

CONFIRMED
FEBRUARY 1986

Specification for

Single point cutting tools —

Part 2: Nomenclature

UDC 621.9.025

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices Technical Committee	Electricity Council, the Central Electricity
Association of Consulting Engineers	Generating Board and the Area Boards in
Association of Hydraulic Equipment	England and Wales
Manufacturers Ltd	Engineering Equipment Users' Association
Association of Mining Electrical and	Gas Council
Mechanical Engineers	Institution of Civil Engineers
British Chemical Plant Manufacturers'	Institution of Gas Engineers
Association	Institution of Heating and Ventilating
British Compressed Air Society	Engineers
British Electrical and Allied Manufacturers'	Institution of Mechanical Engineers*
Association*	Institution of Mechanical Engineers
British Gear Manufacturers' Association	(Automobile Division)
British Internal Combustion Engine	Institution of Plant Engineers
Manufacturers' Association	Institution of Production Engineers*
British Mechanical Engineering Confederation	Locomotive and Allied Manufacturers'
British Pump Manufacturers' Association	Association of Great Britain
British Steel Industry	London Transport Executive
Crown Agents for Oversea Governments and	Machine Tool Trades Association*
Administrations	Ministry of Defence
Department of Employment and Productivity	Ministry of Defence, Army Department*
(H.M. Factory Inspectorate)	National Coal Board
Department of the Environment*	National Physical Laboratory (Department of
Department of Trade and Industry*	Trade and Industry)
Department of Trade and Industry — National	Royal Institute of British Architects
Engineering Laboratory	Telecommunications Engineering
	Manufacturing Association
	Water Tube Boilermakers' Association

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Association of Scientific Technical and	Production Engineering Research Association
Managerial Staffs	Society of Motor Manufacturers and Traders
British Hard Metal Association	Standards Associates
British Railways Board	Trades Union Congress
Gauge and Toolmakers' Association	University of Aston in Birmingham
Machine Tool Industry Research Association	University of Manchester Institute of Science
Ministry of Defence (Air Force Department)	and Technology
Ministry of Defence (Navy Department)	Welded Tool Manufacturers' Association and 7
National Federation of Engineers' Tool	individual experts
Manufacturers	

Amendments issued since publication

Amd. No.	Date	Comments

This British Standard, having been approved by the Mechanical Engineering Industry Standards Committee, was published under the authority of the Executive Board on 15 May 1972

© BSI 11-1999

The following BSI references relate to the work on this standard:
Committee reference MEE/6/3
Draft for comment 71/30933

ISBN 580 07002 6

Contents

	Page
Co-operating organizations	Inside front cover
Foreword	ii
0 Scope	1
1 General	1
2 Types, shapes and styles of single-point tools	2
3 Hand of single-point tools	3
4 Tool elements	3
5 General cutting terms	5
6 Reference systems of planes	7
7 Tool and working angles	8
Appendix A Summary of angles	12
Alphabetical index	43
Figure 1 — General terms and tool elements	13
Figure 2 — General terms and tool elements	14
Figure 3 — Tipped single-point and indexable insert single-point tools; toolholder bit and stick insert	15
Figure 4 — Solid, butt-welded and deposit-tipped single-point tools	16
Figure 5a — Cranked and straight tools	17
Figure 5b — Offset and raised face tools	17
Figure 5c — Swan-necked and raised cutting edge tools	17
Figure 6 — Shank boring, parting and tangential tools	18
Figure 7 — Right hand and left hand tools	19
Figure 8 — General terms and tool elements	20
Figure 9 — General cutting terms	21
Figure 10 — Tool and workpiece motions	22
Figure 11 — Corner dimensions	23
Figure 12 — Tool surfaces and land widths	24
Figure 13a — Tool-in-hand system of planes	25
Figure 13b — Tool-in-hand system of planes	26
Figure 14 — Examples of tool-in-hand planes associated with the minor cutting edge	27
Figure 15 — Choice of P_r and P_f for a shanked boring tool	28
Figure 16 — Choice of P_r and P_f for a parting tool	29
Figure 17 — Choice of P_r and P_f for a tangential tool	30
Figure 18a — Tool-in-use system of planes	31
Figure 18b — Tool-in-use system of planes	32
Figure 19 — Tool-in-use planes showing the effect of feed motion on the orientation of P_{re} in relation to P_r	33
Figure 20a — Orientation of the cutting edges for the tool-in-hand	34
Figure 20b — Orientation of the cutting edges for the tool-in-hand	35
Figure 20c — Orientation of the cutting edges for the tool-in-hand	36
Figure 21a — Tool angles — normal rake system for a straight tool	37
Figure 21b — Tool angles — normal rake system for a tangential tool	38
Figure 22 — Tool normal rake and clearance angles	39
Figure 23 — Tool angles — tool base clearance α_b	40
Figure 24a — Working angles (general case) — normal rake system for a straight tool	41

	Page
Figure 24b — Working angles (general case) — normal rake system for a tangential tool	42
Table 1 — Symbols for land widths associated with the face and flanks	10
Table 2 — Symbols for the rake and clearance on the lands for the major and minor cutting edges	11
Table 3 — List of symbols	11

Foreword

This British Standard has been prepared under the authority of the Mechanical Engineering Industry Standards Committee, following the growing realization that the existing British Standards on cutting tools did not adequately define the nomenclature of the parts and angles of cutting tools, nor serve the practical needs of those concerned with the manufacture and use of those tools.

To meet present and future requirements, a single cutting tool nomenclature suitable for use both in the workshop and in the laboratory should be adopted. The main criteria for deciding the best system for the basis of a vocabulary should be:

- 1) the specified angles should, if possible, have some physical meaning in relation to the cutting process for which the tool is used;
- 2) the system should stress the features common to all types of cutting tools and not create a separate and different nomenclature for each type of cutting tool;
- 3) it should be possible to produce the specified angles when manufacturing or reconditioning the cutting tool by simply setting them directly on to the appropriate vice or jig.

The nomenclature that has been chosen for defining the rake, clearance and other angles of a cutting tool so as to fulfil these requirements is known as the **Normal Rake System**. The system is established in this standard as the referred system for use in the UK.

Definitions of terms for the **Normal Rake System** are printed throughout this standard in bold type. Normal type is used for all other definitions which are used in conjunction with the **Normal Rake System** for defining completely the geometry of single-point cutting tools. Italics have been used, however, for the definitions of certain additional planes and angles; these are not part of the **Normal Rake System**, but are considered of sufficient practical importance to justify their inclusion.

In the preparation of this standard, the BSI Committee concerned has worked very closely with an ISO Working Group established in 1960 to prepare a basic nomenclature for all cutting tools. This standard for single-point cutting tools is based on principles and terms developed by ISO, but anticipates formal international agreement on some aspects of the nomenclature. However, the increasing demand for a revised single-point tool standard has prompted the publication of the present standard at this time¹⁾. Those aspects still to be studied will be dealt with in future revisions of the standard when international agreement on them has been reached.

To reach international agreement on all aspects of the nomenclature, bearing in mind the desirability of providing terms which could be translated without ambiguity from one language into another, some compromises and some changes from accepted usage in individual countries have been inevitable. Changes for the UK will be small and, where they are necessary, have been designed to avoid confusion, although a substantial number of new terms have been introduced.

Owing to close co-operation between the UK and US delegations to the ISO Working Group, the agreement in the English text between this British Standard and the American Standard on single-point tools will be found to be very close.

¹⁾ The ISO basic nomenclature is sufficiently well advanced to proceed with a British Standard, "Basic nomenclature for cutting tools", and this is to be published shortly.

The Committee responsible for preparing this standard wish to express their very sincere thanks to Mr. G. V. Stabler, B.Sc., C.Eng., F.I.Mech.E., F.I.Prod.E., M.I.E.I., formerly Reader in Production Engineering at the University of Strathclyde, whose research and writings on cutting tool nomenclature played an important part in developing the demand for the preparation of this revised British Standard and the related ISO Recommendation. Mr. Stabler's profound knowledge of the subject and his careful and detailed work have been invaluable to the Committee during critical stages of their deliberations.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 44 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Scope

This British Standard defines terms for certain basic concepts concerning single-point cutting tools; it deals with those features which are necessary to define the geometry of the cutting part.

The first three sections define general terms applicable to single-point tools, the types and shapes of single-point tools and the hand of tools, respectively. Subsequent sections define tool elements, tool surfaces, cutting edges, surfaces on the workpiece, tool and workpiece motions and certain specific dimensions.

Two reference systems of planes are defined, with the aid of which so-called “tool angles” and “working angles” are defined. One reference system of planes is the “tool-in-hand” system; this is used to define the geometry of the tool so that it can be manufactured, sharpened and measured. The other reference system of planes, the “tool-in-use” system, is required to define the effective geometry of the tool when it is actually performing a cutting operation.

The angles resulting from tool and workpiece motions, together with the tool and working angles defined in Section 7, are summarized in tabular form in Appendix A.

1 General

No.	Term	Definition
11	Tool terminology	A tool terminating in a single cutting part (1103). Typical examples are shown in the figures.
1101	single-point cutting tool	That part of the tool by which it is held (see Figure 1 and Figure 2).
1102	shank	The functional part of the tool which comprises the chip producing elements.
1103	cutting part	The cutting edges (4301), face (4201) and flank (4203) are elements of the cutting part (see Figure 1 and Figure 2). NOTE The cutting part was previously known as the “point” (BS 1886, “Terms and definitions for single-point cutting tools”, term 4002).
1104	wedge	The portion of the cutting part enclosed between the face (4201) and the flank (4203). It can be associated with either the major or minor cutting edge (4301).
1105	tip	A small piece of cutting material which is permanently fixed by brazing, welding or other suitable process on to a seating formed at the end of a tool shank (see Figure 3).
1106	indexable insert	An insert of cutting material which is clamped into position in a tool holder (1108) and which is not normally reground (see Figure 3).
1107	stick insert	A solid piece of cutting material of uniform cross section. A cross section of the stick normally forms the face (4201) of the cutting part (see Figure 3).
1108	tool holder	A form of tool shank designed to hold a tool holder bit (2106), indexable insert or stick insert (see Figure 3).
1109	heel	The edge formed by the intersection of the flank (4203) and the base (4102) (see Figure 1).
1110	neck	An extension of the shank, having a reduced cross section and carrying a relatively small cutting part. Tools having a neck are frequently used for slotting and boring operations (see Figure 2).
12	Tool dimensions	
1201	size	For a tool having a shank of rectangular or square cross section, size is expressed by giving, in the order named, the height (depth) of the shank, the width of the shank and the overall length of the tool, e.g. 32 mm × 20 mm × 170 mm (see Figure 1 and Figure 2). For a tool having a shank of round cross section, size is expressed by giving, in the order named, the diameter of the shank and the overall length of the tool, e.g. 10 mm × 63 mm.

2 Types, shapes and styles of single-point tools

No.	Term	Definition
21	Types	
2101	solid single-point tool	One in which the cutting part and the shank are of one solid piece of tool steel or other cutting material. (see Figure 4).
2102	butt-welded single-point tool	One in which the cutting part is made from a hard cutting tool material and butt welded to a shank consisting of a material which is itself unsuitable for cutting (see Figure 4).
2103	tipped single-point tool	One in which a tip of hard cutting tool material is permanently attached by brazing or other suitable process on to a seating formed on the end of the shank. The tip is ground to form the cutting part (see Figure 3).
2104	indexable insert single-point tool	One in which an insert of hard cutting tool material is mechanically clamped in a seating formed on the end of the shank (see Figure 3).
2105	deposit-tipped single-point tool	A tipped tool in which a tip of hard cutting tool material is deposit welded on to a seating formed on the end of the shank (see Figure 4).
2106	tool holder bit	A tool which is inserted into a tool holder, roller box or similar tool holding device. The bit may be of rectangular, square, trapezoidal or round section. It may be solid, tipped or deposit tipped (see Figure 3).
22	Shapes	
2201	straight tool	One which has the cutting part on the end of a straight shank (see Figure 5a).
2202	cranked tool	One in which the cutting part end of the shank is cranked. The hand of the tool is determined by the direction of crank and is defined in the Note to Section 3 (see Figure 5a). NOTE A cranked tool was previously known as a "bent tool" (BS 1886, "Terms and definitions for single-point cutting tools", terms 2011 and 2012).
2203	offset tool	A tool in which the cutting part is offset in relation to the shank. It is usual for the cutting edge to be parallel to the tool axis (4101). The hand of the tool is determined by the direction of offset and is defined in the Note to Section 3 (see Figure 5b).
2204	swan-necked tool	One in which the shank is bent at the cutting part end in such a way that the face (4201) of the tool is usually in or below the plane of the base (4102) of the shank (see Figure 5c).
2205	raised face tool	One having its face (4201) entirely raised above the plane of the top of the shank (see Figure 5b).
2206	raised cutting edge tool	One having its cutting edge (4301), but not necessarily the whole of its face (4201), above the plane of the top of the shank (see Figure 5c).
23	Styles	
2301	shanked boring tool	One in which the cutting part is formed on an extension of that part of the shank termed the neck. It is usual for the cutting part end of the tool to be cranked (see Figure 6).
2302	parting tool	One having a single narrow blade approximately parallel to the tool axis (4101) and of the end of which the cutting part is formed (see Figure 6).
2303	tangential tool	One in which the plane of the face (4201) is roughly perpendicular to the tool axis (4101), such as in tools used in roller boxes, some threading tools and slotting tools (see Figure 6).

3 Hand of single-point tools

No.	Term	Definition
3001	right hand tool	One which, when viewed looking on the cutting part of the tool with the face (4201) up and the shank pointing away, cuts on the right hand side (see Figure 7).
3002	left hand tool	One which, when viewed looking on the cutting part of the tool with the face (4201) up and the shank pointing away, cuts on the left hand side (see Figure 7).
NOTE For cranked, offset, parting and other similar tools, the hand is defined in a similar manner with respect to the position of the cutting part in relation to the shank. When viewed with the face (4201) up and the shank pointing away, a right hand tool has the cutting part to the right side of the shank and a left hand tool has the cutting part to the left hand side of the shank (see Figure 5a and Figure 5b).		

4 Tool elements

41	Basic location concepts	
4101	tool axis	An imaginary straight line with defined geometrical relationships to the locating surfaces used for the manufacture and sharpening of the tool and for holding the tool in use. Generally, the tool axis is the centre line of the tool shank (see Figure 1 and Figure 2); it is usually parallel or perpendicular to the locating surfaces, although it could be the centre line of a conical surface, as in the case of a taper shank. When not obvious, it is essential that the tool axis be defined by the designer.
4102	base	A flat surface on the tool shank, parallel or perpendicular to the tool reference plane (6102), useful for locating or orienting the tool for its manufacture, sharpening and measurement (see Figure 1 and Figure 2). Not all tools have a clearly defined base.
42	Tool surfaces	NOTE Each tool surface is provided with a symbol consisting of A with a suffix indicating the identity of the surface (e.g. Ay, the face). When it is necessary to distinguish clearly a surface associated with the minor cutting edge (4301), the appropriate symbol bears a prime (e.g. Aα'the minor flank).
4201	face Ay	The surface or surfaces over which the chip flows (see Figure 1). When the face is composed of a number of surfaces inclined to one another, these are designated first face, second face, etc., starting from the cutting edge (see Figure 12). These surfaces may be called lands and, unless otherwise specified, it is assumed that they are associated with the major cutting edge (4301). Where it is necessary to distinguish the faces associated with the major and minor cutting edges (4301), that part of the face which intersects the flank (4203) to form the major cutting edge is called the major face and that part of the face which intersects the flank to form the minor cutting edge is called the minor face. Thus, it follows that where the major face is composed of a number of surfaces, these may be designated "major first face", etc; likewise, for the minor faces, these may be designated "minor first face", etc. NOTE The major first face was previously known as the "primary face" (BS 1886, "Terms and definitions for single-point cutting tools", term 4005) and the major second face was previously known as the "secondary face" (BS 1886, term 4006).
4202	chip breaker	A modification of the face, either integral or attached, to control or break the chip (see Figure 8).

No.	Term	Definition
4203	flank A_α	The tool surface or surfaces over which the surface produced on the workpiece passes (see Figure 1). When a flank is composed of a number of surfaces inclined to one another, these are designated first flank, second flank, etc., starting from the cutting edge (see Figure 12). These surfaces may be called lands and, unless otherwise specified, it is assumed that they are associated with the major cutting edge (4301). Where it is necessary to distinguish the flanks associated with the major and minor cutting edges (4301), that part of the flank which intersects the face to form the major cutting edge is called the major flank and that part of the flank which intersects the face to form the minor cutting edge is called the minor flank. Thus, it follows that where the major flank is composed of a number of surfaces, these may be designated “major first flank”, etc.; likewise, for the minor flanks, these may be designated “minor first flank”, etc.
43	Cutting edges	That edge of the face which is intended to perform cutting (see Figure 1 and Figure 7). The tool major cutting edge S is that entire part of the cutting edge which commences at the point where the tool cutting edge angle κ_r (7101) is zero and of which at least a portion is intended to produce the transient surface (5103) on the workpiece. In the case of tools having a sharp corner (4302) at which the value κ_r may be considered to pass through zero, the major cutting edge commences at that corner. In the case of tools for which the value of κ_r does not decrease to zero at any point on the cutting edge, the entire cutting edge is the tool major cutting edge as, for example, in the case of a V-shaped threading tool. The tool minor cutting edge S' is the remainder of the cutting edge, if any, and where present, commences at the point on the cutting edge where κ_r is zero but extends from this point in a direction away from the tool major cutting edge. It is not intended to produce any of the transient surface (5103) on the workpiece. Some tools may have more than one tool minor cutting edge as, for example, in the case of a parting tool or cutting-off tool. The working major cutting edge S_e is that entire part of the cutting edge which commences at the point where the working cutting edge angle K_{re} (7201) is zero and of which at least a portion produces the transient surface (5103) on the workpiece. In the case of tools having a sharp corner (4302) at which the value of κ_{re} may be considered to pass through zero, the working major cutting edge commences at that corner. In the case of tools for which the value of κ_{re} does not decrease to zero at any point on the cutting edge, the entire cutting edge is the working major cutting edge as, for example, in the case of a V-shaped threading tool. The working minor cutting edge S_e' is the remainder of the cutting edge, if any, and where present, commences at the point on the cutting edge where κ_{re} is zero but extends from this point in a direction away from the working major cutting edge. It does not produce any of the transient surface (5103) on the workpiece. Some tools may have more than one working minor cutting edge as, for example, in the case of a parting tool or cutting-off tool.
4301	cutting edge	

No.	Term	Definition
		A distinction must be made between the tool major cutting edge and the working major cutting edge because the points at which κ_r and κ_{re} can be considered to be zero are not, in general, coincident.
4302	corner	The relatively small portion of the cutting edge at the junction of the major and minor cutting edges; it may be curved, straight or the actual intersection of these cutting edges (see Figure 1 and Figure 11). NOTE The corner was previously known as the “nose” (BS 1886, “ <i>Terms and definitions for single-point cutting tools</i> ”, term 4010).
4303	rounded corner	A corner having a curved cutting edge (see Figure 1 and Figure 11).
4304	chamfered corner	A corner having a straight cutting edge (see Figure 11).
4305	selected point on the cutting edge	A point selected on any part of the cutting edge in order to define, for example, the tool or working angles at that point (see Section 7, Notes 2, 3 and 4, and Figure 10 and Figure 13a – Figure 24b). The selected point may be on the major cutting edge or on the minor cutting edge. When the selected point is so chosen as to be located on the minor cutting edge, the planes and angles associated with this point are so designated (see Section 6, Notes 2, 3 and 4, and Figure 14).

5 General cutting terms

51	Surfaces on the workpiece	
5101	work surface	The surface on the workpiece to be removed by machining (see Figure 9).
5102	machined surface	The desired surface produced by the action of the cutting tool (see Figure 9).
5103	transient surface	The part of the surface which is formed on the workpiece by the cutting edge and removed during the following cutting stroke of the tool, during the following revolution of the tool or workpiece or, in other cases, as for example in a thread turning operation, during the following pass of the tool (see Figure 9).
52	Tool and workpiece motions	
5201	primary motion	The main motion provided by a machine tool or produced manually to cause relative motion between the tool and the workpiece so that the workpiece material approaches the face of the tool. In a lathe, this motion is provided by the rotary motion of the workpiece; in a planing machine it is provided by the longitudinal motion of the table. In the case of a screw-cutting operation in a lathe, the primary motion is considered to be helical rather than purely rotary. Usually, this motion absorbs most of the total power required to perform a machining operation (see Figure 10).
5202	direction of primary motion	The direction of instantaneous primary motion of the selected point on the cutting edge relative to the workpiece (see Figure 10).
5203	feed motion	A motion which may be provided to the tool or workpiece by the machine tool or produced manually which, when added to the primary motion, leads to a repeated or continuous chip removal and the creation of a machined surface with the desired geometric characteristics. This motion may proceed by steps or continuously; in either case, it usually absorbs a small proportion of the total power required to perform a machining operation (see Figure 10).

No.	Term	Definition
5204	direction of feed motion	The direction of instantaneous feed motion of the selected point on the cutting edge relative to the workpiece (see Figure 10).
5205	resultant cutting motion	The motion resulting from simultaneous primary motion and feed motion (see Figure 10).
5206	resultant cutting direction	The direction of the instantaneous resultant cutting motion of the selected point on the cutting edge relative to the workpiece (see Figure 10).
5207	cutting speed v	The instantaneous velocity of the primary motion of the selected point on the cutting edge relative to the workpiece (see Figure 10).
5208	feed speed v_f	The instantaneous velocity of the feed motion of the selected point on the cutting edge relative to the workpiece (see Figure 10). When the feed is intermittent, e.g. in the case of a planing operation, the feed speed is not defined.
5209	resultant cutting speed v_e	The instantaneous velocity of the resultant cutting motion of the selected point on the cutting edge relative to the workpiece (see Figure 10).
5210	feed motion angle ϕ	The angle between the directions of simultaneous feed motion and primary motion. It is therefore measured in the working plane P_{fe} (6204) (see Figure 10). In certain machining operations such as planing and shaping, this angle cannot be defined.
5211	resultant cutting speed angle η	The angle between the direction of primary motion and the resultant cutting direction. It is therefore measured in the working plane P_{fe} (6204) (see Figure 10).
53	Dimensions	
5301	feed	The displacement of the tool relative to the workpiece in the direction of feed motion per stroke or per revolution of the workpiece (see Figure 9).
5302	depth of cut	NOTE Pending international agreement on a definition of this term, the following modified version of the definition in BS 1886, "Terms and definitions for single-point cutting tools", is included for guidance. The distance between a chosen point on the machined surface and a projection of the work surface measured in a direction perpendicular to the direction of the feed motion and perpendicular to the machined surface at the chosen point (see Figure 9).
5303	corner radius r_c	The nominal radius of a rounded corner measured in the tool reference plane P_r (6102) (see Figure 11).
5304	chamfered corner length b_c	The nominal length of a chamfered corner measured in the tool reference plane P_r (6102) (see Figure 11).
5305	land width b_γ and b_α	The width of a land on the major face (4201) is designated by b_γ and the width of a land on the minor face is designated by b_γ' . The width of a land on the major flank (4203) is designated by b_α and the width of a land on the minor flank is designated by b_α' . The identification number of the land, together with the suffix used to identify the plane of measurement, may be added if necessary, e.g. $b_{\gamma n2}$, $b_{\alpha n1}$, $b_{\alpha n2}'$ (see Figure 12 and Table 1).

6 Reference systems of planes

No.	Term	Definition
		NOTE 1 Reference systems of planes are necessary for defining and specifying the angles of a cutting tool. One system (the tool-in-hand system) is needed for defining the geometry of the tool for its manufacture and measurement. A second system (the tool-in-use system) is needed for specifying the geometry of the cutting tool when it is performing a cutting operation. A third reference system of planes (called the machine reference system) is required to define the orientation of a cutting tool with respect to the machine tool. This third reference system has still to be defined by the ISO Committee for this purpose. The planes defined in the first system are termed "tool-in-hand planes"; their titles, with two exceptions (6101 and 6104), each include the word "tool". The planes defined in the second system are termed "tool-in-use planes"; their titles all include the word "working". NOTE 2 Since the angles and other geometric features vary from point to point along the cutting edge of a tool, it is necessary to locate the reference system at whatever point one desires to be able to define the tool geometry. Each plane is therefore defined with respect to a selected point on the cutting edge (4305). The title of the plane may include an indication of whether the selected point is located on the major or minor cutting edge. For example, at a selected point on the major cutting edge, there is the tool cutting edge plane (6103) and at a selected point on the minor cutting edge the corresponding plane is termed the tool minor cutting edge plane. NOTE 3 Each plane is provided with a symbol consisting of P with a suffix indicating the plane's identity [e.g. P_s, the tool cutting edge plane (6103) (see Table 3)]. For the planes defined below, the selected point on the cutting edge is considered to be located on the major cutting edge. When it is necessary to distinguish clearly a plane passing through a selected point on the minor cutting edge, the appropriate symbol bears a prime (e.g. P_s', the tool minor cutting edge plane). NOTE 4 When the cutting edge, face or flank is curved, the tangents or tangential planes through the selected point should be used in the reference systems of planes. NOTE 5 The symbol used for a plane in the tool-in-use system bears the additional suffix "e" for "effective" [e.g. P_{se}, the working cutting edge plane (6203) to distinguish it from the corresponding tool-in-hand plane P_s, the tool cutting edge plane (6103)].
61	Tool-in-hand system	
6101	cutting edge normal plane P_n	A plane perpendicular to the cutting edge at the selected point on the cutting edge (see Figure 13b, Figure 14, Figure 21a and Figure 21b).
6102	tool reference plane P_r	A plane through the selected point on the cutting edge so chosen as to be either parallel or perpendicular to a plane or axis of the tool convenient for locating or orienting the tool for its manufacture, sharpening or measurement. It is essential that the plane be chosen and defined for each individual type of cutting tool so that it meets the conditions prescribed above and is oriented as nearly perpendicular as possible to the assumed direction of primary motion. For ordinary lathe, planer and shaper tools it is a plane parallel to the base of the tool (see Figure 13a, Figure 13b, Figure 14, Figure 15, Figure 16, Figure 19, Figure 21a and Figure 22). For a vertical shank or tangential tool or for a horizontal shank planer tool it is a plane perpendicular to the tool axis (see Figure 17 and Figure 21b).
6103	tool cutting edge plane P_s	A plane tangential to the cutting edge at the selected point and perpendicular to the tool reference plane P_r (see Figure 13b, Figure 14, Figure 20a, Figure 20b, Figure 20c, Figure 21a, Figure 21b and Figure 22).
6104	assumed working plane P_f	A plane through the selected point on the cutting edge and perpendicular to the tool reference plane P_r and so chosen as to be either parallel or perpendicular to a plane or an axis of the tool convenient for locating or orienting the tool for its manufacture, sharpening or measurement. It is essential that the plane be chosen and defined for each individual type of cutting tool so that it meets the conditions prescribed above and is oriented as nearly parallel as possible to the assumed direction of feed motion. For ordinary lathe tools and planer tools it is a plane perpendicular to the tool axis (see Figure 13a, Figure 14, Figure 20a and Figure 21a). For facing tools, parting tools and tangential tools it is a plane parallel to the tool axis (see Figure 15, Figure 16, Figure 17, Figure 20b, Figure 20c and Figure 21b).

No.	Term	Definition
6105	tool back plane P_p	A plane through the selected point on the cutting edge and perpendicular both to the tool reference plane P_r and to the assumed working plane P_f (see Figure 13a, Figure 20a, Figure 20b, Figure 20c, Figure 21a and Figure 21b).
6106	tool orthogonal plane ^a P_o	<i>A plane through the selected point on the cutting edge and perpendicular both to the tool reference plane P_r and to the tool cutting edge plane P_s (see Figure 13b, Figure 21a and Figure 21b).</i>
6107	tool flank orthogonal plane P_b	A plane through the selected point on the cutting edge and perpendicular both to the flank A_α and to the tool reference plane P_r (see Figure 23).
6201	Tool-in-use system cutting edge normal plane P_{ne}	The cutting edge normal plane in the tool-in-use system is identical with the cutting edge normal plane defined in the tool-in-hand system and $P_{ne} \equiv P_n$ (6101) (see Figure 18b, Figure 24a and Figure 24b).
6202	working reference plane P_{re}	A plane through the selected point on the cutting edge and perpendicular to the resultant cutting direction (see Figure 18a, Figure 18b, Figure 19, Figure 24a and Figure 24b).
6203	working cutting edge plane P_{se}	A plane tangential to the cutting edge at the selected point and perpendicular to the working reference plane P_{re} . This plane thus contains the resultant cutting direction (see Figure 18b, Figure 24a and Figure 24b).
6204	working plane P_{fe}	A plane through the selected point on the cutting edge and containing both the direction of primary motion and the direction of feed motion. This plane is thus perpendicular to the working reference plane P_{re} (see Figure 10, Figure 18a, Figure 19, Figure 24a and Figure 24b).
6205	working back plane P_{pe}	A plane through the selected point on the cutting edge and perpendicular both to the working reference plane P_{re} and to the working plane P_{fe} (see Figure 18a, Figure 19, Figure 24a and Figure 24b).
6206	working orthogonal plane ^a P_{oe}	<i>A plane through the selected point on the cutting edge and perpendicular both to the working reference plane P_{re} and to the working cutting edge plane P_{se} (see Figure 18b, Figure 24a and Figure 24b).</i>

^a There is some evidence that the “working orthogonal clearance” (7208) is a major factor affecting the rate at which a cutting tool wears on the flank during use. This angle is therefore defined in this standard. For completeness “tool orthogonal clearance” (7108) is also defined together with the planes in which these two angles are measured.

7 Tool and working angles

NOTE 1 Defined angles are necessary for the determination of the geometrical position of the tool cutting edge, the face and the flank.

NOTE 2 One set of angles is needed for defining the angles of the tool as an entity in itself, that is, for the tool-in-hand; these angles are designated “tool angles” and, with one exception (7106), have the prefix “tool” in their titles. These angles are necessary for manufacturing, sharpening or measuring the tool.

A second set of angles is needed for defining the angles which affect the action of the tool in the cutting process, that is, for the tool-in-use; these angles are designated “working angles” and have the prefix “working” in their titles.

NOTE 3 Since tool and working angles vary from point to point along the cutting edge, the definition of the angles given below refer always to the angles at the selected point (4305). When the cutting edge, face or flank is curved, the tangents or tangential planes through the selected point are employed in the reference system of planes used to define the angles (see Section 6, Note 4).

NOTE 4 Each angle is specified, where appropriate, with reference to a particular cutting edge on the tool, depending on the location of the selected point on the cutting edge. The title of the angle may include an indication of whether the selected point is located on the major or minor cutting edge. For example, at a selected point on the major cutting edge there is the **tool normal rake** and at a selected point on the minor cutting edge, the corresponding angle is termed the **tool minor cutting edge normal rake**.

No.	Term	Definition
		NOTE 5 Each angle is provided with a symbol consisting of a Greek letter with a suffix, the suffix indicating the plane in which the angle is measured [e.g. γ_n, the tool normal rake (7105) (see Table 3)]. For the angles defined below, the selected point on the cutting edge is considered to be located on the major cutting edge. When it is necessary to distinguish clearly angles defined with respect to a selected point on the minor cutting edge, the appropriate symbol bears a prime (e.g. γ_n', the tool minor cutting edge normal rake). The symbol used for a working angle bears the additional suffix “e” for “effective” [e.g. γ_{ne}, the working normal rake (7205)] to distinguish it from the corresponding tool angle [γ_n, the tool normal rake (7105)]. NOTE 6 When the face or flank is composed of a number of surfaces inclined to one another, these surfaces are numbered consecutively, starting from the cutting edge. The number of the land is used as an additional suffix to the appropriate symbols to associate the rake or clearance angle with its particular land (e.g. γ_{n1}, γ_{n2e}, see Table 2). When the face or flank has only one surface, the suffixes 1, 2, 3 are not used. NOTE 7 The signs of the various angles are defined, where necessary, in the appropriate figures.
71	Tool angles	NOTE The tool angles are defined with the aid of the tool-in-hand reference system of planes defined in 61. The sum of the tool normal rake (7105), the normal wedge angle (7106) and the tool normal clearance (7107) is equal to 90°. In practice, the tool normal rake, tool normal clearance and tool cutting edge inclination (7104) are usually acute angles.
7101	tool cutting edge angle κ_r	The angle between the tool cutting edge plane P_s and the assumed working plane P_f measured in the tool reference plane P_r (see Figure 20a, Figure 20b, Figure 20c, Figure 21a and Figure 21b). NOTE When referred to the minor cutting edge, the tool minor cutting edge angle κ_r' was previously known as the “plan trail angle” (BS 1886, “<i>Terms and definitions for single-point cutting tools</i>”, term 5205). For parting tools and recessing tools, the tool minor cutting edge angle κ_r' was previously known as the “tool back taper”.
7102	tool approach angle Ψ_r	The angle between the tool cutting edge plane P_s and the tool back plane P_p measured in the tool reference plane P_r. Ψ_r is defined only for the major cutting edge. Thus, at any selected point on the major cutting edge the sum of Ψ_r and κ_r is always 90° (see Figure 20a, Figure 20b, Figure 20c, Figure 21a and Figure 21b). NOTE The tool approach angle was previously known as the “plan approach angle” (BS 1886, “<i>Terms and definitions for single-point cutting tools</i>”, term 5204).
7103	tool included angle ϵ_r	The angle between the tool cutting edge plane P_s and the tool minor cutting edge plane $P_{s'}$ measured in the tool reference plane P_r. Thus, $\kappa_r + \epsilon_r + \kappa_r' = 180^\circ$ (see Figure 20a, Figure 20b, Figure 20c, Figure 21a and Figure 21b). NOTE The tool included angle was previously known as the “included plan angle” (BS 1886, “<i>Terms and definitions for single-point cutting tools</i>” term 5206).
7104	tool cutting edge inclination λ_s	The angle between the cutting edge and the tool reference plane P_r measured in the tool cutting edge plane P_s (see Figure 21a and Figure 21b).
7105	tool normal rake γ_n	The angle between the face and the tool reference plane P_r measured in the cutting edge normal plane P_n (see Figure 21a, Figure 21b and Figure 22).
7106	normal wedge angle β_n	The included angle between the face and the flank measured in the cutting edge normal plane P_n (see Figure 21a and Figure 21b).
7107	tool normal clearance α_n	The angle between the flank and the tool cutting edge plane P_s measured in the cutting edge normal plane P_n (see Figure 21a, Figure 21b and Figure 22).
7108	tool orthogonal clearance^a α_o	<i>The angle between the flank and the tool cutting edge plane P_s measured in the tool orthogonal plane P_o</i> (see Figure 21a and Figure 21b).
7109	tool base clearance α_b	The angle between the flank and the tool cutting edge plane P_s measured in the tool flank orthogonal plane P_b (see Figure 23).

No.	Term	Definition
72	Working angles	NOTE The working angles are defined with the aid of the tool-in-use reference system of planes specified in 62. The sum of the working normal rake (7205), the normal wedge angle (7206) and the working normal clearance (7207) is equal to 90°. In practice, the working normal rake, working normal clearance and working cutting edge inclination (7204) are usually acute angles.
7201	working cutting edge angle κ_{re}	The angle between the working cutting edge plane P_{se} and the working plane P_{fe} measured in the working reference plane P_{re} (see Figure 24a and Figure 24b). NOTE When referred to the working minor cutting edge, the working minor cutting edge angle κ_{re}' is approximately equal to the angle previously known as the “working trail angle” (BS 1886, “<i>Terms and definitions for single-point cutting tools</i>”, term 6005).
7202	working approach angle Ψ_e	The angle between the working cutting edge plane P_{se} and the working back plane P_{pe} measured in the working reference plane P_{re}. Ψ_{re} is defined only for the working major cutting edge. Thus, at any selected point on the working major cutting edge the sum of Ψ_{re} and κ_{re} is always 90° (see Figure 24a and Figure 24b). NOTE The angle Ψ_{re} is approximately equal to the angle previously known as the “working approach angle” (BS 1886, “<i>Terms and definitions for single-point cutting tools</i>”, term 6004).
7203	working included angle	The working included angle has not yet been defined by the ISO Committee and has therefore been omitted from this standard.
7204	working cutting edge inclination λ_{se}	The angle between the cutting edge and the working reference plane P_{re} measured in the working cutting edge plane P_{se} (see Figure 24a and Figure 24b).
7205	working normal rake γ_{ne}	The angle between the face and the working reference plane P_{re} measured in the cutting edge normal plane P_n. Note that $P_n \equiv P_{ne}$ (see Figure 24a and Figure 24b).
7206	normal wedge angle β_{ne}	The normal wedge angle in the tool-in-use system is identical with the normal wedge angle defined in the tool-in-hand system and $\beta_n \equiv \beta_{ne}$ (7106) (see Figure 24a and Figure 24b).
7207	working normal clearance α_{ne}	The angle between the flank and the working cutting edge plane P_{se} measured in the cutting edge normal plane P_n. Note that $P_n \equiv P_{ne}$ (see Figure 24a and Figure 24b).
7208	working orthogonal clearance^a α_{oe}	<i>The angle between the flank and the working cutting edge plane P_{se} measured in the working orthogonal plane P_{oe} (see Figure 24a).</i>
7209	base clearance	The base clearance is not defined in the tool-in-use system.

^a There is some evidence that the “working orthogonal clearance” (7208) is a major factor affecting the rate at which a cutting tool wears on the flank during use. This angle is therefore defined in this standard. For completeness, “tool orthogonal clearance” is also defined together with the planes in which these two angles are measured.

Table 1 — Symbols for land widths associated with the face and flanks

Tool surface	Plane of measurement	First land width	Second land width	Third land width
Face A_γ	cutting edge normal plane P_n	$b_{\gamma n1}$	$b_{\gamma n2}$	$b_{\gamma n3}$
Flank A_α	cutting edge normal plane P_n	$b_{\alpha n1}$	$b_{\alpha n2}$	$b_{\alpha n3}$
Minor flank $A_{\alpha'}$	minor cutting edge normal plane P_n'	$b_{\alpha n1'}$	$b_{\alpha n2'}$	$b_{\alpha n3'}$