

BRITISH STANDARD

Parallel screw threads of Whitworth form – Requirements

ICS 21.040.20



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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 58, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 November 2007. It was prepared by Subcommittee SFTSE/1, *Screws and fasteners technical specification committee*, under the authority of Technical Committee FME/9, *Nuts, bolts and accessories*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 84:1956, which is withdrawn.

Relationship with other publications

This British Standard is intended for use with BS 919-2, which specifies the corresponding screw gauges.

Information about this document

This British Standard has been fully revised to bring it up to date.

This British standard includes tables of basic sizes, limits and tolerances for British Standard Whitworth (B.S.W.) and British Standard Fine (B.S.F.) screw threads. In addition it provides a “Selected thread” series of recommended diameter/pitch combinations for use in applications where the standard coarse (B.S.W.) and fine (B.S.F.) series have insufficiently fine pitches.

An allowance (minimum clearance) is provided on certain classes of external threads of sizes up to and including $\frac{3}{4}$ in diameter; the recommended combinations of classes of internal threads and external threads include internal threads having larger effective diameter tolerances than the corresponding sizes of external threads. Three tolerance classes are specified for external threads, close, medium and free. The allowance is provided for medium class and free class external threads by specifying maximum external thread limits below the basic size. The purpose of this allowance is to provide for the threads to be coated if necessary, the coating encroaching within the allowance; it is also intended to permit easy assembly of maximum material condition (MMC) external threads and internal threads, thus facilitating the use of torque wrenches. Two tolerance classes of internal threads are specified, medium and normal.

Close class internal threads are now non-preferred but, in view of their usage in the past and for special uses, limits and tolerances for these are specified in Annex E.

No change has been made in the general three-part formula used as a basis for tolerancing effective diameters, and the formulae used for tolerancing the other thread elements also remain unchanged from those in BS 84:1956; the reason for this is to minimize any changes in the sizes of the gauges used to control the size of the finished work.

The table of recommended diameter/pitch combinations for screw threads in the “Selected thread” series follows very closely the corresponding table (Table 37) in BS 1580-1.

The foreword of BS 84:1956 ended with the following statement. “In conclusion it may be asked why the revision of this standard has been undertaken in view of the standardization of the Unified thread in BS 1580. The reason is that Whitworth threads will undoubtedly continue to be used for many years, especially on replacements or spare parts.” The present revision of BS 84 has been undertaken because, fifty years on, this continues to be the case.

Hazard warnings

WARNING. Attention is drawn to the fact that, with the different screw thread forms available, there is the possibility of a mismatch, which is potentially hazardous. It is the responsibility of the designer of the end product to ensure that this possibility is reduced to a minimum. For further information on mismatches of screw thread systems see PD 6494.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies limits of sizes, and tolerances, for single start parallel screw threads of Whitworth form, for general engineering use. It is not applicable to threads for threaded pipe joints, screw threads associated with interference fits, such as those on the “metal ends” of studs and in the corresponding tapped holes, or to screw threads which are to be subjected to high temperatures.

This standard specifies the following thread series:

- a) a coarse thread series, the British Standard Whitworth (B.S.W.) series, with nominal diameters in the range $\frac{1}{8}$ in to 6 in.
- b) a fine thread series, the British Standard fine (B.S.F.) series, with nominal diameters in the range $\frac{3}{16}$ in to $4\frac{1}{4}$ in.

NOTE The tables of limits and tolerances for the B.S.F. series extend up to the 3 in size only, since nominal sizes above 3 in are rarely used.

- c) a supplementary selected thread (WHIT. S.) series with nominal diameters from $\frac{1}{4}$ in to 7 in.
- d) a truncated Whitworth form series (specified in Annex A).

This British Standard specifies limits of sizes, and tolerances, of uncoated threads and also for metal coated threads (including threads coated with nickel, tin or zinc) with a thickness of coating of the order of 0.000 2 in. It is not applicable to heavily coated threads (i.e. threads with a coating thickness above 0.000 35 in).

NOTE Supplementary information is given in Annex B, Annex C and Annex D.

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.

BS 919-2, *Screw gauge limits and tolerances – Part 2: Specification for gauges for screw threads of Whitworth and B.A. forms*

BS 6528:1984, *Glossary of terms for cylindrical screw threads*

3 Terms and definitions and symbols

3.1 Terms and definitions

For the purposes of this British Standard the terms and definitions given in BS 6528:1984 and the following apply.

3.1.1 effective diameter

diameter of the pitch cylinder

NOTE 1 This is the “simple” effective diameter, as distinct from the “virtual” effective diameter (see 3.1.2).

NOTE 2 Also known as the pitch diameter.

3.1.2 virtual effective diameter

effective diameter of an imaginary thread of perfect pitch and flank angle, having the full depth of flanks, but clear at the crests and roots, which would just assemble with the actual thread over the prescribed length of engagement

NOTE The “virtual” effective diameter exceeds the simple effective diameter in the case of an external thread, but is less than the simple effective diameter in the case of an internal thread, by an amount corresponding to the combined diametral effects due to any errors in the pitch and/or the flank angles of the thread.

3.2 Symbols

For the purposes of this British Standard the following symbols apply.

NOTE 1 These are repeated from BS 6528 for the convenience of users of this standard.

D major diameter of internal thread

D_1 minor diameter of internal thread

D_2 effective diameter of internal thread (see Note 2)

d major diameter of external thread

d_1 minor diameter of external thread

d_2 effective diameter of external thread (see Note 2)

H height of fundamental triangle

P pitch

NOTE 2 These are the symbols given for pitch diameter in BS 6528.

4 Profile of Whitworth screw thread

The basic profile, and the design profile, of the Whitworth thread shall be as shown in Figure 1. The thread shall be a symmetrical V-thread in which the angle between the flanks, measured in an axial plane, is 55° , one-sixth of the V is truncated at the top and bottom, the thread is rounded equally at crests and roots by circular arcs blending tangentially with the flanks and the theoretical depth of the thread is 0.640 327 times the nominal pitch.

NOTE The basic thread depths specified in this standard have been rounded to the nearest 0.000 1 in.

5 Tolerance classes of external and internal threads

External threads and internal threads shall be of one of the following tolerance classes:

- a) close class external threads;

NOTE 1 This class of threads is for use where a close fit is required. Threads of this class are obtainable consistently only by the use of the highest quality production equipment supported by a particularly efficient system of gauging and inspection. They are intended for special work where a high degree of accuracy of pitch and thread form are particularly required.

NOTE 2 Limits and tolerances for close class internal threads for special uses are given in Annex E.

- b) medium class external threads and internal threads;

NOTE 3 This tolerance class is for ordinary use, but the accuracy of pitch and thread form is greater than that for free class and normal class threads.

- c) free class external threads;

NOTE 4 This tolerance class is for ordinary commercial use.

- d) normal class internal threads.

NOTE 5 This tolerance class is for ordinary commercial use.

NOTE 6 This class of internal threads is intended for use with medium class and with free class external threads.

The relative magnitudes and positions of the effective diameter tolerance zones, for uncoated threads, for the recommended combinations of tolerance classes shall be as shown in Figure 2.

NOTE 7 The bases of the tolerances and allowances shown in Figure 2 are given in Annex B.

NOTE 8 The choice of fit for a particular purpose rests with the designer. For use in special circumstances, different combinations of classes to those shown in Figure 2 may be specified.

Coated threads of the various tolerance classes shall conform to Clause 7.

6 Limits of sizes, and tolerances, for uncoated B.S.W. and B.S.F. threads

The basic sizes of B.S.W. series threads shall be as given in Table 1.

The limits and tolerances for the major diameter, effective diameter and minor diameter of the different tolerance classes of B.S.W. series threads shall be as specified in Tables 2 to 6.

The basic sizes of B.S.F. series threads shall be as given in Table 7.

The limits and tolerances for the major diameter, effective diameter and minor diameter of the different tolerance classes of B.S.F. series threads shall be as specified in Tables 8 to 12.

The limits and tolerances for the major diameter, effective diameter and minor diameter of close tolerance class internal threads for special uses shall be as specified in Annex E.

NOTE 1 In Tables 2 to 6 and in Tables 8 to 12, the effective diameter tolerances, which are intended to include the diametral effects of pitch and angle error (see Annex C), have been calculated from the general formula given in Annex B, taking the length of engagement as being equal to the nominal diameter of the thread. In order to reduce to a minimum the number of NOT GO gauges required, the effective diameter tolerances for the B.S.W. and B.S.F. series of threads, although calculated for these lengths of engagement, may be regarded as applicable to lengths of engagement of up to fifteen pitches. The major diameter tolerances and minor diameter tolerances for the B.S.W. and B.S.F. series of threads are applicable to all lengths of engagement.

NOTE 2 In Tables 3 and 5 and Tables 9 and 11, no tolerances are specified for the major diameters of internal threads, but only minimum sizes, which are the same as the basic major diameters specified in Table 1 and Table 7, respectively. The major diameters of internal threads are controlled, in practice, by the major diameters of the taps or other screwing tools used to cut the threads.

NOTE 3 Figure 3, Figure 4 and Figure 5 show, for the three recommended combinations of classes respectively, the relationship between the diametral tolerances for a $\frac{1}{4}$ in B.S.W. external thread and a $\frac{1}{4}$ in B.S.W. internal thread. The minor diameter tolerances for the internal thread are such as to permit a tapping drill of sufficient size to be used to prevent binding at the root of the tap during the tapping operation. If the minor diameter tolerances on internal threads are used to their full extent, the crests of the internal threads will be flat. In special cases, however, where thin nuts are used, it might be desirable not to utilize the tolerance on the minor diameter of the internal thread to its full extent.

Major diameter tolerances on external threads are such as to permit crests which are not perfectly radiused (see Annex D).

The formulae that have been used for calculating the tolerances for major, effective and minor diameters are given in Annex B.

7 Limits of size, and tolerances, for B.S.W. and B.S.F. coated threads

The relative magnitudes and positions of the effective diameter tolerance zones, for coated threads $\leq \frac{3}{4}$ in nominal diameter, for the recommended combinations of tolerance classes, shall be as shown in Figure 6.

NOTE 1 Figure 2 which shows the effective diameter tolerance zones for uncoated threads has been used as the basis for Figure 6, and the tolerance zones for coated threads added.

NOTE 2 The coating is accommodated within the allowance in the case of the medium class and free class internal threads, and by adjustment of the tolerance zone in the case of the close class internal threads.

For free class and medium class external threads, both of which are suitable for coating, the finished size of the threads after coating shall not exceed the basic size specified in Table 1 or Table 7, as applicable.

Should it be necessary to coat close class external threads, the finished size of the threads after coating shall not exceed the basic size specified in Table 1 or Table 7, as applicable.

NOTE 3 In order to avoid any undue restriction of the tolerance for screwing, the sizes of close class external threads before coating may be smaller than the lower limits specified in Table 2 and Table 8, as applicable, by an amount not greater than 0.001 in.

For medium class and normal class internal threads, the finished size of the threads after coating shall not fall below the lower limits specified in Tables 3 or 5, or Tables 9 or 11, as applicable.

NOTE 4 Since the coating of medium class internal threads might necessitate a reduction in the manufacturing tolerances in order that, after coating, they conform to the specified lower size limits, it is strongly recommended that normal class internal screw threads be used instead of medium class where coating is required.

For external and internal threads of nominal sizes above $\frac{3}{4}$ in, the finished size of the threads after coating shall fall within the size limits specified in Tables 1 to 12, as applicable.

NOTE 5 In order to avoid any undue restriction of the tolerance for screwing, the sizes of close class external threads before coating may be smaller than the lower limits specified in Table 2 or Table 8, as applicable, by an amount not greater than 0.001 in.

NOTE 6 If internal threads are to be coated, the threads should be made with minimum sizes slightly greater than basic size in order to effect satisfactory assembly after coating. Similarly, medium class and free class external threads of nominal sizes above $\frac{3}{4}$ in which are to be coated, should be made with maximum sizes slightly less than the basic size.

For coated threads, the limiting sizes of medium class and free class external threads before and after coating shall be as specified in Table 4, Table 6, Table 10 or Table 12, as applicable.

8 Stainless steel external threads

Stainless steel external threads shall conform to Clause 6.

NOTE 1 Owing to the tendency for close-fitting external and internal threads made of stainless steel to seize when tightened together, it is recommended that stainless steel external threads of nominal sizes $\frac{3}{4}$ in and below should not be made to close class limits but rather to the medium class or free class limits specified for uncoated external threads in Table 4, Table 6, Table 10 or Table 12, as applicable.

NOTE 2 It is recommended that stainless steel external threads of nominal sizes above $\frac{3}{4}$ in should have maximum and minimum limits which are 0.001 in smaller than the values specified in the relevant tables.

9 Selected thread series

9.1 General

Unless a special pitch/diameter combination is required for a particular design, the pitch/diameter combinations for the selected thread series shall be as specified in Table 13A or Table 13B. The depths of thread shall be as specified in Table 14. If a pitch/diameter combination other than those specified in Table 13A or Table 13B is required, the number of threads per inch shall be in the series specified in Table 14 (column 1) and the design dimensions and tolerances shall be as specified in **9.3** and **9.4**, respectively.

NOTE 1 This series is for applications for which thread sizes in the B.S.W. and B.S.F. series are not suitable. B.S.W. and B.S.F. pitches are included in Tables 13A and 13B for reference purposes only.

NOTE 2 A fractional series is specified in Table 13A and a decimal series in Table 13B. Both tables contain, above $1\frac{1}{2}$ in diameter, the same $\frac{1}{4}$ in and $\frac{1}{2}$ in steps, the difference between the two tables being that in the decimal series the intermediate $\frac{1}{8}$ in steps have been replaced by steps to the nearest $\frac{1}{10}$ in dimension. This enables the same diameters to be used as are recommended in BS 1916-2.

9.2 Basic sizes

The basic effective diameter and the basic minor diameter shall be determined by subtracting from the basic major diameter specified in Table 13A or Table 13B the basic depth of thread, and twice the basic depth of thread, respectively, as specified in Table 14 (column 3 and column 4, respectively).

9.3 Design sizes

9.3.1 Internal threads

The design sizes of the major diameters, effective diameters and minor diameters of all classes of internal threads shall be the same as the corresponding basic sizes.

9.3.2 External threads

The design sizes of external threads shall be as follows.

- a) *Close class.* The design sizes shall be the same as the basic sizes.
- b) *Medium class and free class:*
 - 1) *Basic major diameters of $\frac{3}{4}$ in and below.* The design sizes shall be obtained from the basic sizes by subtracting the allowance specified in Table 15.
 - 2) *Basic major diameters above $\frac{3}{4}$ in.* The design sizes shall be the same as the basic sizes.

9.4 Tolerances

The tolerances for internal threads and external threads of nominal diameters up to 20 in shall be as specified in Table 16 to Table 20. For internal and external threads of nominal diameters above 20 in the tolerances shall be calculated from the data and formulae given in Annex B.

NOTE 1 The effective diameter tolerances specified in Table 16 to Table 20 have been calculated from the general formula given in Annex B, assuming a length of engagement of the mating threads equal to ten times the pitch. The tolerances so obtained may be regarded as satisfactory for all normal lengths of engagement, i.e. in the range 5 pitches to 15 pitches.

NOTE 2 For lengths of engagement outside this range, if these tolerances are found to be unsuitable, the effective diameter tolerance should be calculated from the basic formula given in Annex B, giving L_e its actual value.

NOTE 3 No tolerances are specified for the major diameters of internal threads as it is considered that this dimension will be controlled adequately by the crests of the taps or other cutting tools used to produce the threads.

All diametral tolerances shall be applied unilaterally to the design dimensions, i.e. for external threads the tolerance shall be subtracted from the design dimension and for internal threads the tolerance shall be added to the design dimension.

NOTE 4 Examples illustrating the use of Table 14 to Table 20 for determining limits and tolerances of threads in the selected thread series are given following Table 14.

10 Designation of screw threads of Whitworth form

Screw threads in the British Standard Whitworth series shall be designated B.S.W.

Screw threads in the British Standard fine series shall be designated B.S.F.

Screw threads in the selected series with pitch/diameter combinations specified in Table 13A and Table 13B shall be designated Whit. S.

Non-standard threads in the Whitworth selected series, which have pitch/diameter combinations other than those specified in Table 13A and Table 13B shall be designated Whit.

The designation shall include the basic major diameter of the thread and the number of threads per inch.

For left hand threads the designation shall be followed by the letters LH.

EXAMPLES

$\frac{1}{4}$ in — 20 B.S.W.

$\frac{1}{2}$ in — 16 B.S.F., LH

1 in — 20 Whit. S.

0.67 in — 20 Whit.

If the thread tolerance class (close, medium, free or normal) is to be included in the designation this shall be added in parentheses followed by “internal thread” or “external thread”, as applicable.

EXAMPLES

$\frac{1}{4}$ in — 20 B.S.W. (close) external thread

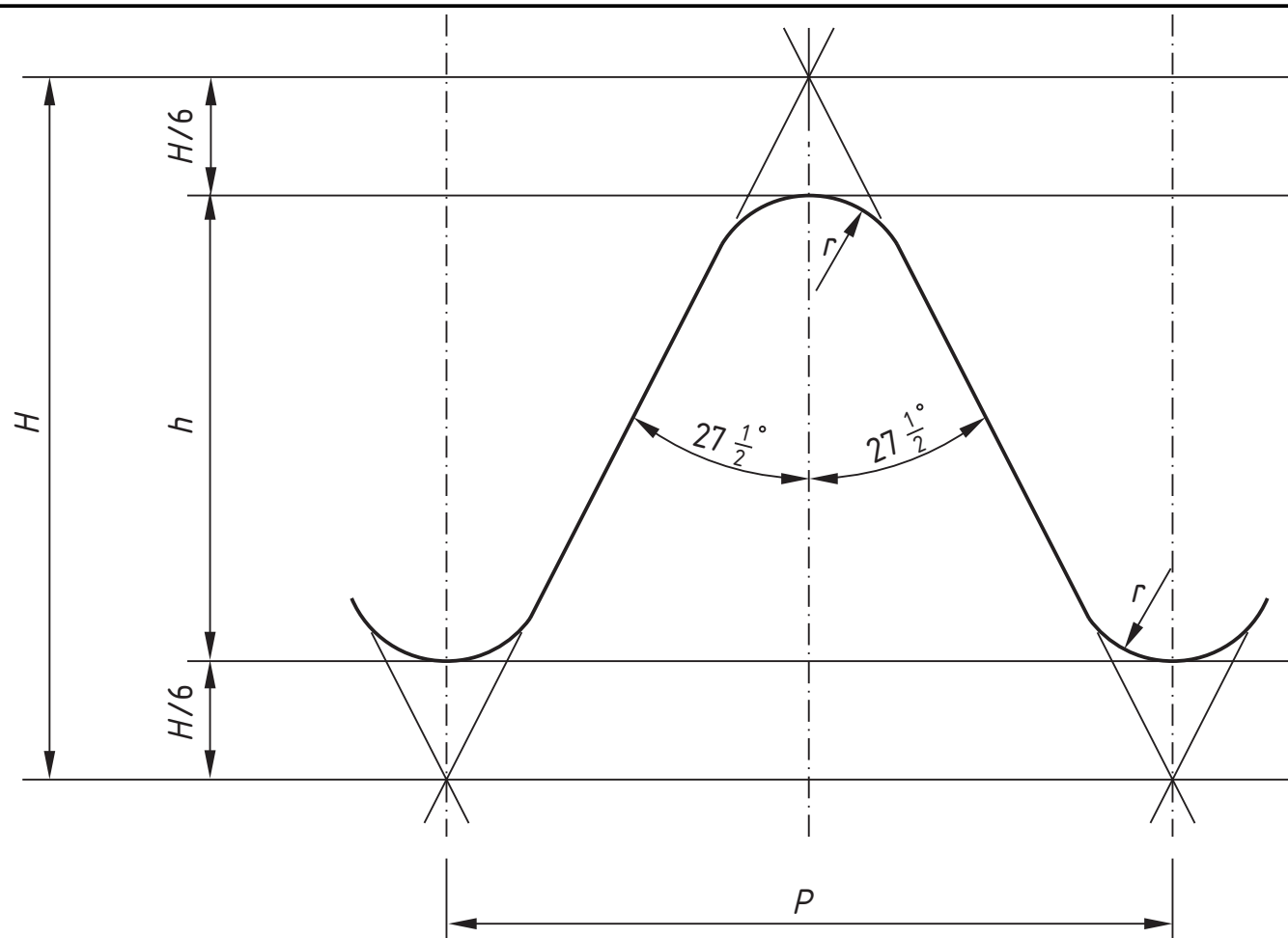
1 in — 20 Whit. S. (free) external thread

$1\frac{1}{2}$ in — 8 B.S.F. (normal) internal thread

11 Gauges

The dimensions of the screw threads shall be checked using screw gauges conforming to BS 919-2.

Figure 1 Basic form of Whitworth thread



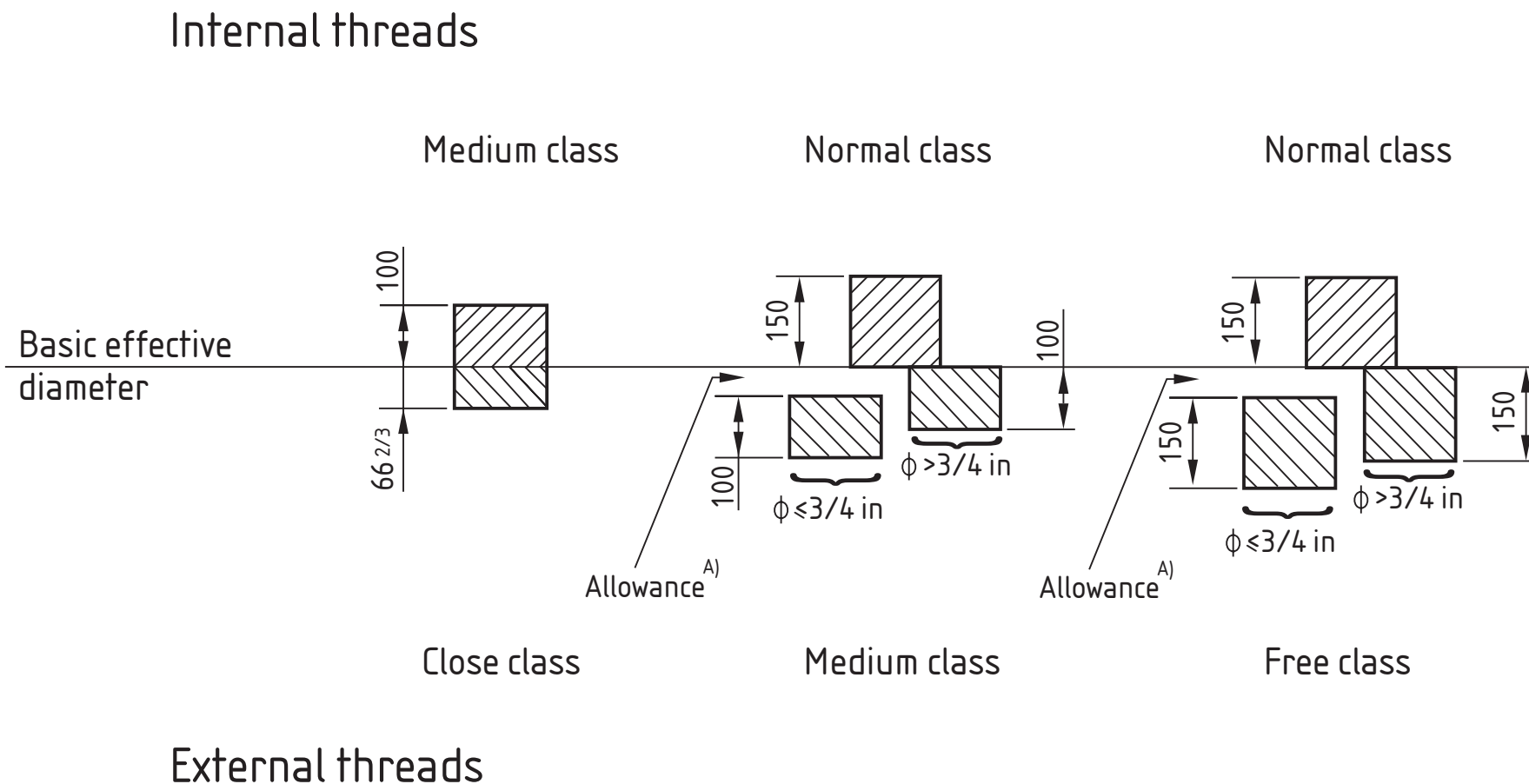
$$H = 0.960\,491P$$

$$H/6 = 0.160\,082P$$

$$h = (2/3)H = 0.640\,327P$$

$$r = 0.137\,329P$$

Figure 2 Effective diameter tolerance zones of recommended combinations of classes of internal and external Whitworth form threads

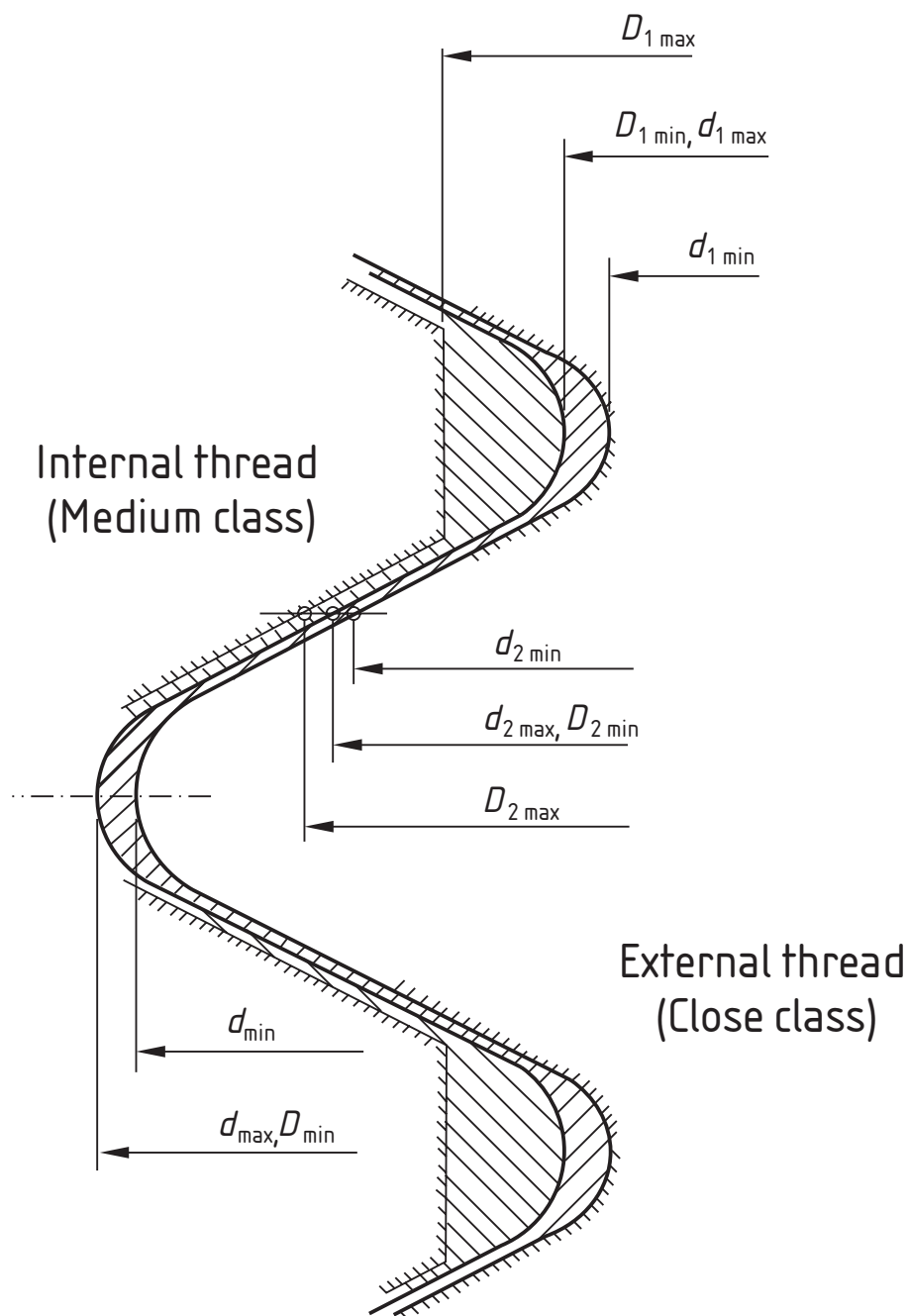


NOTE 1 The tolerance on the effective diameter of a medium class external thread is shown as 100 units and the other values are expressed as a percentage of this tolerance. The formula used to calculate the tolerance on the effective diameter is given in Annex B.

NOTE 2 Limits and tolerances for close class internal threads for special uses are specified in Annex E.

^{A)} See Clause 5 and Annex B.

Figure 3 Tolerance zones for a close class external thread and a medium class internal thread [$\frac{1}{4}$ in B.S.W. (20 t.p.i.) illustrated]

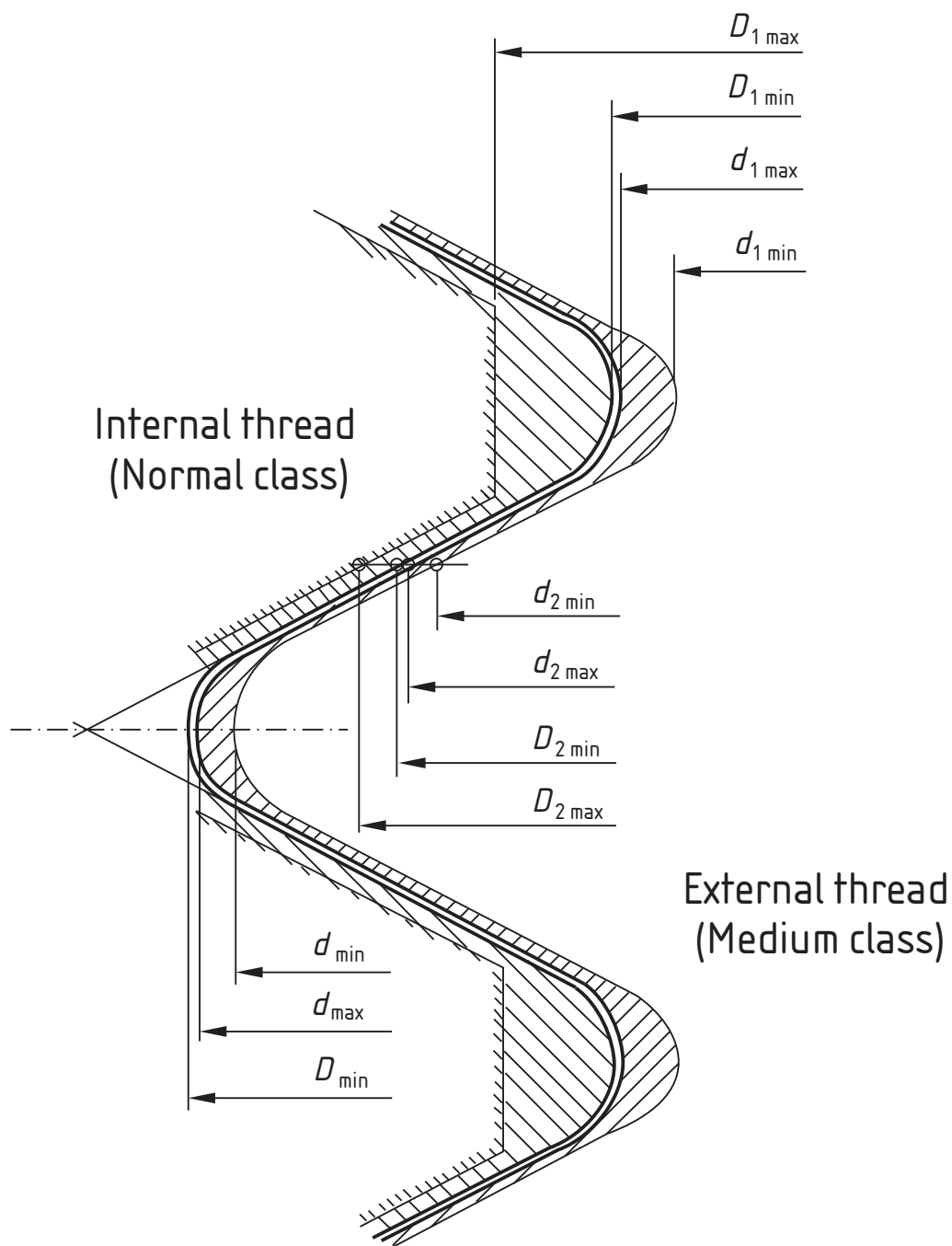


$D_{1\min}$ and $d_{1\max}$ correspond to the basic minor diameter.

$D_{2\min}$ and $d_{2\max}$ correspond to the basic effective diameter.

$D_{\min}$ and $d_{\max}$ correspond to the basic major diameter.

Figure 4 Tolerance zones for a medium class external thread with allowance and a normal class internal thread [$\frac{1}{4}$ in B.S.W. (20 t.p.i.) illustrated]



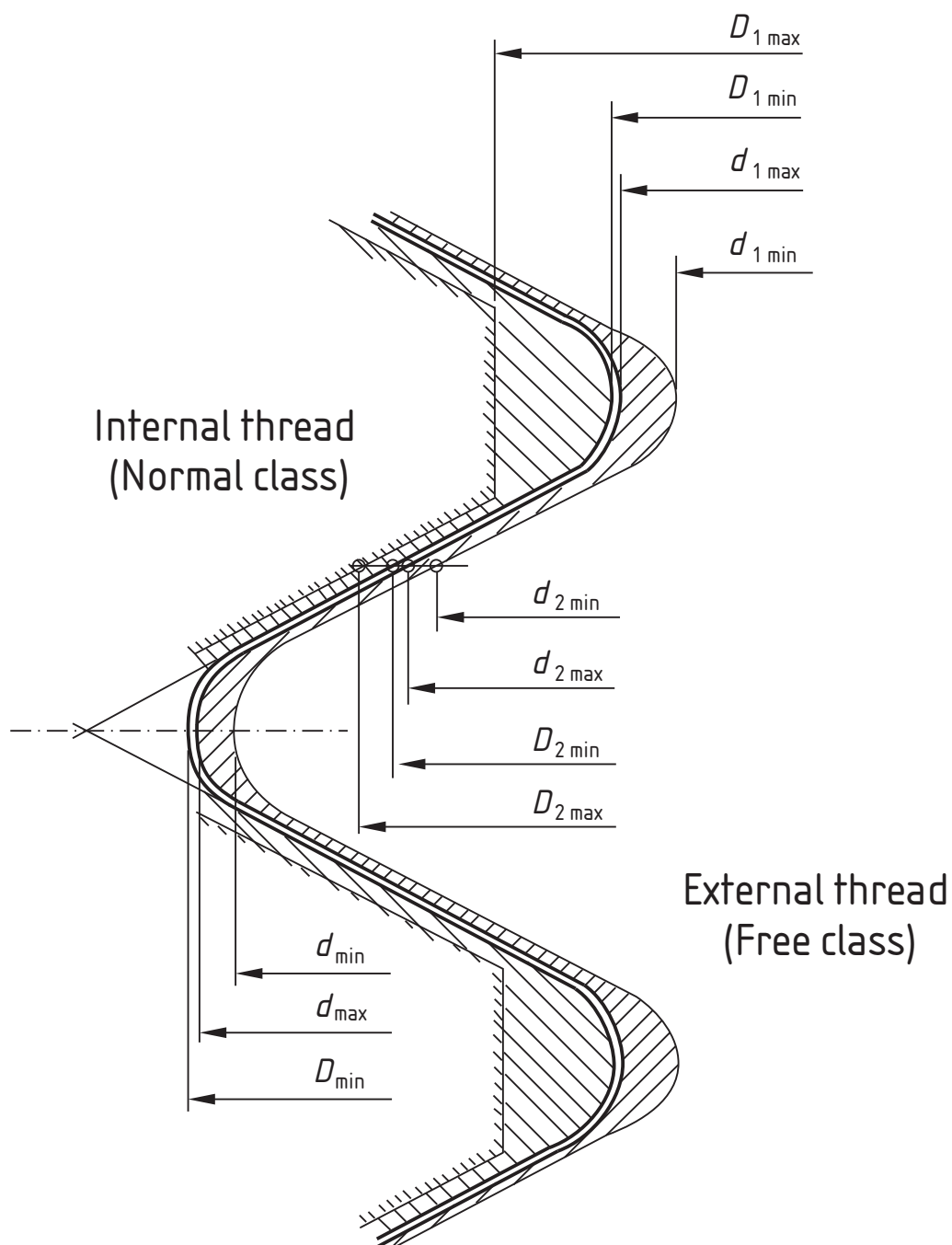
$D_{1\min}$ corresponds to the basic minor diameter.

$D_{2\min}$ corresponds to the basic effective diameter.

$D_{\min}$ corresponds to the basic major diameter.

NOTE The maximum external thread dimensions are applicable to uncoated threads only.

Figure 5 Tolerance zones for a free class external thread with allowance and a normal class internal thread [$\frac{1}{4}$ in B.S.W. (20 t.p.i.) illustrated]

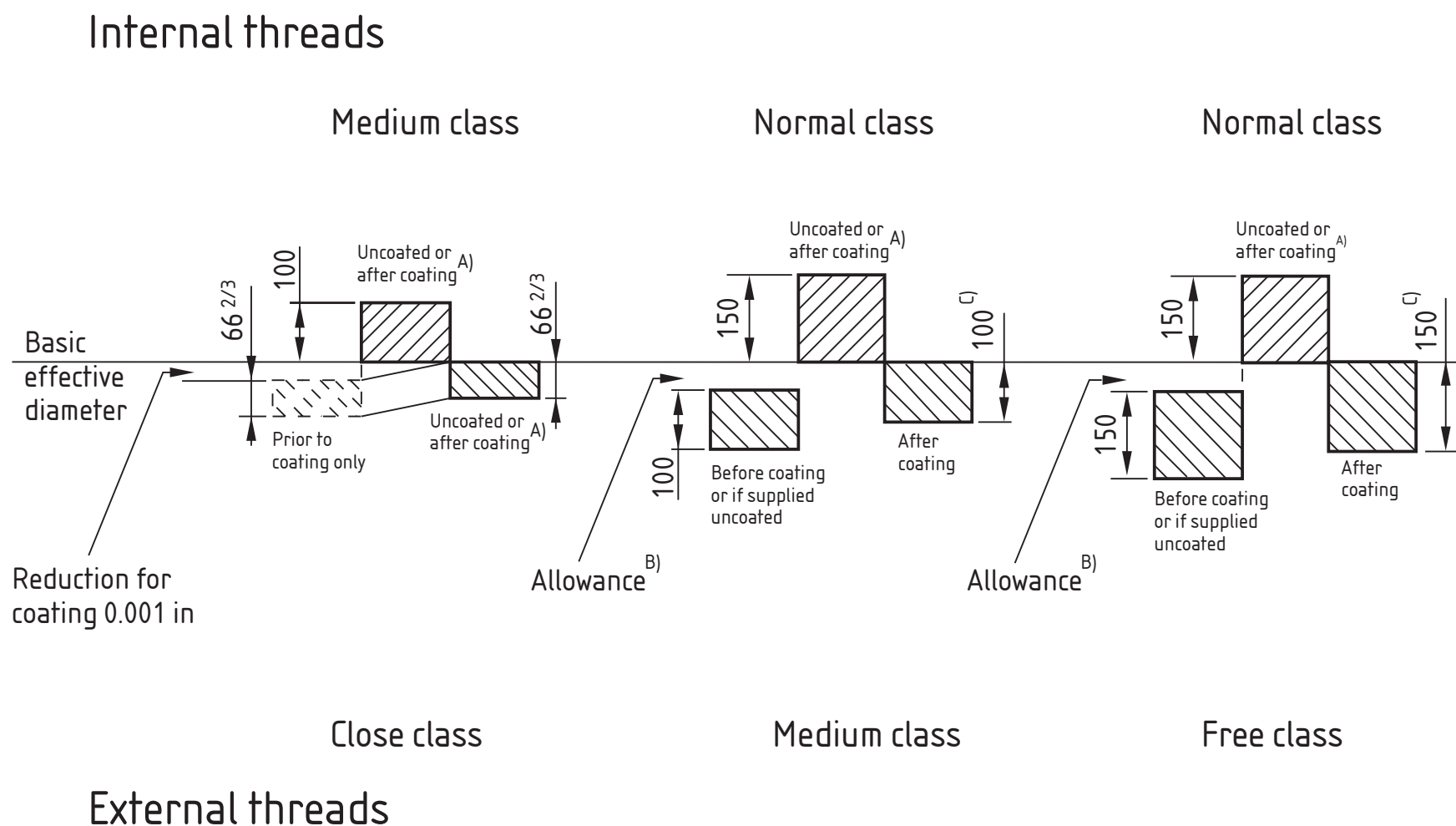


$D_{1\min}$ corresponds to the basic minor diameter.

$D_{\min}$ corresponds to the basic major diameter.

NOTE The maximum external thread dimensions are applicable to uncoated threads only.

Figure 6 Effective diameter tolerance zones for external and internal threads, uncoated or before coating, and after coating (c.f. Figure 2) of sizes $\frac{3}{4}$ in nominal size and smaller



NOTE 1 The tolerance on the effective diameter of a medium class external thread is shown as 100 units and the other values are expressed as a percentage of this tolerance. The formula used to calculate the tolerance on the effective diameter is given in Annex B.

NOTE 2 Limits and tolerances for close class internal threads for special uses are specified in Annex E.

^{A)} See Clause 7.

^{B)} See Clause 5 and Annex B.

^{C)} Approximate, depending on thickness of coating.