.

8.2 Testing of standard properties

8.2.1 Frequency of sampling and testing for wire

The inspection lot should be composed of units of products from the same cast.

The manufacturer should sample and test in accordance with table 3.

Table 3 — Frequency of sampling and testing for manufacturer's inspection of wire

Cross-sectional area Maximum force Constriction	Every unit
0,1 % proof force Elongation at maximum force Reverse bend	1 in 5 units
Indentation depth	1 in 10 units

8.2.2 Frequency of sampling and testing for strand

The inspection lot should be composed of units of products, the total mass of which should not exceed 50 t.

The manufacturer should sample and test in accordance with table 4.

Table 4 — Frequency of sampling and testing for manufacturer's inspection of strand

Cross-sectional area Maximum force Constriction	Every unit
0,1 % proof force Elongation at maximum force	1 in 5 units

8.2.3 Frequency of sampling and testing for bars

The inspection lot should be composed of units of products from the same cast.

The manufacturer should sample and test in accordance with table 5.

Table 5 — Frequency of sampling and testing for manufacturer's inspection of bars

Geometrical properties Maximum force Constriction	Minimum of 10 per cast, at a rate of 1 or more in each 3 units
0,1 % proof force Elongation at maximum force Bend test on a mandrel of diameter 10 × nominal bar diameter	Minimum of 5 per cast, at a rate of 1 or more in each 8 units

8.2.4 Evaluation of test results for each inspection lot

An inspection lot should be deemed to comply with the requirements of the product standard if the following conditions are met.

- a) Less than 5 % of the results for the maximum force and the 0,1 % proof force are lower than the specified values.
- b) All the units of products exhibiting one or more of the following have been rejected:
 - 1) maximum force lower than 95 % of the specified characteristic value or greater than the upper specified maximum force;
 - 2) out of tolerance on cross-sectional area;
 - 3) a constriction where a ductile break is not visible to the unaided eye;
 - 4) unacceptable surface defect.
- c) All the results for elongation at maximum force and, when applicable, reverse bend are greater than or equal to specified minimum values, and all the results for the 0,1 % proof force are greater than or equal to 95 % of the specified characteristic value. 95 % of the results of the indentation depth for indented wire and strand and of the rib height for ribbed bars and wire should be within the specified tolerance. For bar, there should be no rupture in the bend test.

If the inspection lot does not comply with the requirements of c) then it should be rejected or the manufacturer may test every unit of product. He should then reject the units of product which do not comply with the requirements. Where this testing includes 0,1 % proof force, compliance with a) should be reverified.

8.3 Testing of special properties

As factory production control the manufacturer should carry out, during provisional certification and after full certification when applicable, tests of special properties with doubled frequencies of the ones given in table 2.

8.4 Determination of the long-term quality level

8.4.1 Assessment of the characteristic values

The results of tests on all inspection lots of continuous production should be collated product per product, and for maximum force F_m and proof force $F_{p0,1}$ statistically evaluated using data based on a 6 month operation (or a 12 month operation if the production quantity is limited).

The following requirement should be satisfied for the maximum force and the 0,1 % proof force:

$$m - ks \geq c_v$$

where

m is the average value;

s is the estimate of the standard deviation of all the available data;

k is a coefficient;

c_v is the specified characteristic value.

As an example, table 6 gives the values of coefficient k as a function of a number (n) of test results for a reliable failure rate of 5 % ($p = 0,95$) at a probability of 95 % ($1 - \alpha = 0,95$).

**Table 6 — Coefficient k as a function of a number (n) of test results
for a reliable failure rate of 5 % ($p = 0,95$) at a probability of 95 % ($1 - \alpha = 0,95$)**
(See ISO 3207:1975, table 7)

n	k	n	k
5	4,21	30	2,22
6	3,71	40	2,13
7	3,40	50	2,07
8	3,19	60	2,02
9	3,03	70	1,99
10	2,91	80	1,97
11	2,82	90	1,94
12	2,74	100	1,93
13	2,67	150	1,87
14	2,61	200	1,84
15	2,57	250	1,81
16	2,52	300	1,80
17	2,49	400	1,78
18	2,45	500	1,76
19	2,42	1 000	1,73
20	2,40		

The foregoing is based on the assumption that the distribution of a large number of results is normal. However, it is generally not a requirement of the product standard that the distribution be normal.

9 External supervision during full certification

9.1 General

The purpose of external supervision is to:

- a) confirm that the quality system continues to comply with the requirements of 5.2. This requirement will be satisfied by an existing certification of conformity to ISO 9002 issued by a certification body complying with ISO/IEC Guide 65 and ISO/IEC Guide 62;
- b) select samples for independent testing according to 9.2;
- c) review the producer's factory production control in accordance with clause 8.

External supervision by the certification body should be carried out at maximum intervals of 6 months.

9.2 Properties to be tested

All properties (standard and special) should be tested by sampling the products. The sampling should permit the tests given in table 2 to be carried out yearly (see also 3.12).

These tests are carried out on one product family taken at random per product type. Where several product families are included in the certification of a product type, the certification body proceeds the sampling in such a way as to cover the greatest number of families in a certain period of time.

9.3 Evaluation, reporting and action

The results of the producer's long-term quality level assessment should be submitted to the responsible certification body every six months.

The result of external supervision should be recorded in a supervision report which should be produced within a period of 4 weeks.

The test results should be evaluated as in 6.3, together with appropriate methods.

If the results show that the production does not conform to the requirements, appropriate measures should be taken. The measures will depend on the type and significance of the deficiencies noted but will include

- a) a warning to the producer,
- b) intensification of supervision (increase the frequency of testing),
- c) a suggestion to change the conditions of production,
- d) withdrawal of certification.