INTERNATIONAL STANDARD

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Acceptance conditions for gear hobbing machines — Testing of the accuracy

Conditions de réception des machines à tailler les engrenages par fraise-mère — Contrôle de la précision

Reference number
ISO 6545 : 1992 (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.

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 6545 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Sub-Committee SC 2, *Acceptance conditions for machines operating by removing metal.*

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Acceptance conditions for gear hobbing machines — Testing of the accuracy

1 Scope

This International Standard specifies geometrical tests and practical tests, with reference to ISO 230-1 and also kinematic tests (accuracy of the transmission of motion) for general purpose and normal accuracy gear hobbing machines, with vertical or horizontal spindle. This International Standard also gives the terminology used for the main elements of the machine.

NOTE — In addition to terms used in the official ISO languages (English, French and Russian), this International Standard gives the equivalent terms in the German language; these are published under the responsibility of the member body for Germany (DIN). However, only the terms given in the official languages can be considered as ISO terms.

It deals only with the verification of the accuracy of the machine. It does not apply to the testing of the running of the machine (vibrations, abnormal noises, stick-slip motion of components, etc.) or to machine characteristics (such as speeds, feeds, etc.) which should generally be checked before the accuracy is tested.

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 230-1 : 1986, *Acceptance code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or finishing conditions.*

ISO 701 : 1976, *International gear notation — Symbols for geometrical data.*

ISO 1328 : 1975, *Parallel involute gears — ISO system of accuracy.*

3 Preliminary remarks

3.1 In this International Standard, the dimensions and the permissible deviations are expressed in millimetres and inches.

3.2 To apply this International Standard, reference should be made to ISO 230-1, especially for the installation of the machine before testing, warming up of spindles and other moving parts, description of measuring methods and recommended accuracy of testing equipment.

3.3 The sequence in which the geometrical tests are given is related to the sub-assemblies of the machine and this in no way defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be applied in any order.

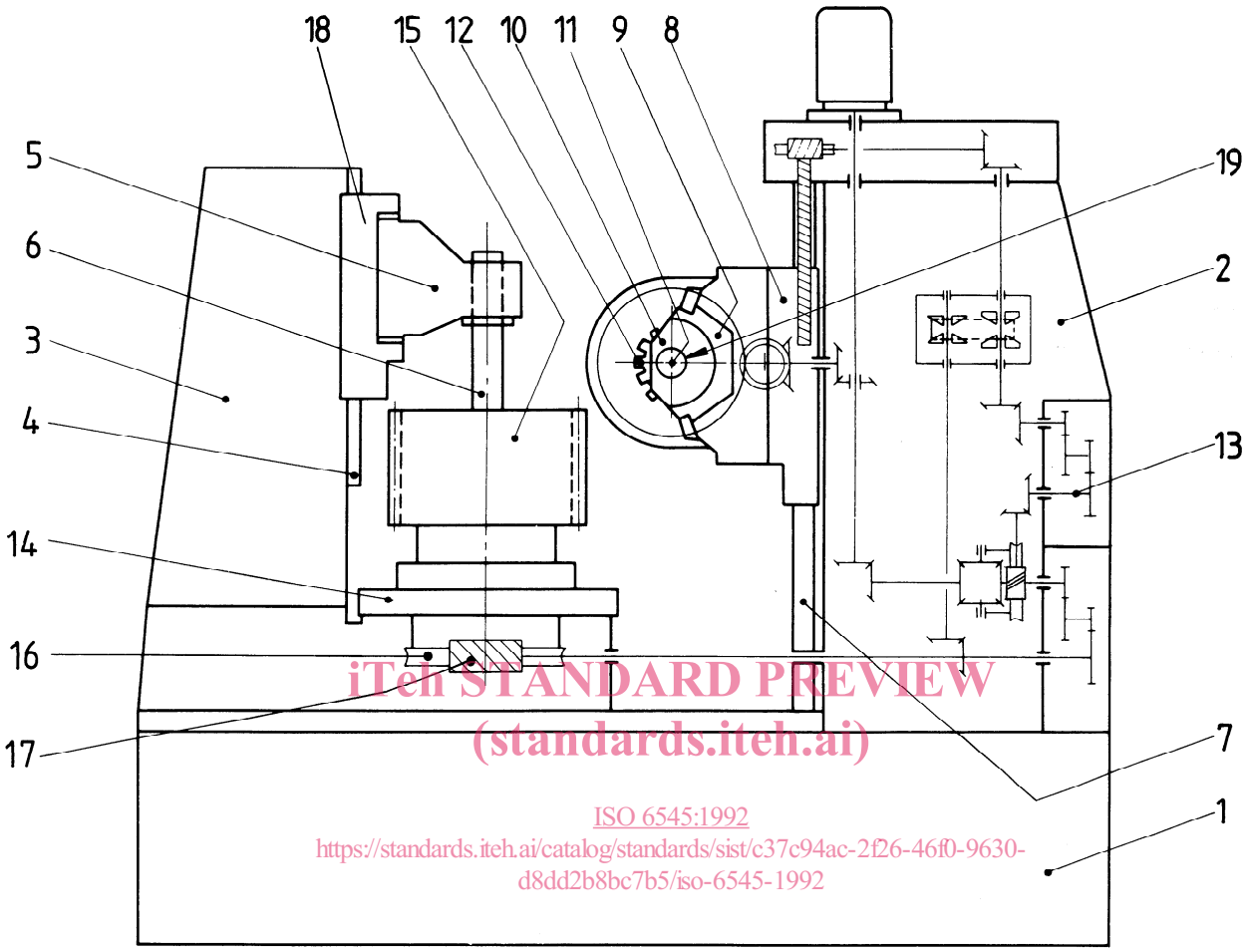
3.4 When inspecting a machine, it is not always possible, or necessary, to carry out all the tests described in this International Standard. It is up to the user to choose, in agreement with the manufacturer, those tests relating to the existing elements of the machine or to the properties which are of interest, but these tests are to be clearly stated when ordering a machine.

3.5 Practical tests shall be made with finishing cuts and not with roughing cuts which are liable to generate appreciable cutting forces. The actual feeds and speeds will be selected by the manufacturer to suit the particular machine.

3.6 When the tolerance is established for a measuring range different from that given in this International Standard (see ISO 230-1 : 1986, 2.311) it should be taken into consideration that the minimum value of tolerance is 0,005 mm (0,000 2 in).

3.7 The values using the formulae shall be rounded to the nearest 0,001 mm (0,000 1 in).

4 Terminology



Ref.	English language	French language	Russian language	German language
1	Bed	Banc	Станина	Bett
2	Column	Montant	Передняя стойка	Hauptständer
3	Work-steady column	Montant de la lunette	Задняя стойка с люнетом	Gegenhalterständer
4	Work-steady slideway	Glissière de la lunette	Направляющая люнета	Gegenhalterführung
5	Work-steady	Lunette	Люнет	Gegenhalterarm
6	Work arbor (clamping arbor)	Arbre porte-piece	Оправка	Aufspanndorn
7	Axial slideway	Glissière du chariot axial	Направляющая суппорта фрезы	Axialschlittenführung
8	Axial slide	Chariot axial	Суппорт фрезы	Axialschlitten
9	Tangential slide	Chariot tangentiel (ou porte-fraise)	Поперечный суппорт	Tangentialschlitten
10	Outboard bearing	Contre-palier du madrin porte-fraise	Подшипник оправки фрезы	Fräsdorn-Gegenlager
11	Axis of rotation of the hob spindle	Axe de la broche porte-fraise	Ось шпинделя	Drehachse des Werkzeug-trägers
12	Hob	Fraise-mère	Фреза	Wälzfräser
13	Reference shaft	Arbre de référence	Эталонный вал	Bezugswelle
14	Work-table (-carrier; -spindle)	Plateau porte-pièce	Рабочий стол	Werkstückträger
15	Workpiece	Pièce	Обрабатываемая деталь	Werkstück
16	Index worm wheel	Roue de division	Делительное колесо	Teilschneckenrad
17	Index worm	Vis de division	Делительный винт	Teilschnecke
18	Work-steady slide	Chariot porte-lunette	Суппорт люнета	Gegenhalterschlitten
19	Hob arbor	Arbre porte-fraise	Фрезерная оправка	Fräserdorn

5 Symbols

For the purposes of this International Standard, the following symbols in addition to those given in ISO 701 apply.

5.1 Reference workpiece

d_u	reference diameter
m_{tu}	transverse module
P_{tu}	transverse diametral pitch
z_u	number of teeth

5.2 Test workpiece

b	face width
d	reference diameter
m	normal module
m_t	transverse module
P	normal diametral pitch, in reciprocal inches
P_t	transverse diametral pitch, in reciprocal inches
z	number of teeth
β	helix angle

5.3 Capacity of the machine

d_{max}	reference diameter of the largest workpiece that can be hobbed on the machine
$m_{0,max}$	maximum hob module
$P_{0,min}$	minimum diametral pitch of the hob, in reciprocal inches

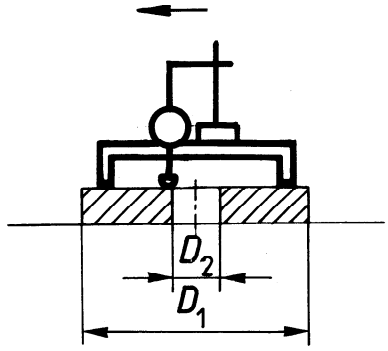
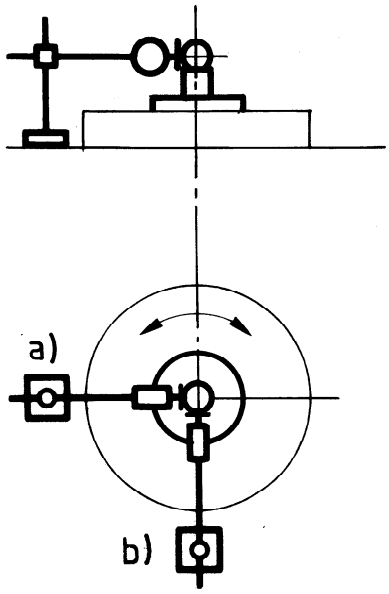
5.4 Accuracy of the machine or of the test gear

f_{dk}	high-frequency component of the angular transmission deviation
f_{dk0}	part of f_{dk} proportional to the transverse module of a reference or test workpiece
f_{dkT}	part of f_{dk} proportional to the reference diameter of a reference or test workpiece
f_{dl}	low-frequency component of the angular transmission deviation
$f_{dl,max}$	maximum amplitude (peak to peak) of the low-frequency component of the angular transmission deviation
$f_{f\beta}$	helix form deviation
$f_{H\beta}$	helix slope deviation
f_{pt}	single pitch deviation
f_{tk}	high-frequency component of the tangential linear transmission deviation
f_{tl}	low-frequency component of the tangential linear transmission deviation
f_{xk}	high-frequency component of the axial linear transmission deviation
f_{xl}	low-frequency component of the axial linear transmission deviation
F_d	angular transmission deviation
F_p	total cumulative pitch deviation
F_{pj}	cumulative pitch deviation
F_t	tangential linear transmission deviation
F_x	axial linear transmission deviation
F_α	total profile deviation

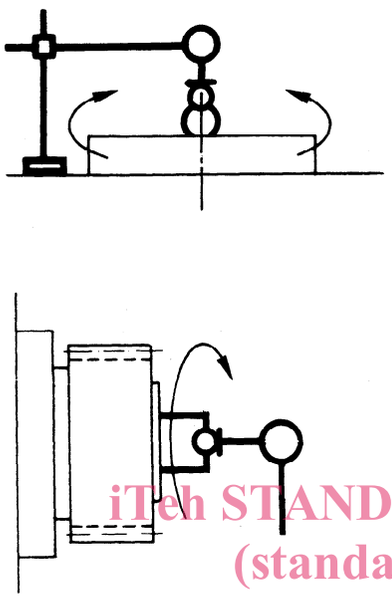
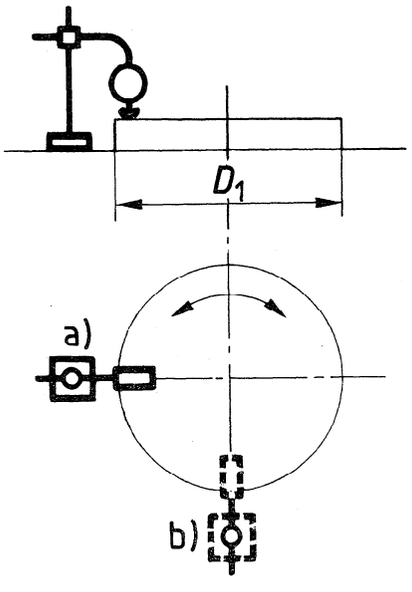
5.5 Additional symbols

p_1	number of periods of the cumulative pitch deviation defined in accordance with 8.2
s	length of arc on a reference circle
z_S	number of starts of the index worm
z_T	number of teeth of the index worm wheel

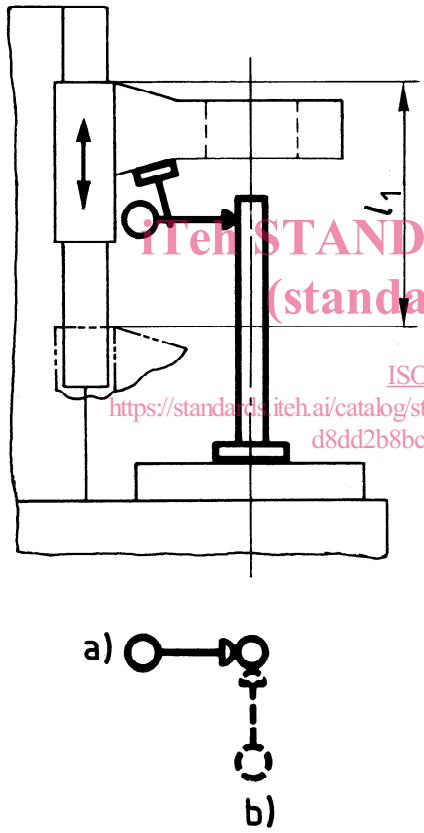
6 Geometrical tests

No.	Diagram	Object
		A — WORK-TABLE
G1		Measurement of the diametral straightness of the surface of the work-table
G2		Measurement of radial run-out of the axis of rotation of the work-table or work-spindle

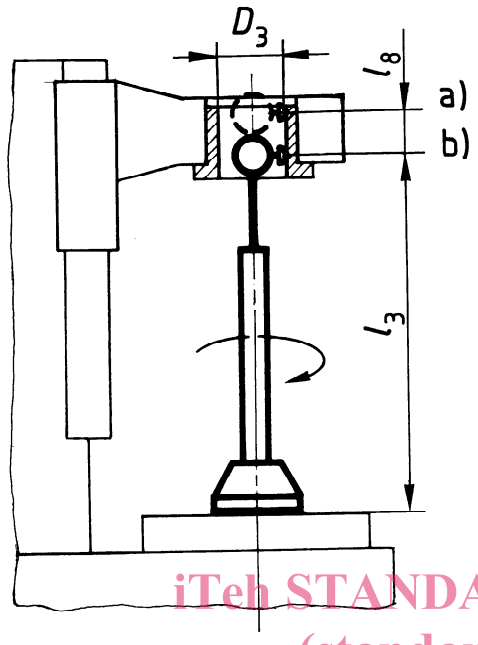
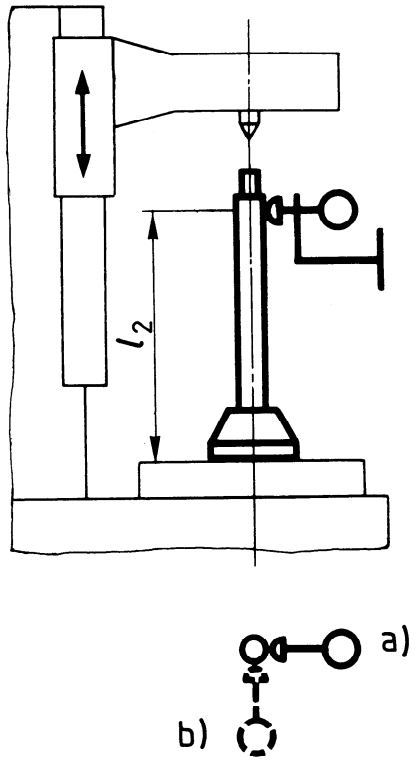
Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 : 1986 acceptance code
0,001 mm	0,000 1 in		
d, D, l, m in millimetres	d, D, l, m, $\frac{1}{P}$ in inches		
$6 + 0{,}6\sqrt{D_1 - D_2}$	$2{,}36 + 1{,}19\sqrt{D_1 - D_2}$	Straightedge and dial gauge, level or other equipment	Subclauses 5.2 and 5.3 Trace the surface of the work-table with a precision dial gauge using the bridge-type straightedge as a reference. Machines without work-tables do not require this test. For machines up to 500 mm diameter work-table check the straightness on two diameters and on machines with a work-table greater than 500 mm on four diameters.
Straight or concave			
$4 + 0{,}1\sqrt{d_{max}}$	$1{,}57 + 0{,}2\sqrt{d_{max}}$	Flat-tipped dial gauge, ball, and special support or test cylinder	Subclause 5.612 Place two gauges, located 90° apart at a) and b) against the ball, perpendicular to the axis of rotation of the work-spindle. Adjust the ball on the support so that the variations of the indicator readings of both dial gauges during one revolution of the work-table will be as small as possible. The variations of the indicator readings at a) and b) shall be recorded as the measured radial run-out. Take measurements in both directions of rotation of the work-spindle at a) and b). The largest of the indicator reading variations shall be recorded as the measured radial runout. These measurements can also be made by using a test cylinder in place of the ball and special support.

No.	Diagram	Object
G3		Measurement of periodic axial slip of the work-spindle
G4		Measurement of camming of the work-table

Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 : 1986 acceptance code
0,001 mm	0,000 1 in		
d, D, l, m in millimetres	d, D, l, m, $\frac{1}{P}$ in inches		
$4 + 0{,}06\sqrt{d_{max}}$	$1{,}57 + 0{,}12\sqrt{d_{max}}$	Flat-tipped dial gauge, ball and special support	Subclauses 5.622.1 and 5.622.2 Place the stylus of the dial gauge in alignment with the axis of rotation of the work-spindle and against the ball adjusted as in test G2. Take measurements in both directions of rotation of the work-spindle. On machines where the work arbor axis is horizontal, apply a force F, if necessary*), in order to eliminate the axial play in the bearing; the value of this force shall be specified by the manufacturer. *) Not necessary in the case of axially preloaded bearings.
$6 + 0{,}25\sqrt{D_1}$	$2{,}36 + 0{,}5\sqrt{D_1}$	Crown-tipped dial gauge	Subclause 5.632 Touch the work-table surface with a dial gauge successively at two points a) and b) located 90° apart on the largest possible measuring circle diameter (one measuring point a) or b) opposite the hob). Take measurements in both directions of rotation of the work-table. The largest of the indicator reading variations shall be recorded as the measured camming. On machines where the work arbor axis is horizontal, apply a force F, if necessary*), as in test G3. NOTE — It may be useful to put a flat block between the stylus and the table surface. *) Not necessary in the case of axially preloaded bearings.

No.	Diagram	Object
		B — WORK-STEADY
G5	 l_1 maximum working traverse of the work-steady	Measurement of parallelism of the work-steady movement with the axis of rotation of the work arbor

Permissible deviation		Measuring instruments	Observations and references to the ISO 230-1 : 1986 acceptance code
0,001 mm	0,000 1 in		
d, D, l, m in millimetres	d, D, l, m, $\frac{1}{P}$ in inches		
a)			
Permissible deviation at the free end of the test mandrel			Subclause 5.422.3
towards the axis of the hob spindle:			Attach the dial gauge to the work-steady near the bore of the steady, and place the tip against the test mandrel in positions a) and b). Adjust the test mandrel to its position of mean radial run-out for each measuring direction.
$8 + 0{,}8\sqrt{l_1}$	$3{,}15 + 1{,}59\sqrt{l_1}$	Crown-tipped dial gauge and cylindrical test mandrel	
in the opposite direction:			Take measurements at a) and b) over the full working traverse of the work-steady, with the work-steady slide clamped, if applicable.
$4 + 0{,}4\sqrt{l_1}$	$1{,}57 + 0{,}79\sqrt{l_1}$		
b)			Determine the mean of the variations of the indicator readings at a) and b) per spindle revolution. The variation of the mean values is the deviation of parallelism.
$6 + 0{,}5\sqrt{l_1}$	$2{,}36 + 0{,}99\sqrt{l_1}$		These measurements may also be taken with a recording instrument while the work arbor is rotating.

No.	Diagram	Object
G6.1	 l_3 maximum working height of the work-steady above the surface of the table l_8 distance between the two measuring planes D_3 diameter of the bush bore	Measurement of coincidence of the work-steady bush bore with the work arbor axis of rotation
G6.2	 l_2 distance between the measuring point and the surface of the table	**For machines with centres** Measurement of coincidence or alignment of the work-steady centre with the axis of rotation of the work arbor