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Metallic materials — Verification of static uniaxial testing machines —

Part 1:
Tension/compression testing machines — Verification and calibration of the force-measuring system

Matériaux métalliques — Vérification des machines pour essais statiques uniaxiaux —

Partie 1: Machines d'essai de traction/compression -- Vérification et étalonnage du système de mesure de force

[Revision of third edition (ISO 7500-1:2004) and Technical Corrigendum (ISO7500-1:2004/Cor.1:2008)]

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ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7500-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 1, *Uniaxial testing*.

This fourth edition cancels and replaces the third edition (ISO 7500-1:2004) and has been technically revised.

ISO 7500 consists of the following parts, under the general title *Metallic materials — Verification of static uniaxial testing machines*:

— *Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

— *Part 2: Tension creep testing machines — Verification of the applied load*

Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system

1 Scope

This part of ISO 7500 specifies the verification of tension/compression testing machines.

The verification consists of

— a general inspection of the testing machine, including its accessories for the force application;

— a calibration of the force-measuring system.

NOTE This part of ISO 7500 addresses the static verification of the force-measuring systems. The calibration values are not necessarily valid for high-speed or dynamic testing applications. Further information regarding dynamic effects is given in the Bibliography.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 376, *Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines*

3 Terms and definitions

For the purposes of this document, the following term and definition apply.

3.1
calibration
operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

NOTE 1 A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

NOTE 2 Calibration should not be confused with adjustment of a measuring system, often mistakenly called “self-calibration”, nor with verification of calibration.

NOTE 3 Often, the first step alone in the above definition is perceived as being calibration.

See VIM[1].

4 Symbols and their meanings

Symbols and their meanings are given in Table 1.

Table 1 — Symbols and their meanings

Symbol	Unit	Meaning
a	%	Relative resolution of the force indicator of the testing machine
b	%	Relative repeatability error of the force-measuring system of the testing machine
f_0	%	Relative zero error of the force-measuring system of the testing machine
F	N	True force indicated by the force-proving instrument with increasing test force
F'	N	True force indicated by the force-proving instrument with decreasing test force
F_c	N	True force indicated by the force-proving instrument with increasing test force, for the complementary series of measurements for the smallest range used
F_i	N	Force indicated by the force indicator of the testing machine to be verified, with increasing test force
F'_i	N	Force indicated by the force indicator of the testing machine to be verified, with decreasing test force
$\overline{F}_i$, $\overline{F}$	N	Arithmetic mean of several measurements of F_i and F for the same discrete force
F_{ic}	N	Force reading on the force indicator of the testing machine to be verified, with increasing test force, for the complementary series of measurements for the smallest range used
F_{i0}	N	Residual indication of the force indicator of the testing machine to be verified after removal of force
F_N	N	Maximum capacity of the measuring range of the force indicator of the testing machine
g_n	m/s^2	Local acceleration due to gravity
q	%	Relative accuracy error of the force-measuring system of the testing machine
q_{max}	%	The maximum value of q at each calibration point
q_{min}	%	The minimum value of q at each calibration point
r	N	Resolution of the force indicator of the testing machine
v	%	Relative reversibility error of the force-measuring system of the testing machine
ρ_{air}	kg/m^3	Density of air
ρ_m	kg/m^3	Density of the dead weights

5 General inspection of the testing machine

The verification of the testing machine shall only be carried out if the machine is in good working order. For this purpose, a general inspection of the machine shall be carried out before calibration of the force-measuring system of the machine (see Annex A).

NOTE Good metrological practice requires a calibration run prior to any maintenance or adjustments to the testing machine.

6 Calibration of the force-measuring system of the testing machine

6.1 General

This calibration shall be carried out for each of the force ranges used and with all force indicators in use. Any accessory devices (e.g. pointer, recorder) that may affect the force-measuring system shall, where used, be verified in accordance with 6.4.6.

If the testing machine has several force-measuring systems, each system shall be regarded as a separate testing machine. The same procedure shall be followed for double-piston hydraulic machines.

The calibration shall be carried out using force-proving instruments with the following exception. If the force to be verified is below the lower limit of the smallest capacity force-proving device used in the calibration procedure, use known masses.

When more than one force-proving instrument is required to calibrate a force range, the maximum force applied to the smaller device shall be the same as the minimum force applied to the next force-proving instrument of higher capacity. When a set of known masses is used to verify forces, the set shall be considered as a single force-proving instrument.

The calibration may be carried out with constant indicated forces, F_i or the calibration can be carried out with constant true forces, F.

NOTE 1 Calibration can be carried out using a slowly increasing force. The word “constant” signifies that the same nominal value of F_i (or F) is used for the three series of measurements (see 6.4.5).

The instruments used for the calibration shall have a certified traceability to the international system of units.

The force-proving instrument shall comply with the requirements specified in ISO 376. The class of the instrument shall be equal to or better than the class for which the testing machine is to be calibrated. In the case of dead weights, the relative error of the force generated by these weights shall be less than or equal to ± 0,1 %.

NOTE 2 The exact equation giving the force, F, in newtons, created by the dead weight of mass m, in kilograms, is:

$$F = mg_n \left[1 - \frac{\rho_{air}}{\rho_m} \right] \quad (1)$$

This force can be calculated using the following approximate formula:

$$F = mg_n \quad (2)$$

The relative error of the force can be calculated, using the formula:

$$\frac{\Delta F}{F} = \frac{\Delta m}{m} + \frac{\Delta g_n}{g_n} \quad (3)$$

6.2 Determination of the resolution

6.2.1 Analogue scale

The thickness of the graduation marks on the scale shall be uniform and the width of the pointer shall be approximately equal to the width of a graduation mark.

The resolution, r, of the indicator shall be obtained from the ratio between the width of the pointer and the centre-to-centre distance between two adjacent scale graduation marks (scale interval). The recommended ratios are 1:2, 1:5 or 1:10, a spacing of 2,5 mm or greater being required for the determination of one-tenth of a scale division.

6.2.2 Digital scale

The resolution is taken to be one increment of the count of the numerical indicator, provided that, when the instrument is unloaded and the motors and controls system are operating, the indication does not fluctuate by more than one increment.

6.2.3 Variation of readings

If the readings vary by more than the value previously calculated for the resolution (with the force-proving instrument unloaded and with the motor and/or drive mechanism and control on for determining the sum of all electrical noise), the resolution, r, shall be deemed to be equal to half the range of fluctuation plus one increment.

NOTE 1 This only determines the resolution due to system noise and does not account for control errors, i.e., in the case of hydraulic machines.

NOTE 2 For auto-ranging machines, the resolution of the indicator changes as the resolution or gain of the system changes.

6.2.4 Unit

The resolution, r, shall be expressed in units of force.

6.3 Prior determination of the relative resolution of the force indicator

The relative resolution, a, of the force indicator is defined by the relationship:

$$a = \frac{r}{F} \times 100 \tag{4}$$

where

r is the resolution defined in 6.2;

F is the force at the point under consideration.

The relative resolution shall be determined at each calibration point and shall not exceed the values given in Table 2 for the class of machine being verified.

6.4 Calibration procedure

6.4.1 Alignment of the force-proving instrument

Mount tension force-proving instruments in the machine in such a way as to minimize any effects of bending (see ISO 376). For the alignment of a force-proving instrument in the compression mode, mount a platen with a ball nut on the instrument if the machine does not have an incorporated ball cup.

For testing systems that do not use compression platens for testing, the force proving device may be attached to the testing machine with threaded studs, for the verification of tension and compression modes. In this case, the force proving device shall be calibrated in a similar fashion (i.e. with threaded studs) and rotation of the force-proving instrument through an angle of 120º is required between each series of measurements during the verification of the testing machine.

NOTE If the machine has two work areas with a common force application and indicating device, one calibration could be performed, so that e.g., compression in the upper work area equals tension in the lower work area, and vice versa. The certificate should carry an appropriate comment.