INTERNATIONAL STANDARD

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Plain bearings — Quality assurance of thin-walled half bearings — Selective assembly of bearings to achieve a narrow clearance range

Paliers lisses — Assurances qualité des demi-coussinets minces — Assemblage sélectif des paliers pour obtenir un jeu faible

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 13778 was prepared by Technical Committee ISO/TC 123 *Plain bearings*, Subcommittee SC 5 *Quality analysis and assurance*.

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Plain bearings — Quality assurance of thin-walled half bearings — Selective assembly of bearings to achieve a narrow clearance range

1 Scope

This International Standard specifies the selective assembly of bearings (in accordance with ISO 3548).

The bearing diametral clearance is determined by the housing diameter, journal diameter and the wall thickness of the two half bearings. Typically, these components will have a total tolerance "stack up" of 50 µm to 60 µm. Current engine development and in particular, the desire for improved engine refinement, have suggested that the clearance range due to the tolerance "stack up" must be decreased. This International Standard suggests various schemes of selective assembly to achieve such ranges.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3548, *Plain bearings — Thin-walled half bearings with or without flange — Tolerances, design features and methods of test.*

ISO 4378-1, *Plain bearings — Terms, definitions and classification — Part 1: Design, bearing materials and their properties.*

3 Terms and definitions

For the purposes of this International Standard the terms and definitions in ISO 4378-1 and the following apply.

3.1
theoretical bearing diametral clearance
C
the difference between the housing diameter D_H less twice the half bearing wall thickness s_3 and the journal diameter D_J

$$C = D_H - (2\,s_3 + D_J)$$

3.2
housing diameter
D_H
the diameter of the housing with no bearing fitted measured perpendicular to the split line

3.3
bearing wall thickness
s_3
the wall thickness measured at 90° from the split line (at the "crown")

NOTE If two measurements are made the larger of the two is used.

3.4
journal diameter
D_J
the diameter of the finished shaft measured at a position to give maximum diameter

3.5
tolerance
the range between the upper and lower limits specified on the drawing

3.6
housing swell
expansion of a housing bore caused by the interference fit of the bearings

4 Housing swell and thermal expansion

Housing swell is defined as the "expansion of a housing bore, caused by the interference fit of the bearings". When two half bearings are assembled into a housing and the housing is bolted up, the assembled bore will be slightly greater than the arithmetical subtraction of the two bearing wall thicknesses from the housing diameter as measured before the bearing is fitted. Housing swell is generally of the order of a few micrometres. Maximum housing swell will occur with a combination of maximum bearing overstand (nip) and minimum housing diameter. It is prudent to measure actual housing swell by carrying out fitting tests. Actual housing deformation may also be affected by the degree of control of bolt tension.

With light alloy housings the housing swell may be larger, due not only to the lower modulus of elasticity but also to thermal expansion.

Allowance for housing swell and thermal expansion has to be made when setting the bearing diametral clearance.

5 Measurement and identification

5.1 Housings and journals

Specific measurement of each housing and journal may be necessary in more complex grading schemes. Whilst bearings will be graded according to only the crown wall thickness, journals in particular may have to be measured in several places, both axially and circumferentially, to ascertain the mean journal diameter. The crown housing diameter may be the only housing measurement necessary. With grade tolerances of a few micrometres, accurate measurement with minimal dirt and constant temperature is necessary.

Traditionally, crankshaft journals of different grades have been identified with a dab of paint or ink adjacent to the journal. Housings have been similarly identified. Such a method relies upon the visual discrimination of the operator and this may on occasions be unreliable. One alternative is to bar or dot code the housing and/or journal with either adhesive labels or by etching, another is to store the data on computer for retrieval at assembly stage.

5.2 Bearings

If bearing grades with wall thickness tolerances of less than the normal process capability are required then consideration must be given as to how the bearings are graded and identified. The part number is stamped upon the bearing prior to final wall thickness machining. Additional stamping after bearing grading is not feasible as this will create high spots of wall thickness. The usual practice is to mark the bearing side face after grading with a permanent colour code or with other suitable methods.

6 Suggested schemes for fitting

Before choosing the scheme for selectively fitting bearings it is first necessary to set the desired clearance range. As a general rule, the narrower the clearance range, the more complex the grading scheme will be and the tighter the tolerance on each component. As an example, if a clearance range of 24 µm is required this could entail grade tolerances of 6 µm, whilst with a clearance range of 32 µm grade tolerances of 8 µm would be acceptable.

Whilst it may be desirable from the design viewpoint to achieve a very narrow clearance range there may come a point at which perceived performance gains from working very close to the desired mean clearance become offset by the cost and complexity of the selective fitting scheme.

Whilst such schemes are feasible for OE engine assembly they are not practical for replacement bearings where the bearings are packed in sets of similar sizes.

Other points to consider are as follows.

a) Due to the normal distribution of journal and housing sizes the required quantity of each bearing grade will not necessarily be equal. Carefully controlled scheduling will be necessary in order to minimize bearing stocks and prevent shortages of particular bearing grades.

b) Intermediate grades can be formed by fitting together half bearings from adjacent grades. This can significantly increase the flexibility of the system.

c) If it is necessary to grade bearings by measurement after final wall thickness machining then overlapping bearing grades are permissible and in fact allow the bearing supplier flexibility in achieving correct quantities of each bearing grade.

d) When choosing a grading scheme, the difference in process capability for wall thickness between bimetallic and multi-layer should be taken into account.

The schemes described in 6.1 to 6.6 are examples only.

6.1 Scheme 1: Standard application; without grading

The clearance shall be determined by the limitations of normal process capability.

Housing diameter D_H: not graded

Journal diameter D_J: not graded

Bearing wall thickness s_3: not graded

Table 1 — Standard application; without grading

Dimensions in millimetres

Grade	Without grading
D_H	50,000 to 50,018
D_J	46,000 to 46,018
s_3	1,972 to 1,978
C	0,026 to 0,074

6.2 Scheme 2: Grading of bearings

Applicable where a slight reduction in the clearance tolerance is required. The bearings are graded to effectively reduce the tolerance of the grade.

Housing diameter D_H: not graded

Journal diameter D_J: not graded

Bearing wall thickness s_3: 3 grades of 4 µm

Table 2 — Grading of bearings

Dimensions in millimetres

Grade	A	B	C
D_H [a]	50,000 to 50,018		
D_J [a]	46,000 to 46,018		
s_3	1,970 to 1,974	1,974 to 1,978	1,978 to 1,982
C [b]	0,026 to 0,070		

[a] Without grading

[b] According to the selection procedure

Depending on the selection procedure, fit as a bearing pair, either two of grade B or one of grade A and one of grade C.

NOTE 1 The scheme is simple to administer.

NOTE 2 Compared to scheme 1 the clearance range of 0,026 mm to 0,074 mm is reduced to 0,026 mm to 0,070 mm.

6.3 Scheme 3: Grading of bearings and journals or housings

The housing or the journal is graded, usually into two or three grades and the bearings are graded into a similar number of grades.

Housing diameter D_H: not graded

Journal diameter D_J: 3 grades of 6 µm grade tolerance

Bearing wall thickness s_3: 3 grades of 4 µm grade tolerance

Table 3 — Grading of bearings and journals or housings

Dimensions in millimetres

Grade	A	B	C
D_H [a]	50,000 to 50,018		
D_J	46,000 to 46,006	46,006 to 46,012	46,012 to 46,018
s_3	1,984 to 1,980	1,981 to 1,977	1,978 to 1,974
C	0,026 to 0,058		

[a] Without grading

NOTE 1 The spacing of each bearing grade is determined by the spacing of each journal grade in order to achieve an identical clearance range for each combination.

NOTE 2 Compared to scheme 2 the clearance range of 0,026 mm to 0,070 mm is reduced to 0,026 mm to 0,058 mm.

NOTE 3 Overlapping grades are used effectively.

NOTE 4 The scheme is simple.

6.4 Scheme 4: Unmixed bearings (Matrix scheme)

Housing and journal diameter both graded with equal grade tolerances. With an equal number of housing and journal grades the matrix is symmetrical and the distribution of bearings will be even. The bearing wall thickness grade tolerance is half that of the housing to journal diameter grade tolerance.

Housing diameter D_H: 3 grades of 6 µm grade tolerance

Journal diameter D_J: 3 grades of 6 µm grade tolerance

Bearing wall thickness s_3: 5 grades of 3 µm grade tolerance

Table 4a — Unmixed bearings

Dimensions in millimetres

Grade	A	B	C	D	E
D_H	50,000 to 50,006	50,006 to 50,012	50,012 to 50,018	–	–
D_J	46,000 to 46,006	46,006 to 46,012	46,012 to 46,018	–	–
s_3	1,975 to 1,978	1,978 to 1,981	1,981 to 1,984	1,984 to 1,987	1,987 to 1,990
C	0,026 to 0,044				

Table 4b — Bearing grades

Journal grade	Bearing grade according to table 4a		
	Housing grade		
	A	B	C
A	C + C	D + D	E + E
B	B + B	C + C	D + D
C	A + A	B + B	C + C

NOTE 1 Many bearing grades may be required giving difficulty in discerning the colour shades involved.

NOTE 2 Compared to scheme 3 the clearance range 0,026 mm to 0,058 mm is reduced to 0,026 mm to 0,044 mm.

NOTE 3 Achieved clearance range may be narrow but bearing grade wall thickness tolerance shall be small.

6.5 Scheme 5: Mixed bearings (Matrix scheme)

Housing and journal diameter are both graded with equal grade tolerances. Bearing wall thickness grade tolerance is the same as for the housing and journal diameter.

Housing diameter D_H: 3 grades of 6 µm grade tolerance

Journal diameter D_J: 3 grades of 6 µm grade tolerance

Bearing wall thickness s_3: 3 grades of 6 µm grade tolerance

Table 5a — Mixed bearings (Matrix scheme)

Dimensions in millimetres

Grade	A	B	C
D_H	50,000 to 50,006	50,006 to 50,012	50,012 to 50,018
D_J	46,000 to 46,006	46,006 to 46,012	46,012 to 46,018
s_3	1,972 to 1,978	1,978 to 1,984	1,984 to 1,990
C	0,026 to 0,050		

Table 5b — Bearing grades

Journal grade	Bearing grade according to table 5a		
	Housing grade		
	A	B	C
A	B + B	B + C	C + C
B	A + B	B + B	B + C
C	A + A	A + B	B + B

NOTE 1 Compared to scheme 4 the clearance range 0,026 mm to 0,044 mm is increased to 0,026 mm to 0,050 mm because there are two less bearing grades required.

NOTE 2 Achieved bearing clearance range is narrow.

NOTE 3 In order to increase usage of bearing grades at either end of the range intermediate pairs such as B + B can be replaced by A + C.

6.6 Scheme 6: Mixed bearings (fine matrix)

In this scheme the housing and journal diameters are measured to the nearest micrometre and depending on their respective positions on the fine matrix the bearings will be fitted.