TECHNICAL REPORT

ISO TR 10064-1

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Cylindrical gears — Code of inspection practice —

Part 1:
Inspection of corresponding flanks of gear teeth

Engrenages cylindriques — Code pratique de réception —

Partie 1: Contrôle relatif aux flancs homologues de la denture

Reference number
ISO/TR 10064-1:1992(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.

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 Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.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 10064-1, which is a Technical Report of type 3, was prepared by Technical Committee ISO/TC 60, *Gears*.

This Technical Report updates description of and advice on gear inspection methods.

ISO 10064 consists of the following parts, under the general title *Cylindrical gears — Code of inspection practice*:

— *Part 1: Inspection of corresponding flanks of gear teeth* [Technical Report]

— *Part 2: Inspection of radial composite deviations, runout and tooth thickness allowance*

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

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INTRODUCTION

Together with definitions and values allowed for gear element deviations, the international standard ISO 1328-1975 also provided advice on appropriate inspection methods.

In the course of revising ISO 1328-1975, it was agreed that the description and advice on gear inspection methods should be brought up to date. Because of necessary enlargement and other considerations, it was decided that the relevant section should be published under separate cover as a Technical Report, Type 3, and that, together with this Technical Report, a system of documents as listed in clause 2 (References) should be established.

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Cylindrical gears — Code of inspection practice —

Part 1:
Inspection of corresponding flanks of gear teeth

1. SCOPE

This part of the Technical Report constitutes a code of practice dealing with the inspection of corresponding flanks of cylindrical involute gears, i.e. with the measurement of pitch deviations, profile deviations, helix deviations and tangential composite deviations.

In providing advice on gear checking methods and the analysis of measurement results, it supplements the standard ISO 1328, part 1.

Most of the terms used are defined in ISO 1328 part 1, others are defined as they appear in the text and in clause 3.

2. REFERENCES

ISO 53:1954, Cylindrical gears for general and heavy engineering - Basic rack.

ISO 54:1977, Cylindrical gears for general engineering and heavy engineering - Modules and diametral pitches.

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

ISO 1122-1:1983, Glossary of gear terms - Part 1: Geometrical definitions.

ISO 1328-1: - [1], Cylindrical gears - ISO system of accuracy - Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth.

ISO 1328-2: - [1], Cylindrical gears - ISO system of accuracy - Part 2: Definitions and allowable values of deviations relevant to radial composite allowance and backlash.

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1) To be published.

ISO 10063: - [1], Cylindrical gears - Flanks, undulation, surface roughness, shaft centre distance and parallelism of axes - Numerical values.

ISO/TR 10064-2: - [1], Cylindrical gears - Code of inspection practice - Part 2: Inspection of radial composite deviations, runout and tooth thickness allowance.

ISO/TR 10064-3: - [1], Cylindrical gears - Code of inspection practice - Part 3: Function groups, test groups and tolerance families.

3. SYMBOLS AND CORRESPONDING TERMS

3.1 Gear data

b	Facewidth
d	Reference diameter
d_b	Base diameter
m, m_n	Normal module
m_t	Transverse module
p_n	Normal pitch
p_t	Transverse pitch
p_b, p_{bn}	Normal base pitch
p_{bt}	Transverse base pitch
s	Number of pitches per sector
z	Number of teeth
α, α_n	Normal pressure angle
α_t	Transverse pressure angle
β	Helix angle
β_b	Base helix angle
ε_α	Transverse contact ratio
ε_β	Overlap ratio
ε_γ	Total contact ratio

1) To be published.

3.2 Gear deviations

Symbols used for deviations of individual element measurements from specified values are composed of lower case letters "f" with subscripts whereas symbols used for "cumulative" or "total" deviations, which represent combinations of several individual element deviations, are composed of capital letters "F" also with subscripts.
It is necessary to qualify some deviations with an algebraic sign. A deviation is positive when e.g. a dimension is larger than optimum and negative when smaller than optimum.

f_{db}	1)	Base diameter difference
f_{dbm}	1)	Mean base diameter difference
f_e (f_{eL}, f_{eR})		Eccentricity between gear axis and axis of gear teeth (or of corresponding flanks, respectively)
$f_{f\alpha}$		Profile form deviation
$f_{f\beta}$		Helix form deviation
$f_{H\alpha}$	1)	Profile slope deviation
$f_{H\alpha m}$	1)	Mean profile slope deviation
$f_{H\beta}$	1)	Helix slope deviation
$f_{H\beta m}$	1)	Mean helix slope deviation
f_i'		Tooth-to-tooth tangential composite deviation (with master gear)
f_l'		Long period component of tangential composite deviation
f_s'		Short period component of tangential composite deviation

1) These deviations can be + (plus) or - (minus)

f'		Tooth-to-tooth transmission deviation (product gear pair)
f_{pb}	1)	Base pitch deviation
f_{pbm}	1)	Mean base pitch deviation
f_{pbt}		Transverse base pitch deviation
f_{pS}	1)	Pitch sector deviation
f_{pt}	1)	Single pitch deviation
$f_{w\beta}$		Undulation height (along helix)
f_{α}	1)	Pressure angle deviation (normal)
$f_{\alpha m}$	1)	Mean pressure angle deviation
f_{β}	1)	Helix angle deviation
$f_{\beta m}$	1)	Mean helix angle deviation
F_p		Total cumulative pitch deviation
F_{pk}	1)	Cumulative pitch deviation
F_{pkS}	1)	Cumulative pitch sector deviation
F_{pS}		Total cumulative pitch sector deviation
F_i'		Total tangential composite deviation (with master gear)
F'		Total transmission deviation (product gear pair)
F_{α}		Total profile deviation
F_{β}		Total helix deviation

1) These deviations can be + (plus) or - (minus)

3.3 Gear inspection terms

$d_{b\ eff}$	Effective base diameter
k	Number of successive pitches
l	Left hand helix
r	Right hand helix
C_a	Tip relief
C_f	Root relief
C_α	Profile barrelling
C_β	Tooth crowning
C_I (C_{II})	End relief at reference (non-reference) face
L	Left flank
L_{AE}	Active length
L_{AF}	Usable length
L_E	Base tangent length to start of active profile
L_α	Profile evaluation range
L_β	Helix evaluation range
N...	Number of a tooth, number of a pitch
R	Right flank
λ_β	Wave length of undulation (in direction of helix)

$\lambda_{\beta x}$	Axial wavelength of undulation
ξ	Involute roll angle
I	Reference face
II	Non-reference face

4. EXTENT OF GEAR INSPECTION

Inspection of the various gear tooth elements requires several measuring operations. It is necessary to ensure that for all measurements involving rotation of the gear, the in-service axis of the gear coincides with the axis of rotation during the measuring process.

It may not be economical or necessary to measure all gear tooth element deviations (such as those of single pitch, cumulative pitch, profile, helix, tangential and radial composite deviation, runout, surface roughness etc., for some of the elements concerned may not significantly influence the function of the gear under consideration. Furthermore, some measurements can often be substituted for others, for example the tangential composite check might replace pitch checking or the radial composite check might replace runout inspection. In order to take account of these aspects, recommended test groups and tolerance families relative to the function of gears are included in ISO / TR 10064, part 3. However, it is emphasised that curtailment of quality control measures is subject to agreement between purchaser and supplier.

5. IDENTIFICATION OF DEVIATION POSITION

It is convenient to identify deviations associated with measurements of gear teeth by specific reference to individual right flanks, left flanks, pitches or the groups of these.

In the following, conventions are described which enable positive determination of the location of deviations.

5.1 Right or left flank

It is convenient to choose one face of the gear as reference face and to mark it with the letter "I". The other non-reference face might be termed face "II".

For an observer looking at the reference face, so that the tooth is seen with its crest uppermost, the right flank is on the right and the left flank is on the left.

Right and left flanks are denoted by the letters "R" and "L" respectively.

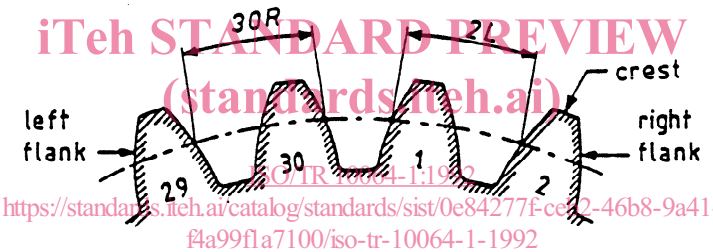

Fig. 1 Notation and numbering for external gear
30 R = pitch Nr. 30, right flank
2 L = pitch Nr. 2, left flank

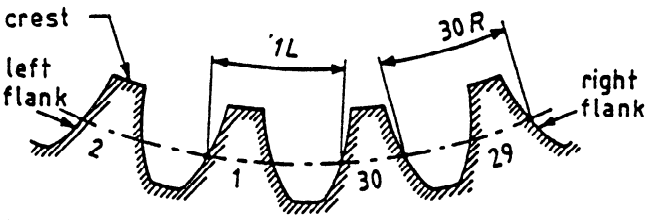

Fig. 2 Notation and numbering for internal gear
1 L = pitch Nr. 1, left flank
30 R = pitch Nr. 30, right flank

5.2 Right hand or left hand helical gears

The helix of an external or internal helical gear is referred to as being right hand or left hand. The hand of helix is denoted by the letters "r" and "l" respectively.

The helix is right hand (left hand) as, when looking from one face, the transverse profiles show successive clockwise (anticlockwise) displacement with increasing distance from an observer.

5.3 Numbering of teeth and flanks

Looking at the reference face of a gear, the teeth are numbered sequentially in the clockwise direction. The tooth number is followed by the letter R or L, indicating whether it is a right or a left flank.
Example: "Flank 29 L".

5.4 Numbering of pitches

The numbering of individual pitches is related to tooth numbering as follows: pitch number "N" lies between the corresponding flanks of teeth numbers "N-1" and "N"; with a letter R or L it is indicated whether the pitch lies between right or left flanks. For example "Pitch 2 L", (see Fig. 1)

5.5 Number of pitches "k"

The subscript "k" of a deviation symbol denotes the number of consecutive pitches to which the deviation applies.

In practice, a number is substituted for "k", for example F_{p3} indicates that a given cumulative pitch deviation refers to three pitches.

5.6 Checking recommendations

Measurements are normally carried out at approximately mid tooth depth and/or mid facewidth, as appropriate.If the facewidth is larger than 250 mm, two additional profile measurements, each approximately 15% of the facewidth distant from either end of the facewidth, is advisable. Profile and helix deviations should be measured over three or more equally spaced, corresponding flanks.

In order to ensure accuracy of measurements, inspection apparatus should be calibrated periodically against approved standards.

6. THE CHECKING OF SINGLE AND CUMULATIVE PITCH DEVIATIONS

6.1 General

Checking of pitch deviations implies measurement of the actual (angular) values or comparator checks between corresponding flanks of teeth around the circumference of a gear.

In contrast to the checking of normal, transverse and cumulative pitch deviations, base pitch deviations are checked in base tangent planes and are therefore independent of the gear axis.

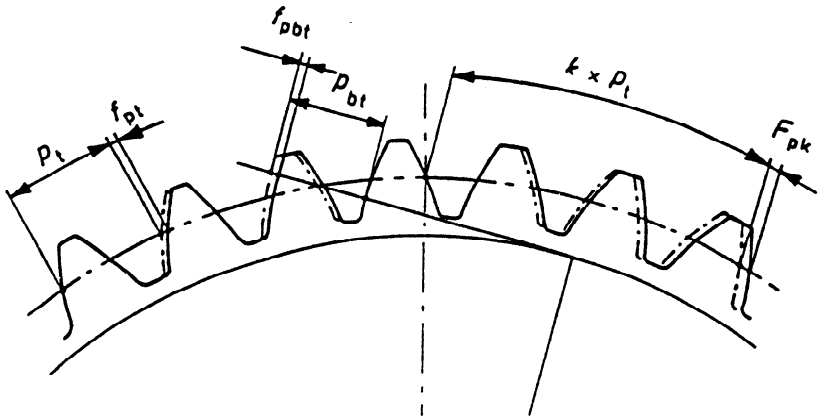

Fig. 3 Pitch (p_t), pitch deviation (f_{pt}), transverse base pitch (p_{bt}), transverse base pitch deviation (f_{pbt}), cumulative pitch ($k \times p_t$, in the Fig. k=3), cumulative pitch deviation (F_{pk}, in the Fig. k=3)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	25	23	26	24	19	19	22	19	20	18	23	21	19	21	24	25	27	21
B	22.00																	
C	+3	+1	+4	+2	-3	-3	0	-3	-2	-4	+1	-1	-3	-1	+2	+3	+5	-1
D	+3	+4	+8	+10	+7	+4	+4	+1	-1	-5	-4	-5	-8	-9	-7	-4	+1	0

Fig. 4 Sample table with hypothetical deviation values obtained by single pitch checking with a comparator. In practice, integer values are seldom encountered.

N = pitch number

A = Values obtained with a pitch comparator (two probes), without reference to a defined absolute value

B = Arithmetic mean of all values A

C = Pitch deviations f_{pt}, expressed as the difference between individual values and mean value B

D = Cumulative pitch deviations, acquired by consecutive addition of f_{pt} (C) values, in the Fig. referred to the flank between the pitches 18 and 1, corresponding to the descriptions in Fig. 4 and Fig. 5.

When angular pitch measurement (one probe) is applied, values D are ascertained by subtracting the theoretical angle from the measured angle at each position, then multiplying the differences (in radians) by the radial distance to points of probe/flank contact. Values C are then obtained by subtracting value D of flank number N-1 from value D of flank number N.

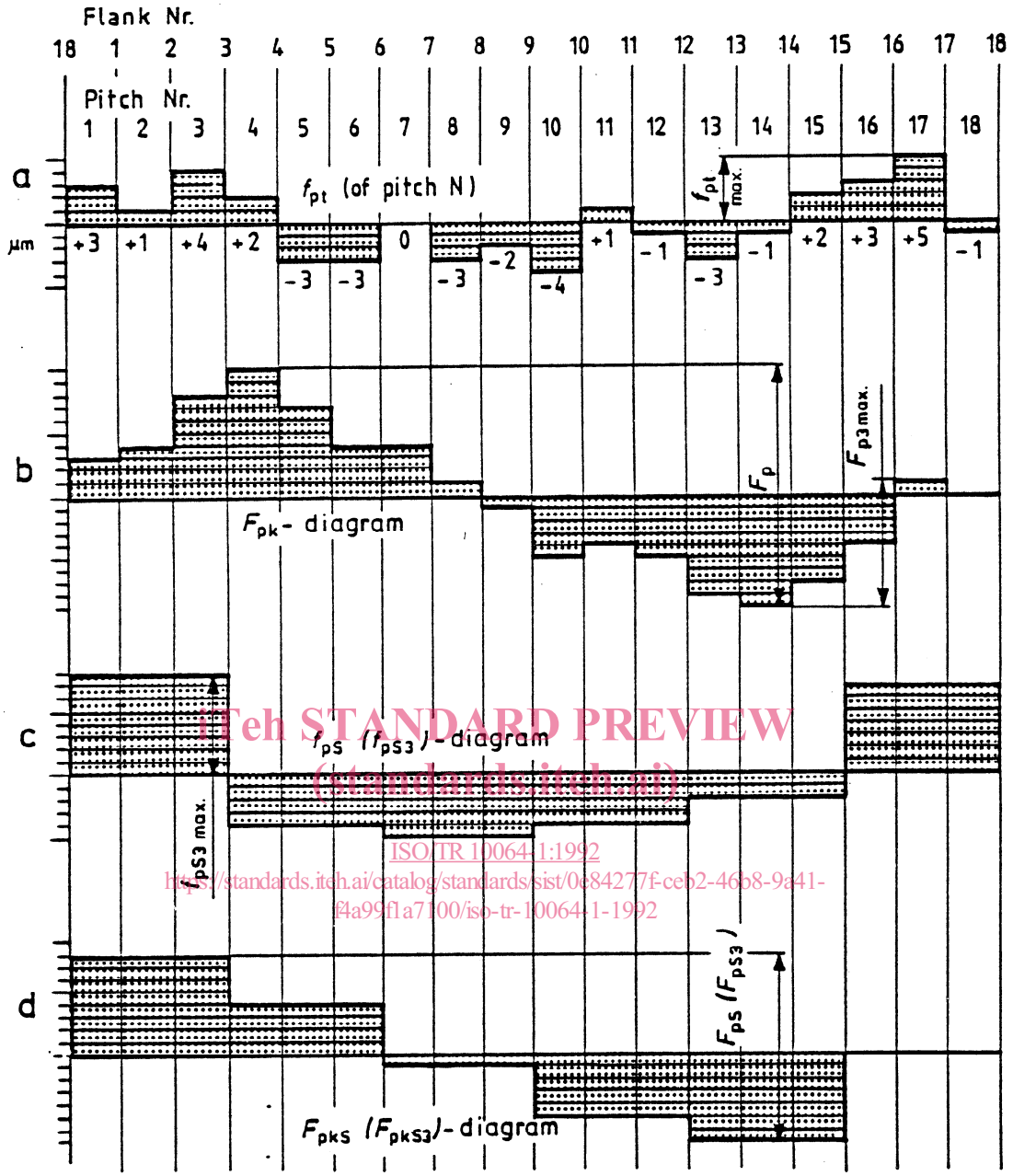

Fig. 5 A diagrammatic representation of pitch deviations on the sample gear of Fig. 4 (z = 18)