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Gear hobs — Accuracy requirements

Fraises-mères — Exigences d'exactitude

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 1, *Nomenclature and wormgearing*.

This third edition cancels and replaces the second edition (ISO 4468:2009), which has been technically revised. It also incorporates the Technical Corrigendum ISO 4468:2009/Cor 1:2009.

The main changes compared to the previous edition are as follows:

— oversize tolerances: when the hob outside diameter exceeds the recommended size given in ISO 2490, the standard tolerances shall be increased by a factor of one-half of the percent oversize;

— hob sizes: the standard hob sizes from ISO 2490 were added as Annex A.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Gear hobs — Accuracy requirements

1 Scope

This document specifies requirements for the accuracy of general-purpose hobs of 0,5 module to 40 module.

These hobs are intended for producing gears which conform to ISO 53 and ISO 54.

This document applies to hobs for spur and helical gears. It applies to solid (monobloc) and inserted blade hobs.

The elemental features of hobs are graded according to accuracy, as follows:

— Grade 4A;

— Grade 3A;

— Grade 2A;

— Grade A;

— Grade B;

— Grade C;

— Grade D.

Grade 4A is the highest order of precision.

In addition to the elemental tests for hobs, this document gives permitted tolerances for composite tests that are taken along the cutting edges on the line of action. The two groups of tests are not equivalent and one can choose between one or the other. If there was no previous agreement, the hob is regarded as belonging to the precision class specified if it satisfies one or the other of the two methods of inspection.

NOTE The tolerances in this document were determined for gear hobs whose dimensions conform to ISO 2490, but with certain precautions they can be applied to hobs not specified in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 1122-1, *Vocabulary of gear terms — Part 1: Definitions related to geometry*

ISO 2768-1, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1122-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
radial runout of hub diameter
total deviation in radial distance of the hub periphery from the axis

3.1.2
axial runout of hub face
total axial deviation of the hub face from a true plane of rotation

3.1.3
radial runout of tips of teeth
total deviation in the radial distance from the axis to the tips of the hob teeth

3.1.4
straightness and radial alignment over cutting depth
angular relationship between the tooth face and a radial line intersecting the tooth face at the hob outside diameter, measured in a plane perpendicular to the axis

3.1.5
adjacent spacing of cutting face of gashes
maximum deviation between any two consecutive cutting face measurements

3.1.6
total spacing of cutting face of gashes
maximum deviation between any two cutting face measurements

3.1.7
gash lead deviation per 100 mm
maximum deviation as the probe contacts the tooth faces within the axial region of the gash

Note 1 to entry: Allowable values for deviations are given per 100 mm of cutting face width.

3.1.8
tooth profile deviation
maximum deviation of the portion of the hob tooth that generates an unmodified involute profile

3.1.9
tooth thickness
normal tooth thickness difference of the actual and reference datum at the reference cylinder

Note 1 to entry: Tooth thickness is negative only.

3.1.9.1
addendum
radial distance between the top of the hob tooth and the reference cylinder.

3.1.9.2
tooth thickness difference along one gash
difference between the maximum and minimum nominal *tooth thickness* (3.1.9) along one gash at the reference cylinder

Note 1 to entry: Test 9B is used for tooth thickness difference along one gash. This test is only valid for quality Grades 4A, 3A and 2A (see Table 6).

3.1.10
lead deviation on adjacent teeth
maximum lead deviation between any two consecutive teeth

3.1.11
lead deviation in one axial pitch
maximum deviation between any two teeth within any group of consecutive teeth contained in one axial pitch

Note 1 to entry: The number of teeth in one axial pitch is the number of teeth encountered by the measurement probe as it moves parallel to the reference axis during lead testing for a distance of one axial pitch of the hob.

Note 2 to entry: Hobs having one thread:

Measuring distance = one axial pitch = one revolution

Hobs having two threads:

Measuring distance = one axial pitch = 1/2 revolution

Hobs having three threads:

Measuring distance = one axial pitch = 1/3 revolution, etc.

Note 3 to entry: The number of teeth is determined by the number of gashes, the number of threads and, in the case of helical gash hobs, the gash lead.

Note 4 to entry: Test 11A is used for lead deviation in one axial pitch when the line of action test is used.

3.1.12
lead deviation in three axial pitches
maximum lead deviation between any two teeth contained in three axial pitches

Note 1 to entry: The number of teeth in three distance of three axial pitches of the hob axial pitches is that number of teeth encountered by the measurement probe as it moves parallel to the reference axis during lead testing for a distance of three axial pitches of the hob.

Note 2 to entry: The number of teeth is determined by the number of gashes, the number of threads and, in the case of helical gash hobs, the gash lead.

3.1.13
adjacent deviation along line of action
maximum deviation between any two consecutive teeth of a given line of action test

Note 1 to entry: Adjacent hob line of action allowable deviation can be applied to adjacent line of action test results in those cases where the hob has been specified to be manufactured with involute helicoid geometry.

3.1.14
total deviation along line of action
total maximum deviation between any two teeth of a given line of action test

3.1.15
axial pitch deviation from thread to thread
maximum axial pitch deviation between any two consecutive teeth contained within two gashes

Note 1 to entry: For an odd number of threads, the angle between the gashes is approximately 90°. For an even number of threads, it is approximately 120°.

3.1.16
axial pitch deviation in any three axial pitches over all threads
maximum axial pitch deviation over any three adjacent teeth contained within two gashes

Note 1 to entry: For an odd number of threads, the angle between the gashes is approximately 90°. For an even number of threads, it is approximately 120°.

3.2 Symbols

D hob outside diameter given by Annex A for the given module

D_o hob oversize outside diameter

K_e ratio for test element (see Table 3)

K_m ratio for division of module (see Table 4)

K_g ratio for grade (see Table 3)

K_t ratio for number of threads (see Table 5)

K_{tol} standard tolerance for the test

K_i calculated value for test i

K_{9d} deviation test 9

α_h hob normal pressure angle

4 Allowable deviations

Hobs shall conform to the requirements of Tables 2 and 4, as appropriate. The hob sizes shall be in accordance with Annex A.

When prior agreement between the hob manufacturer and purchaser specifies measurement of hobs, the manufacturer should select:

— the measurement method to be used from among the applicable methods described in this document and summarized in Table 1;

— the piece of measurement equipment to be used by the selected measurement method, provided it is in proper calibration;

— the individual teeth to be measured, as long as they are approximately equally spaced.

No particular method of measurement or documentation is considered mandatory. When applications require measurements beyond those recommended in this document, it is recommended to negotiate special measurement methods prior to manufacturing the hob.

Table 1 — Reference for measurement methods

Test method definition	Test description	Test number[a]	
		Elemental test	Composite test[b]
3.1.1	Radial runout of hub diameter	1	1
3.1.2	Axial runout of hub face	2	2
3.1.3	Radial runout of tips of teeth	3	3
3.1.4	Straightness and radial alignment over cutting depth	4	4
3.1.5	Adjacent spacing of cutting face of gashes	5	5
3.1.6	Total spacing of cutting face of gashes	6	6
3.1.7	Gash lead deviation per 100 mm	7	7
3.1.8	Tooth profile deviation	8	8A
3.1.9	Tooth thickness	9	9
3.1.9.1	Addendum difference of values related to the designed normal tooth thickness	9A	9A
3.1.9.2	Tooth thickness difference along one gash	9B	9B
3.1.10	Lead deviation on adjacent teeth	10	10
3.1.11	Lead deviation in one axial pitch	11	11A
3.1.12	Lead deviation in three axial pitches	12	—
3.1.13	Adjacent deviation along line of action (measured at the cutting edge)	Not applicable	13
3.1.14	Total deviation along line of action (measured at the cutting edge)	Not applicable	14
3.1.15	Axial pitch deviation from thread to thread	15	15
3.1.16	Axial pitch deviation in any three axial pitches over all threads	16	16

[a] See Clause 5.

[b] Select the composite test when the line of action test is used

5 Derivation of allowable values

5.1 General

Test 7 does not conform to a datum value and is not among the statements in Clause 5 concerning grade relationships.

With the exception of Test 7, the datum from which all the values in Table 6 are derived is the value of 45 µm Test 14 Grade A modules 16 to 25. See 3.2 for the explanations of symbols used.

5.2 Tests 1-6, 9, 12, 13 and 14

For tests 1 to 6, 9, 12, 13 and 14, use Formula (1):

$$K_{1\text{ to }6,\,9,\,12,\,13,\,14} = 45\ K_e\ K_m\ K_g \tag{1}$$

5.3 Test 7

For test 7, use Formula (2):

$$K_7 = 80\ K_g \tag{2}$$

5.4 Test 9A

For test 9A, use Formula (3):

$$K_{9A} = K_{9d} / [2 \times \tan \alpha_h] \tag{3}$$

5.5 Tests 10

For test 10, use Formula (4):

$$K_{10} = 45\ K_e\ K_m\ K_g \sqrt{K_t} \tag{4}$$

5.6 Tests 8, 8A, 9B, 11, 11A, 12, 15 and 16

For tests 8, 8A, 9B, 11, 11A, 12, 15 and 16, use Formula (5):

$$K_{8,\,8A,\,9B,\,11,\,11A,\,12,\,15,\,16} = 45\ K_e\ K_m\ K_g\ K_t \tag{5}$$

Test 9B is only valid for quality Grades 4A, 3A and 2A.

Tests 8, 8A, 9B, 10, 11, 11A, 15 and 16 are only valid for the following:

a) 1-thread, all module ranges;

b) 2-threads, module range 0,5 ≤ m ≤ 16;

c) 3- and 4-threads, module range 0,5 ≤ m ≤ 6;

d) 5-, 6- and 7-threads, module range 0,5 ≤ m ≤ 3,5.

5.7 Oversize tolerances

When the hob outside diameter exceeds the size given in Annex A, the following will apply. The standard tolerances shall be increased by a factor of one-half of the percent oversize.

For tests 4, 5, 6, 10, 11, 11A, 12, 13, 14, 15 and 16, use Formula (6):

$$K_{4,\,5,\,6,\,10,\,11,\,11A,\,12,\,13,\,14,\,15,\,16} = K_{tol}\ [(D_o\text{-}D)/D/2] + K_{tol} \tag{6}$$

5.8 All tests

The value of the allowable deviations has been rounded to the nearest whole value after calculation. The minimum value of allowable deviations is 2 < m.

Standard bores shall be finished straight and parallel within the tolerances given in Table 2 for 75 % of each bearing length for Grades 4A, 3A, 2A, A and B hobs and 50 % for Grades C and D hobs.

A reference mandrel of nominal bore diameter shall pass through the bore as a check of alignment.

The tolerances on bore diameter are specified in Table 2.

Table 2 — Tolerance on bores

Grade of hob	Tolerance[a]										
	Datum diameter mm										
	8	10	13	16	22	27	32	40	50	60	80
4A	H3										
3A	H3			H4							
2A											
A	H4			H5							
B	H5										
C	H6										
D											
[a] The tolerance shall be in accordance with ISO 286-2.											

Table 3 — Ratio for test element and grade

Test number	Ratio of test element K_e	Ratio of grade K_g						
		4A	3A	2A	A	B	C	D
1	0,3	0,35	0,5	0,71	1	1,6	1,6	2,11
2	0,25							
3	1,6					1,8	3,6	4,75
4	1,25						1,8	2,38
5	1,4							
6	2,6							
7	No relationship to test 14					1,25		2,31
8	0,5					2	4	5,28
8A	0,85							
9	1,5	0,71	0,71	1			2	2,54
9A	As by Table 4							
[a] The tolerance shall be in accordance with ISO 286-2.								

Table 3 *(continued)*

Test number	Ratio of test element K_e	Ratio of grade K_g						
		4A	3A	2A	A	B	C	D
9B	0,8	0,35	0,5	0,71	—	—	—	—
10	0,4				1	2	4	5,28
11	0,7							
11A	0,8							
12	1,3							
13	0,4							
14	1							
15	0,45							
16	0,8							
[a] The tolerance shall be in accordance with ISO 286-2.								

The ratio for division of module s are defined in Table 4.

Table 4 — Ratio for division of module

Module range m	Ratio for module range K_m	Multiplication factor
0,5 ≤ m ≤ 1	0,33	1,12
1 < m ≤ 2	0,37	1,12
2 < m ≤ 3,5	0,41	1,25
3,5 < m ≤ 6	0,51	1,25
6 < m ≤ 10	0,64	1,25
10 < m ≤ 16	0,8	1,25
16 < m ≤ 25	1	1,32
25 < m ≤ 40	1,32	

The ratio for number of threads are defined in Table 5.