INTERNATIONAL STANDARD

ISO 9013

First edition
1992-09-15

Welding and allied processes — Quality classification and dimensional tolerances of thermally cut (oxygen/fuel gas flame) surfaces

Soudage et techniques connexes — Niveaux de qualité et tolérances dimensionnelles des surfaces découpées thermiquement (à la flamme d'oxygène/gaz de chauffe)

Reference number
ISO 9013:1992(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 9013 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Sub-Committee SC 8, *Gas welding equipment*.

Annex A of this International Standard is for information only.

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

Printed in Switzerland

Welding and allied processes — Quality classification and dimensional tolerances of thermally cut (oxygen/fuel gas flame) surfaces

1 Scope

This International Standard is valid for materials suitable for oxygen cutting and for workpiece thicknesses from 3 mm to 300 mm. It applies to cut metal surfaces produced by oxygen/fuel gas flame cutting and requires quality classification and dimensional tolerances.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1302:1978, *Technical drawings — Method of indicating surface texture on drawings.*

ISO 4287-1:—[1], *Surface roughness — Terminology — Part 1: Surface and its parameters.*

ISO 8015:1985, *Technical drawings — Fundamental tolerancing principle.*

3 Basis of process

3.1 Process

Oxygen cutting refers to those thermal cutting processes in which the cutting kerf is created such that

— the material in the kerf is primarily oxidized;

— oxidized products are driven out of the kerf by a high velocity oxygen jet.

3.2 Prerequisites

The material shall be heated at the point of reaction to a temperature at which it reacts spontaneously with oxygen (ignition temperature). The process shall deliver sufficient thermal energy such that areas of the material in the cutting direction are heated up to this ignition temperature. The ignition temperature shall be below the melting temperature of the material. Cutting slag shall be liquid enough to be driven out of the cutting kerf by the oxygen jet.

3.3 Material

The prerequisites given in 3.2 are fulfilled by pure iron, low-alloyed and some alloyed steels as well as by titanium and some titanium alloys. The cutting process is detrimentally affected by alloying elements, except manganese, and increasingly so with increasing content of the alloying element e.g. chromium, carbon, molybdenum or silicon. Therefore, among others, high-alloyed CrNi-steels or silicon steels and cast iron cannot be oxygen cut without special steps. These materials can be cut with other thermal cutting processes, e.g. by metal powder oxygen cutting or plasma arc cutting.

4 Designation

The designation of a flame cut surface shall comprise the following information in the order given:

a) description block, e.g. “flame cut”;

b) a reference to this International Standard;

1) To be published. (Revision of ISO 4287-1:1984)

c) the indication of quality containing perpendicularity and angularity tolerance and permissible ten point height of irregularity according to 5.1 or 5.2;

d) the indication of tolerance class according to clause 6.

EXAMPLE

An oxygen flame cut surface with quality I and tolerance class A is designated as follows:

Flame cut ISO 9013 - IA

5 Quality of flame cut edge (face)

5.1 Factors and explanations

For the classification of quality of flame cut edges (faces), the following factors are used:

a) perpendicularity tolerance, u (see figure 1) or angularity tolerance, u (see figure 2);

b) ten point height of irregularities, R_{y5} (see figure 3).

The following factors may be used for visual evaluation:

c) drag, n (see figure 4);

d) melting of top edge, r (see figure 5).

Perpendicularity or angularity tolerance, u, is the distance between two parallel straight lines (contacting lines) that limit the cut face profile at the theoretically correct angle (i.e. at 90° for square edge cuts).

The contacting lines are situated in a plane normal to both the workpiece surface and to the cut face.

The perpendicularity tolerance and the angularity tolerance include deviations from straightness and flatness.

Ten point height of irregularities, R_{y5}, is the mean of the absolute values of the heights of the five highest profile peaks and the depths of the five deepest profile valleys within the sampling length (from ISO 4287-1).

Drag, n, is the projected distance between the two edges of a drag line in the direction of cutting (see figure 4).

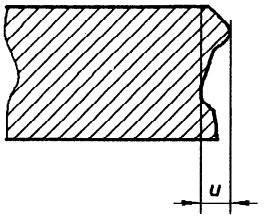


Figure 1 — Perpendicularity tolerance

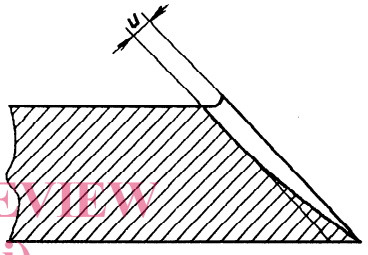
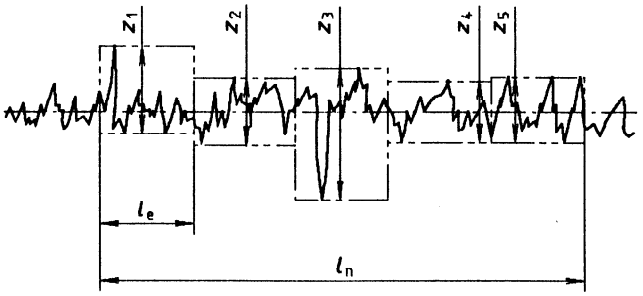


Figure 2 — Angularity tolerance



KEY

l_n is the roughness sampling length

Z_1 to Z_5 are individual profile departures

l_e is the individual sampling length (one fifth of l_n)

Figure 3 — Ten point height of irregularities

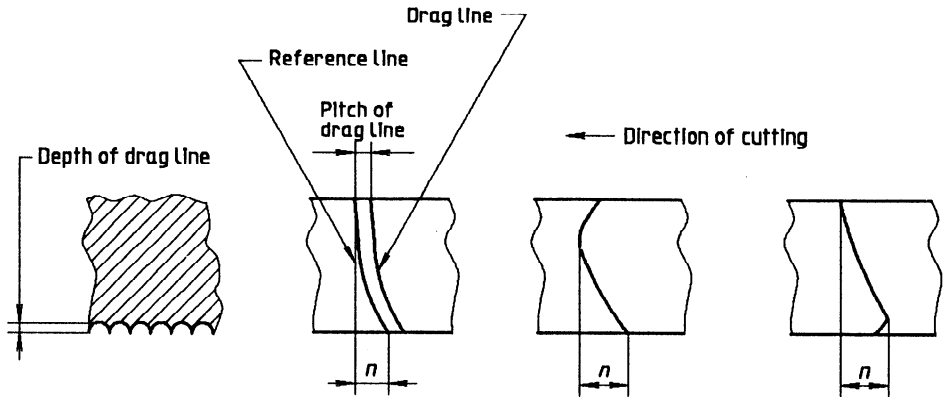


Figure 4 — Drag line

Melting of the top edge, r, is the factor characterizing the shape of the top edge of a cut, such as a sharp edge, a rounded edge with overhang or a train of fused beads with overhang (see figure 5).

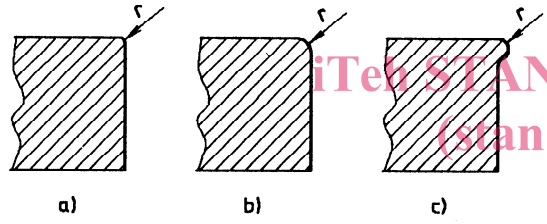


Figure 5 — Melting of top edge

The cut face profile used for the definition of perpendicularity tolerance and angularity tolerance shall be reduced by the value of Δa as given in table 1 from both the top and the bottom of the cut face (see figure 6).

Table 1 — Values of Δa for various cutting thicknesses, a

Dimensions in millimetres

Cutting thickness, a	Δa
$3 \leqslant a \leqslant 6$	0,3
$6 < a \leqslant 10$	0,6
$10 < a \leqslant 20$	1,0
$20 < a \leqslant 40$	1,5
$40 < a \leqslant 100$	2,0
$100 < a \leqslant 150$	3,0
$150 < a \leqslant 200$	5,0
$200 < a \leqslant 250$	8,0
$250 < a \leqslant 300$	10,0

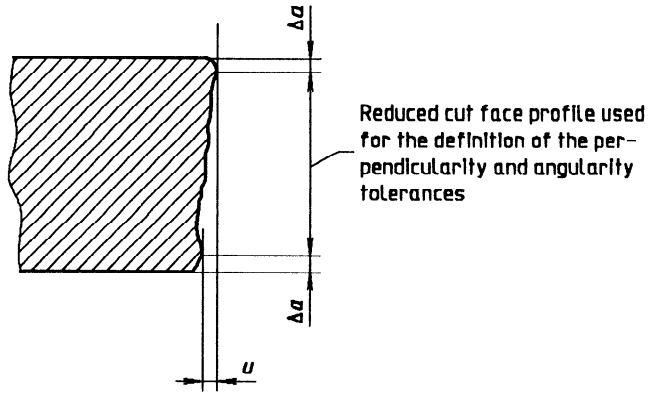


Figure 6 — Definition of measuring area for perpendicularity and angularity tolerances

Individual defects, e.g. gougings, are not considered for the definition of quality grades in this International Standard.

In the case of multiple bevel cutting, e.g. for single-V, double-V, or double bevel cuts or K-cuts, each cutting surface is to be classified separately.

For a classification of the quality of cut surfaces in accordance with table 2, the reduction of the profile for the perpendicularity and angularity tolerance u and for the permissable ten point height of irregularities R_{y5} as described above is not necessary. The definition, however, has been maintained to point out the possibility of achieving these very small deviations and also in order to demonstrate the capabilities of the process.

5.2 Quality of cut surfaces

The cut surfaces are classified as either quality I or quality II in accordance with table 2. The perpendicularity and angularity tolerance, u, and the ten point height of irregularities, R_{y5}, are given as functions of cutting thickness, a, in figures 7 and 8. Enlarged projections of u and R_{y5} for cutting thicknesses up to 20 mm are given in figures A.1 and A.2 (see annex A).

5.3 Agreed-upon quality

Following prior agreement or in order to take application conditions into consideration one may deviate from quality classifications I and II. To describe the agreed-upon quality, the fields for the perpendicularity and angularity tolerance, u, and the ten point height of irregularities, R_{y5}, are to be laid down in the sequence u, R_{y5}. In cases where no value for the field is to be specified, insert "0" (zero).

EXAMPLE 1

Field 1 for u

Field 1 for R_{y5}

Code: 11

EXAMPLE 2

Field 2 for u

0 for R_{y5} (i.e. no value specified)

Code: 20

Table 2 — Quality classifications

Quality classification of cut surface	Perpendicularity and angularity tolerance, u, in accordance with figure 7	Ten point height of irregularities, R_{y5}, in accordance with figure 8
I	Fields 1 and 2	Fields 1 and 2
II	Fields 1 to 3	Fields 1 to 3

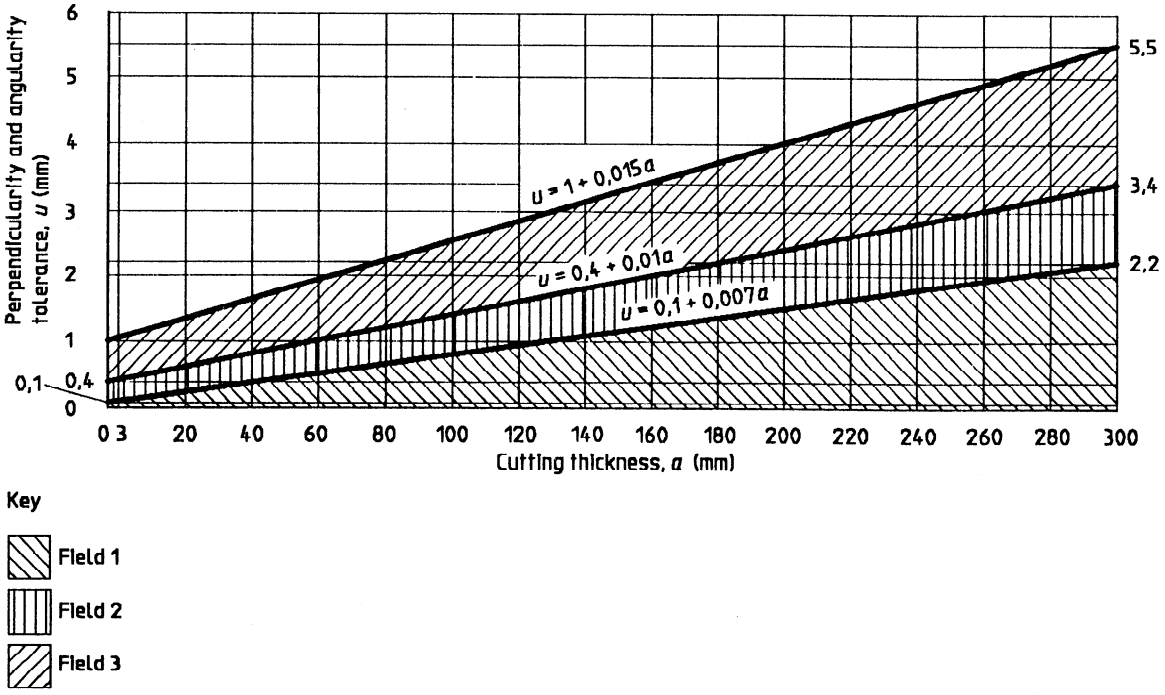


Figure 7 — Perpendicularity and angularity tolerance, u

6 Dimensional tolerances

Dimensions shown in drawings are nominal dimensions. The actual dimensions are to be measured on cleaned cutting surfaces. The limit deviations given in tables 3 and 4 are valid for dimensions without a tolerance indication when drawings or other documents (e.g. delivery conditions) refer to this International Standard. Limit deviations in table 3 are only valid for the workpiece thicknesses given in the table and on parts on which the ratio of length to width is no more than 4:1 and for which the minimum total circumference is 350 mm.

For workpieces where the ratio between length and width is more than 4:1, the tolerances have to be agreed upon between manufacturer and user in accordance with this International Standard.

The given limit deviations are based on the principle of independency specified in ISO 8015, in which the dimensional and geometrical tolerances are valid independently of each other. The part of the tolerance caused by perpendicularity and angularity deviations in the direction of the cutting jet shall be within the limit deviations. If other dimensional and geometrical tolerances, e.g. straightness tolerance or perpendicularity tolerance in cutting longitudinal direction, should be maintained, a particular agreement shall be reached.

For parallel straight line cuts with perpendicular cut surfaces being cut simultaneously, the limit deviations of table 4 are valid.

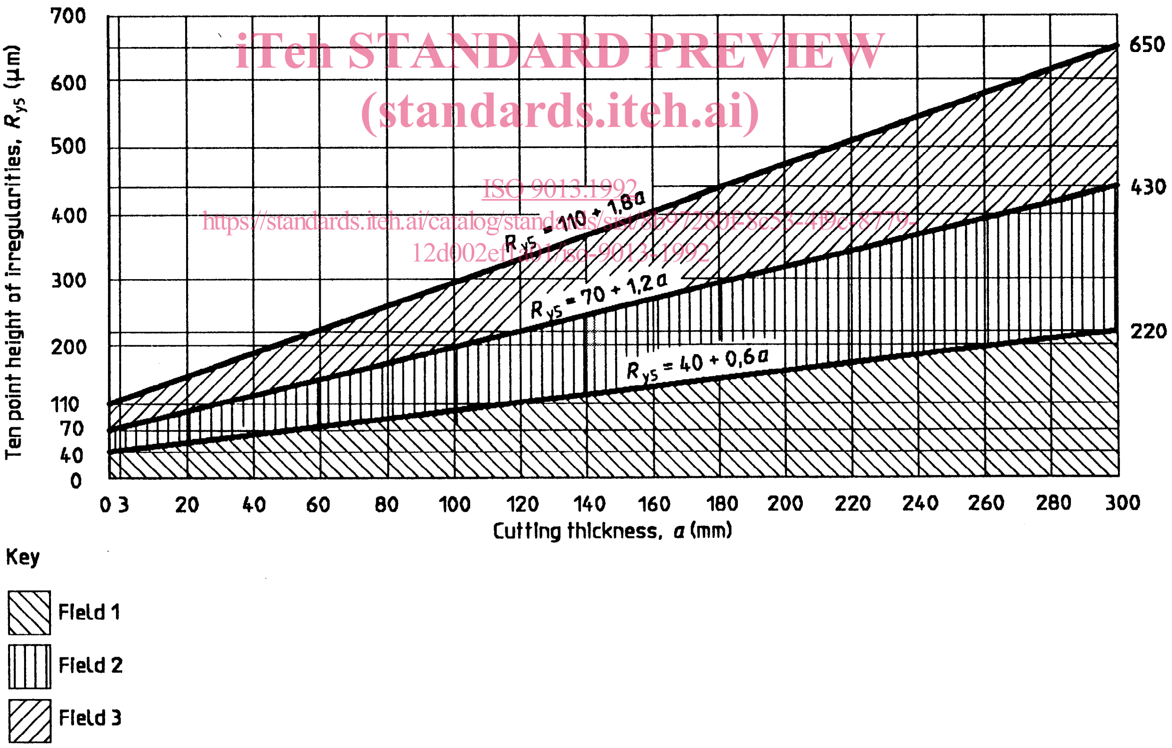


Figure 8 — Permissible ten point height of irregularities, R_{y5}

Table 3 — Limit deviations for nominal dimensions

Dimensions in millimetres

Tolerance class	Workpiece thickness, t	Limit deviations for nominal dimensions			
		35 up to 315	315 up to 1 000	1 000 up to 2 000	2 000 up to 4 000
A	$3 < t \leqslant 12$	± 1,0	± 1,5	± 2,0	± 3,0
	$12 < t \leqslant 50$	± 0,5	± 1,0	± 1,5	± 2,0
	$50 < t \leqslant 100$	± 1,0	± 2,0	± 2,5	± 3,0
	$100 < t \leqslant 150$	± 2,0	± 2,5	± 3,0	± 4,0
	$150 < t \leqslant 200$	± 2,5	± 3,0	± 3,5	± 4,5
	$200 < t \leqslant 250$	—	± 3,0	± 3,5	± 4,5
	$250 < t \leqslant 300$	—	± 4,0	± 5,0	± 6,0
B	$3 < t \leqslant 12$	± 2,0	± 3,5	± 4,5	± 5,0
	$12 < t \leqslant 50$	± 1,5	± 2,5	± 3,0	± 3,5
	$50 < t \leqslant 100$	± 2,5	± 3,5	± 4,0	± 4,5
	$100 < t \leqslant 150$	± 3,0	± 4,0	± 5,0	± 6,0
	$150 < t \leqslant 200$	± 3,0	± 4,5	± 6,0	± 7,0
	$200 < t \leqslant 250$	—	± 4,5	± 6,0	± 7,0
	$250 < t \leqslant 300$	—	± 5,0	± 7,0	± 8,0

Table 4 — Limit deviations for simultaneously-cut parallel straight line cuts

Dimensions in millimetres

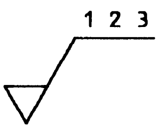
Tolerance class	Workpiece thickness, t	Limit deviations for nominal dimensions up to 10 000
F	$10 < t \leqslant 100$	± 0,2
G	$6 < t \leqslant 100$	± 0,5
H	$6 < t \leqslant 100$	± 1,5

7 Information in technical documents

7.1 Cutting quality and tolerance class

7.1.1 Representation on technical drawings

The required quality and tolerance class produced by flame cutting shall be given in accordance with ISO 1302 as shown in figure 9.



KEY

1 Reference to this International Standard i.e. ISO 9013

2 Quality classification in accordance with clause 5

3 Tolerance class in accordance with clause 6

Figure 9 — Representation on technical drawings

When agreed-upon deviations from this International Standard are desired, this has to be indicated specifically (see also 5.3).

EXAMPLE 1

Quality classification I and tolerance class A are required. The representation is shown in figure 10.

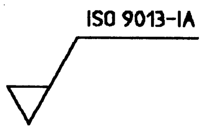


Figure 10

EXAMPLE 2

An agreed-upon quality with code 23 (field 2 for u, field 3 for R_{y5}) and tolerance class A are required. The representation is shown in figure 11.

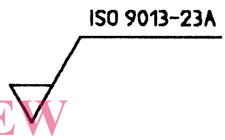


Figure 11

7.1.2 Representation in the title block of technical documents

The required quality classification and tolerance class together with a reference to this International Standard shall be given as follows:

EXAMPLE

Quality classification II and tolerance class G are required.

ISO 9013 - IIG