IS 6987 (1973): Steel Precision Polygons [PGD 25: Engineering Metrology]

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UDC 531·747 : 513·19 : 621·753·3

(Reaffirmed 2005)

Indian Standard

SPECIFICATION FOR STEEL PRECISION POLYGONS

Engineering Metrology Sectional Committee, EDC 43; Gauges Subcommittee, EDC 43 : 3 [Ref : Doc : EDC 43 (2063)]

1. Scope — Covers requirements for steel precision polygons of regular form designed for use with an autocollimator in measuring angular displacements.

2. Nomenclature and Definitions

2.1 The nomenclature indicated in figure in Table 1 along with the definitions given in **2.2** and **2.3** shall apply. The figure illustrates the requisite markings for a 30° polygon (12 sided polygon).

2.2 *Tolerance on Flatness* — The maximum permissible distance separating two imaginary parallel planes which can just enclose the surface under consideration (*see* Fig. 1).

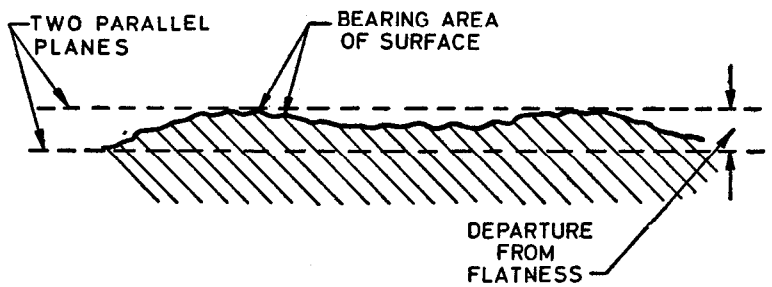

FIG. 1 TOLERANCE ON FLATNESS

2.3 *Tolerance on Parallelism* — The maximum permissible distance between two imaginary parallel planes within which the surface under consideration can be just enclosed. The two imaginary parallel planes are parallel to the datum plane in question (*see* Fig. 2).

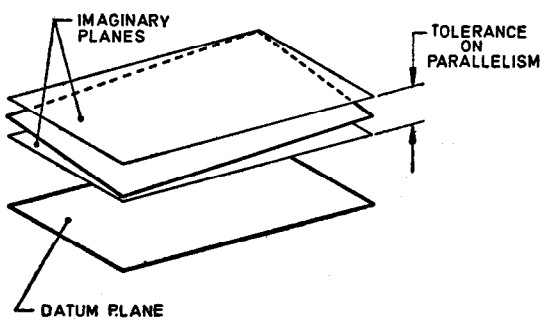

FIG. 2 EXAGGERATED ILLUSTRATION OF PARALLELISM TOLERANCE

3. Types — The steel precision polygons are divided into three types:

Type 1 — Having from 5 to 20 working faces,

Type 2 — Having above 20 and up to 40 working faces, and

Type 3 — Having above 40 and up to 72 working faces.

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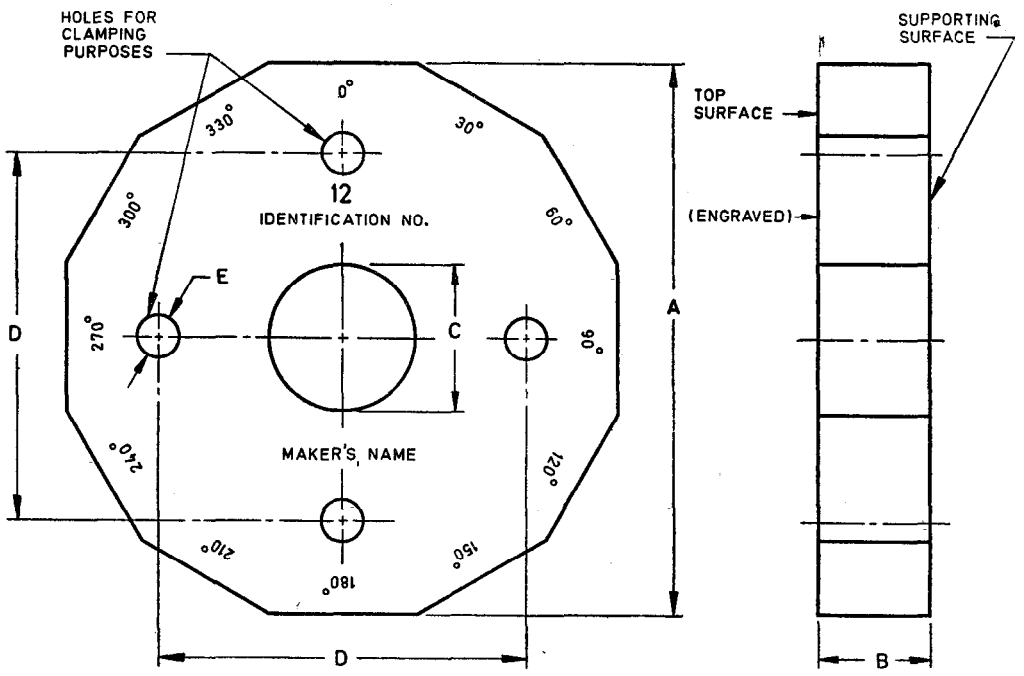
4. Material — The polygon shall be made of high grade steel, hardened and subjected to a suitable heat treatment for dimensional stabilization. A minimum hardness value of 700 *HV* is recommended [*see* IS : 1501-1968 Methods for Vickers hardness test for steel (*first revision*)]. The polygon can also be of composite structure with hardened steel strips being inserted on to the steel body.

5. Dimensions

5.1 The general dimensions of the three types of polygons shall be as given in Table 1.

TABLE 1 DIMENSIONS FOR STEEL PRECISION POLYGONS

All dimensions in millimetres.



Number of Peripheral Working Faces	Dimensions					
	A	*B*	*C* H 7	*D*	*E* Plain	*E* Threaded
From 5 to 20	75	15	20	50	4	—
Above 20 and up to 40	150	20	40	100	—	M8×1
Above 40 and up to 72	300	25	40	150	—	M8×1

5.2 All sharp corners shall be chamfered or rounded off suitably.

6. Finish

6.1 The top and supporting surfaces of the steel polygons shall be lightly lapped.

6.2 The peripheral reflecting faces shall have a highly lapped finish and adequate reflectivity. The lapping shall be non-directional. If the lapping be directional then it shall be parallel and not perpendicular to the top and the supporting surfaces.

7. Accuracy — The steel polygons shall conform in all respects to the accuracy requirements as specified in Table 2.

TABLE 2 ACCURACY REQUIREMENTS AND TOLERANCES FOR STEEL PRECISION POLYGONS

All dimensions in millimetres.

Sl No.	Accuracy Requirement	Maximum Permissible Error		
		Type 1	Type 2	Type 3
1	The top and supporting surface shall be flat (Any departure from flatness shall be such as to give the surface a concave configuration)	0·002 5	0·002 5	0·007
2	The top and the supporting surface shall be parallel	0·003 5	0·005	0·01
3	The peripheral working faces disregarding a marginal region of 1·0 mm width at the boundaries of face shall be flat	0·000 1	0·000 1	0·000 1
4	The faces shall be square to the bottom supporting surface	2·5 μm over the thickness of the steel polygon		
5	The angle between any working face and the datum face shall agree with its nominal value	10 seconds of arc		
6	The angle between any two adjacent working faces shall agree with its nominal value	10 seconds of arc		

8. Designation — The steel precision polygon shall be designated by the number of sides (working faces) and number of this standard.

Example:

Precision Polygon 10 — IS : 6987

9. General Requirements

9.1 The face of the polygon shall be identified to enable the result of its calibration to be recorded, and subsequently applied in the use of the polygon (*see* Appendix A).

9.2 The top and supporting surfaces of the polygon shall be legibly marked.

9.3 Each polygon shall be supplied with certificates in which the error of the angles between adjacent faces and the cumulative angles from the datum face (*see* Appendix B) shall be given to an accuracy of ± 1 second of arc or finer.

10. Marking

10.1 Each polygon shall be legibly marked with the following:

a) the number of sides (working faces),

b) identification number,

c) maker's name or trade-mark,

d) the top surface and the supporting surface,

e) (i) If the external angle of the polygon, that is, the acute angle between the normals to adjacent working faces, contains an exact number of degrees, the cumulative angular values shall be engraved adjacent to the working faces, the datum face being 0°.

(ii) Otherwise, the successive working faces shall be identified by numbering them serially from 1 upwards, and the external angle shall be marked on the polygon in a suitable position.

10.1.1 *ISI Certification Marking* — Details available with the Indian Standards Institution, New Delhi 110001.

11. Care and Maintenance

11.1 The lapped working faces should not be fingered in order to avoid the risk of tarnishing. To clean the faces wipe them gently with a clean chamois leather.

11.2 When not in use the faces should be protected with high quality rust inhibitor and stored in a protective case.

APPENDIX A

(*Clause* 9.1)

IDENTIFICATION OF POLYGON FACES

The faces of the polygons have to be identified to enable the results of its calibration to be recorded and subsequently applied in the use of the polygon. Each face is identified by engraving on the top surface the nominal angles between the face and a datum face. (The datum face can be any one of the working faces.) The angles are the nominal external angles of the polygons or the nominal angles between the normals to the faces. However, with polygon having large number of faces and in all cases where these nominal angles are not a whole number of degrees, the faces are identified by a series of numbers from 1 upwards.

APPENDIX B

(*Clause* 9.3)

EXAMPLE OF 'CERTIFICATE OF ACCURACY' FOR STEEL PRECISION POLYGON TO BE SUPPLIED BY THE MANUFACTURER

Identification No.

This polygon has been tested for accuracy and is found to comply with the IS Specification No.....on Steel Precision Polygon.

The measured errors of the external angles between the working faces are given below.

CALIBRATION TABLE OF A 12 SIDED STEEL PRECISION POLYGON

Error in Angles Between Adjacent Faces

Angles Between Faces	Measured Error From Nominal Value of 30° (seconds of arc)
0° and 30°	+0·1
30° and 60°	+1·8
60° and 90°	−1·6
90° and 120°	−0·2
120° and 150°	−0·7
150° and 180°	+1·4
180° and 210°	−0·2
210° and 240°	−1·6
240° and 270°	+1·1
270° and 300°	−0·2
300° and 330°	−1·0
330° and 0°	+1·1

Error in Angles Between the Various Faces and the Face Marked 0°.

Angle Between Faces	Nominal Angle Degrees	Measured Error From Nominal Angle (seconds of arc)
0° and 30°	30	+0·1
0° and 60°	60	+1·9
0° and 90°	90	+0·3
0° and 120°	120	+0·1
0° and 150°	150	−0·6
0° and 180°	180	+0·8
0° and 210°	210	+0·6
0° and 240°	240	−1·0
0° and 270°	270	+0·1
0° and 300°	300	−0·1
0° and 330°	330	−1·1

Note — A plus sign indicates that the measured angle is greater than the nominal and a minus sign that the angle is less than the nominal.

EXPLANATORY NOTE

The precision polygons are made of hardened steel. The angle between the peripheral faces constitute in a material form the division of 360° into any number of very accurate equal parts according to the number of faces on the polygons.

In the preparation of this standard, assistance has been derived from:

Moy/SCMI/11, Issue 4, Accuracy for an NPL steel precision polygon, National Physical Laboratory (Teddington).

Hilger & Watts, Publication No. B. 2125

A complete list of polygons having every number of sides from 5 to 72 together with the nominal angle between their adjacent faces to the nearest 0·01 seconds is given below, for guidance only.

No. of Faces	Nominal Angle	No. of Faces	Nominal Angle
*5	72°	39	9° 13′ 50.77″
*6	60°	*40	9°
7	51° 25′ 42·86″	41	8° 46′ 49·76″
*8	45°	42	8° 34′ 17·14″
*9	40°	43	8° 22′ 19·53″
*10	36°	44	8° 10′ 54·55″
11	32° 43′ 38·18″	45	8°
*12	30°	46	7° 49′ 33·91″
13	27° 41′ 32·31″	47	7° 39′ 34·47″
14	25° 42′ 51·43″	48	7° 30′ 00″
*15	24°	49	7° 20′ 48·98″
16	22° 30′ 00″	50	7° 12′ 00″
17	21° 10′ 35·29″	51	7° 3′ 31·76″
*18	20°	52	6° 55′ 23·07″
19	18° 56′ 50·53″	53	6° 47′ 32·83″
*20	18°	54	6° 40′ 00″
21	17° 8′ 34·29″	55	6° 32′ 43·63″
22	16° 21′ 49·09″	56	6° 25′ 42·86″
23	15° 39′ 7·83″	57	6° 18′ 56·84″
*24	15°	58	6° 12′ 24·83″
25	14° 24′ 00″	59	6° 6′ 6·10″
26	13° 50′ 46·15″	*60	6°
27	13° 20′ 00″	61	5° 54′ 5·90″
28	12° 51′ 25·71″	62	5° 48′ 23·23″
29	12° 24′ 49·66″	63	5° 42′ 51·43″
*30	12°	64	5° 37′ 30·0″
31	11° 36′ 46.45″	65	5° 32′ 18·46″
32	11° 15′ 00″	66	5° 27′ 16·36″
33	10° 54′ 32·72″	67	5° 22′ 23·28″
34	10° 35′ 17·65″	68	5° 17′ 38·82″
35	10° 17′ 8·54″	69	5° 13′ 2·61″
*36	10°	70	5° 8′ 34·29″
37	9° 43′ 47·02″	71	5° 4′ 13·52″
38	9° 28′ 25·26″	*72	5°

*These polygons give submultiples in whole degrees and are those which may normally be manufactured.

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