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**Steel — Surface finish of hot-rolled  
plates and wide flats — Delivery  
requirements**

*Acier — État de surface des tôles et larges-plats laminés à chaud —  
Conditions de livraison*

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Published in Switzerland

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## 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 3, *Steels for structural purposes*.

This second edition cancels and replaces the first edition (ISO 7788:1985), which has been technically revised.

The main changes are as follows:

- updated normative reference;
- new definitions added and definitions in former Annex A added to [Clause 3](#);
- deletion of distinction concerning boilers and pressure vessel applications ([Clause 4](#));
- new definition of two classes and three subclasses added ([Clause 5](#));
- new [Clause 6](#) on depth and determination of affected areas, repair requirements and repair procedures;
- new [Annex B](#) with classes and subclasses for surface conditions with their respective requirements;
- deletion of former Annex A.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

# Steel — Surface finish of hot-rolled plates and wide flats — Delivery requirements

## 1 Scope

This document specifies delivery requirements applicable to the surface finish of hot-rolled plates rolled on reversing mills and wide flats, with a nominal thickness  $\geq 3$  mm and  $\leq 400$  mm.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 6929, *Steel products — Vocabulary*

ISO 7452, *Hot-rolled steel plates — Tolerances on dimensions and shape*

ISO 9034, *Hot-rolled structural steel wide flats — Tolerances on dimensions and shape*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6929 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1

#### **imperfection**

surface discontinuity other than *cracks* (3.10), *shell and seams* (3.11) with a depth and/or an area equal to or less than a specified limiting value

Note 1 to entry: Discontinuities that are required to be repaired are regarded as defects.

### 3.2

#### **defect**

surface discontinuity with a depth and/or area greater than a specified limiting value and all *cracks* (3.10), *shell and seams* (3.11), irrespective of their depth or/and area

### 3.3

#### **rolled-in scale and pitting**

marks on the rolled surface varying in shape, thickness and frequency resulting from the unsatisfactory subsequent removal of scale from the stock before or during hot rolling and processing

Note 1 to entry: Rolled-in scale-pitting can be regarded as discontinuities.

### 3.4

#### **indentations and roll marks**

marks appearing at periodic intervals caused by damaged rolls or pinch rolls

Note 1 to entry: Indentations (depressions) or roll marks (protuberances) can be distributed at definite distances apart or irregularly throughout the length and width of the stock. Indentations can be caused, among other things, by protuberances on rolls or rollers.

Note 2 to entry: Indentations and roll marks can be regarded as discontinuities.

### 3.5

#### **scratches and grooves**

mechanical damages varying in width, depth and length at the surface, mostly parallel or at right angles to the rolling direction

Note 1 to entry: They can be slightly rolled over and seldom contain scale. These damages are caused by friction between the stock and parts of the equipment due to relative movements.

Note 2 to entry: Scratches and grooves can be regarded as discontinuities.

### 3.6

#### **spills and slivers**

minute surface discontinuities of an irregular and flake-like nature

Note 1 to entry: Spills and slivers are elongated in the direction of rolling, their extent depending on the degree of reduction. They are still connected – as minute particles of shell – to the base metal at certain points.

Note 2 to entry: Spills and slivers can be regarded as discontinuities.

### 3.7

#### **blisters**

blow holes of varying size and shape located closely beneath the surface and appearing during hot rolling

Note 1 to entry: Blisters can be regarded as discontinuities.

### 3.8

#### **hot tears**

variably orientated material discontinuities in the surface region varying in length, width and depth and occurring in preferred directions and/or distributed over a limited area

Note 1 to entry: Hot tears arise in the processing of slab ingots, roughed slabs and continuously cast slabs and are associated with the steel, with stresses in the initial material or with adverse forming conditions.

Note 2 to entry: Hot tears can be regarded as discontinuities.

### 3.9

#### **sand patch**

non-metallic inclusion in the surface that varies in size and shape, elongated in the direction of rolling, randomly localized and distinctly coloured, standing out from its background

Note 1 to entry: Sand patches can be regarded as discontinuities.

### 3.10

#### **crack**

localized discontinuity of varying length and varying orientation related to the rolling direction in the region of the surface, and which can less frequently occur as crazing

Note 1 to entry: Cracks are due mainly to material stresses that arise during the cooling process.

Note 2 to entry: Cracks are always considered as defects, see [6.2.1.2.3](#).

### 3.11 shell and seams

overlapping material being irregularly distributed over areas of the rolled product and being only partially connected with the base material

Note 1 to entry: The overlapping portions of the surface varying in shape and extent. There is a preponderance of non-metallic inclusions and/or scale among the shell. Shell can originate during casting or because of the shifting or sliding of layers of the material during hot rolling. Seams are caused mainly when defects in the semi-product parallel to the rolling direction, for instance, flame-cutting burrs, are overlapped during rolling.

Note 2 to entry: To get information about other surface of defects on the flat products, refer to valid references, including Reference [3].

Note 3 to entry: Shell and seams are always considered defects, see [6.2.1.2.3](#).

## 4 General

For plates with a nominal thickness greater than 400 mm and for special applications for which a different surface condition is required, special agreements shall be made at the time of enquiry and order.

Responsibility for the required surface condition, whether the product is delivered descaled or not, rests with the material producer, who has to take the necessary precautions. The producer can only take account of discontinuities that are visible to the naked eye. Rolling or heat-treatment scale can conceal surface discontinuities.

If the purchaser needs to be sure that all discontinuities visible to the naked eye have been identified, assessed and where necessary, repaired before delivery, products should be ordered descaled.

If, during the subsequent descaling or working operations by the user, the material is found to be defective because of faulty rolling or processing by the producer, the producer shall be given opportunity to repair the product, provided that this is not in conflict with the appropriate material or product standard.

## 5 Classification

The surface requirements and repair conditions are subdivided into 2 classes. Each class is further subdivided into 3 subclasses (see also [Annex B](#)):

Class A: The surface condition shall conform to the requirements of [6.2.1](#) and [6.3.1.1](#). The remaining thickness of the affected area (see [6.1.2](#)) under the discontinuities and of the repaired ground areas may be less than the minimum thickness as specified in the appropriate tolerance standard.

Class B: The surface condition shall conform to the requirements of [6.2.2](#) and [6.3.1.2](#). The remaining thickness of the affected area under the discontinuities and of the repaired ground areas shall not be less than the minimum thickness as specified in the appropriate tolerance standard.

Subclass 1: Repair by chipping and/or grinding followed by welding is permitted in accordance with [6.3.2.2](#).

Subclass 2: Repair by welding is only permitted if agreed at the time of the order and under agreed conditions (see [6.3.2.3](#)).

Subclass 3: Repair by welding is not allowed.

The required class and subclass are specified in the appropriate material or product standard. If this is not the case, the class and subclass shall be class A and subclass 1 unless otherwise specified at the time of order.

## 6 Requirements

### 6.1 Depth and affected area of discontinuities

#### 6.1.1 Depth

To differentiate the surface discontinuities in terms of imperfections and defects, the depth of representative surface discontinuities shall be measured when necessary. The measurement shall be carried out from the surface of the product. The depth of the discontinuities chosen as the representative ones shall be determined after the discontinuity has been removed by grinding.

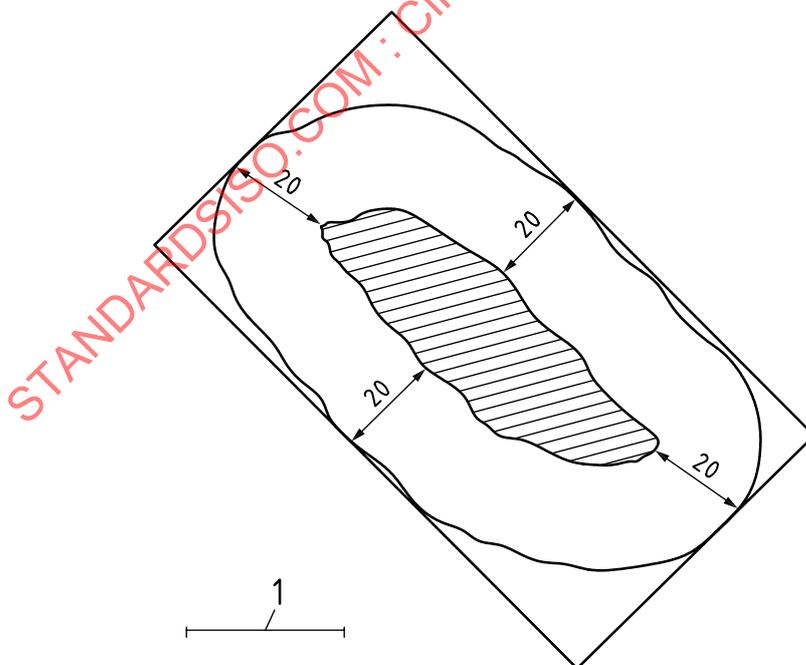
#### 6.1.2 Affected area

When necessary, areas affected by surface discontinuities shall be determined as follows:

- a) For isolated discontinuities (Figure 1), the affected area is obtained by drawing a continuous line that follows the circumference of the discontinuity at a distance of 20 mm or by drawing a rectangle whose sides are 20 mm from the edges of the discontinuity.
- b) For discontinuities appearing in a cluster (Figure 2), the affected area is obtained by drawing a continuous line that follows the circumference of the cluster at a distance of 20 mm or by drawing a rectangle whose sides are 20 mm from the continuous line that follows the cluster or by the product edge if it is closer.
- c) For discontinuities appearing in a line (Figure 3), the affected area is obtained by drawing a rectangle whose sides are 20 mm in the longitudinal direction and 20 mm in the transverse direction from the edge of the discontinuity or by the product edge if it is closer.

Multiple appearing discontinuities whose edges are closer together than 40 mm shall be considered as one cluster.

Dimensions in millimetres

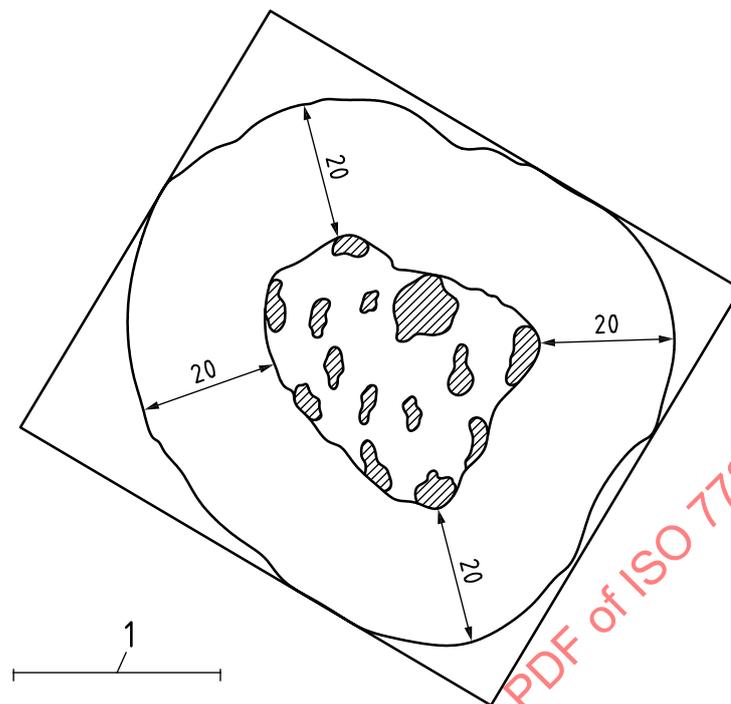


#### Key

- 1 horizontal line

**Figure 1 — Determination of the affected area due to an isolated discontinuity**

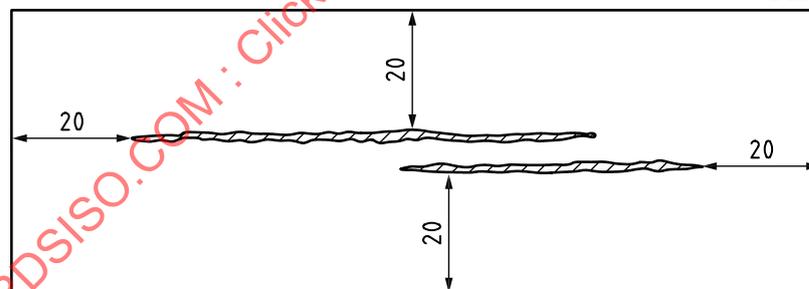
Dimensions in millimetres

**Key**

1 horizontal line

**Figure 2 — Determination of the affected areas due to clustered discontinuities**

Dimensions in millimetres

**Figure 3 — Determination of the affected areas due to aligned single or multiple discontinuities****6.2 Repair requirements**

The actions to undertake in function of the nature and the geometrical characteristics of discontinuities can be found in [Figure A.1](#) and [Table A.1](#).

**6.2.1 Class A****6.2.1.1 Imperfections**

**6.2.1.1.1** Typical imperfections are for example rolled in scale and pitting, indentations and roll marks, scratches and grooves, spills and slivers, blisters, hot tears or sand patches.

Discontinuities other than cracks, shell and seams (see 6.2.1.2.3) not exceeding the limits of Table 1 are regarded as being inherent of the manufacturing process and are permissible irrespective of their number.

A surface area with discontinuities within the limits of Table 1 but with a remaining thickness under the discontinuities less than the minimum thickness as specified in ISO 7452 and ISO 9034 is permissible with a maximum of 15 % of the inspected surface.

**Table 1 — Maximum permissible depth of imperfections**

Nominal thickness of the product <i>t</i> mm	Maximum permissible depth of imperfections mm
$3 \leq t < 8$	0,2
$8 \leq t < 25$	0,3
$25 \leq t < 40$	0,4
$40 \leq t < 80$	0,5
$80 \leq t < 250$	0,7
$250 \leq t \leq 400$	1,3

6.2.1.1.2 Discontinuities other than cracks, shell and seams (see 6.2.1.2.3) with a depth exceeding the limits of Table 1 but not exceeding the limits of Table 2 and of which the sum of affected areas does not exceed 5 % of the inspected surface may be left unrepaired.

**Table 2 — Maximum permissible depth of discontinuities**

Nominal thickness of the product <i>t</i> mm	Maximum permissible depth of discontinuities mm
$3 \leq t < 8$	0,4
$8 \leq t < 25$	0,5
$25 \leq t < 40$	0,6
$40 \leq t < 80$	0,8
$80 \leq t < 150$	0,9
$150 \leq t < 250$	1,2
$250 \leq t \leq 400$	1,5

A surface area with a remaining thickness under the discontinuities less than the minimum thickness as specified in ISO 7452 and ISO 9034 is permissible with a maximum of 2 % of the area of the inspected surface.

**6.2.1.2 Defects**

6.2.1.2.1 Discontinuities with a depth exceeding the limits of Table 1 but not exceeding the limits of Table 2, but with an affected surface area of more than 5 % of the inspected surface shall be repaired.

6.2.1.2.2 Discontinuities with a depth exceeding the limits of Table 2 shall be repaired, irrespective of their number.

6.2.1.2.3 Discontinuities such as cracks, shell and seams, which are in general deep and sharp, and therefore impair the use of the products, shall always be repaired irrespective of their depth and number.

## 6.2.2 Class B

The requirements of [6.2.1.1](#) and [6.2.1.2](#) shall apply, except that the remaining thickness under the discontinuities and repair ground areas shall not be less than the minimum permissible thickness as specified in ISO 7452 and ISO 9034 (or in another agreed dimensional standard).

## 6.3 Repair procedures

The repair possibilities in function of the class and nominal thickness of the product are represented in [Figure A.2](#) and [Table A.1](#).

### 6.3.1 Grinding

If a discontinuity must be repaired, it shall be removed completely by grinding to its full depth. The ground areas shall have a smooth transition to the surrounding surface of the product. In case of dispute, complete elimination of the defect may be demonstrated by magnetic particle or dye penetrant test techniques.

The producer shall be allowed to repair the entire surface by grinding to the minimum thickness specified in ISO 7452 and ISO 9034 (or in another agreed dimensional standard).

Grinding of defects shall be carried out subject to the following conditions.

#### 6.3.1.1 Class A

**6.3.1.1.1** The maximum permissible depth of ground areas is given in [Tables 3](#) and [4](#).

**Table 3 — Maximum permissible depth of ground areas with a maximum of 15 % of the inspected area**

Nominal thickness of the product $t$ mm	Permitted grinding depth allowances below the minimum thickness as specified in ISO 7452 and ISO 9034 mm
$3 \leq t < 8$	0,3
$8 \leq t < 15$	0,4
$15 \leq t < 25$	0,5
$25 \leq t < 40$	0,6
$40 \leq t < 60$	0,7
$60 \leq t < 80$	0,8
$80 \leq t < 150$	1,0
$150 \leq t < 250$	1,2
$250 \leq t \leq 400$	1,4

**Table 4 — Maximum permissible depth of ground areas with a maximum of 2 % of the inspected area**

Nominal thickness of the product $t$ mm	Permitted grinding depth allowances below the minimum thickness as specified in ISO 7452 and ISO 9034 mm
$3 \leq t < 8$	0,4
$8 \leq t < 15$	0,5
$15 \leq t < 25$	0,7
$25 \leq t < 40$	0,9
$40 \leq t < 60$	1,1
$60 \leq t < 80$	1,3
$80 \leq t < 150$	1,6
$150 \leq t < 250$	1,9
$250 \leq t \leq 400$	2,2

**6.3.1.1.2** When the depth of the ground area is less than indicated in [Table 3](#), a surface area with a remaining thickness under the ground area less than the minimum thickness as specified in ISO 7452 and ISO 9034 is permissible with a maximum of 15 % of the inspected surface.

**6.3.1.1.3** When the depth of the ground area exceeds the limits given in [Table 3](#) but is less than indicated in [Table 4](#), the sum of all ground areas below the minimum permissible thickness of one side of the product shall not exceed 2 % of the inspected surface area. For products of surface greater than 12,5 m<sup>2</sup>, the size of a single ground area below the minimum permissible thickness shall not exceed 0,25 m<sup>2</sup>.

**6.3.1.1.4** For the remaining thickness of two ground areas lying opposite to each other on both sides of the product, [Table 4](#) shall apply.

### 6.3.1.2 Class B

The remaining thickness of the repaired ground area shall not be under the minimum permissible thickness as specified in ISO 7452 and ISO 9034.

### 6.3.2 Welding

Defects shall be completely eliminated before any weld repair is commenced. This procedure shall not reduce the thickness of the product to less than 70 % of its nominal thickness.

Prior to weld repair of edges of flat products, the depth of the groove, measured from the edge inward, shall not exceed the nominal thickness of the product with a maximum of 30 mm.

The welding shall be carried out by welders qualified in accordance with ISO 9606-1 using a procedure appropriate to the grade of steel and acceptable to the purchaser. Welding procedures shall be carried out in accordance with ISO 15607.

The weld shall be free of any lack of fusion, undercutting, cracks and other defects which could impair the workability or use of the product in question as specified by the purchaser.

The deposited weld material shall reach above the plate surface and shall subsequently be ground smooth and level with the product surface. After grinding smooth, ordered product thickness tolerances shall apply to the ground area.

After repair, a post-weld heat treatment may be agreed between the producer and the purchaser.

Proper repair shall be verified by ultrasonic, radiographic, magnetic particle or dye penetrant inspection. When the method has not been specified by the purchaser, the choice of the method is at the manufacturer's discretion.

If requested at the time of the order for every welding repair, the producer shall provide reports containing a sketch, showing dimensions and location of the defect and full details of the repair procedure, including the welding consumables, eventual post-weld heat treatment and non-destructive testing.

#### **6.3.2.1 General**

The following conditions apply for the repair by welding of defects which cannot be repaired by grinding in accordance with [6.3.1](#).

#### **6.3.2.2 Subclass 1**

A single welded area shall not exceed 0,125 m<sup>2</sup> and the sum of the welded areas shall not exceed 0,125 m<sup>2</sup> or 2 % of the surface area under inspection, whichever is the greater, for plates having a surface area greater or equal to 6 m<sup>2</sup> or 5 %, for plates having a surface area less than 6 m<sup>2</sup>.

Ground and welded areas that are separated by a distance less than their average width shall be treated as a single area for the purpose of determining the limiting area.

#### **6.3.2.3 Subclass 2**

Repair by welding is only allowed if agreed at the time of the order. In this case, requirements different from [6.3.2.2](#) can be specified.

#### **6.3.2.4 Subclass 3**

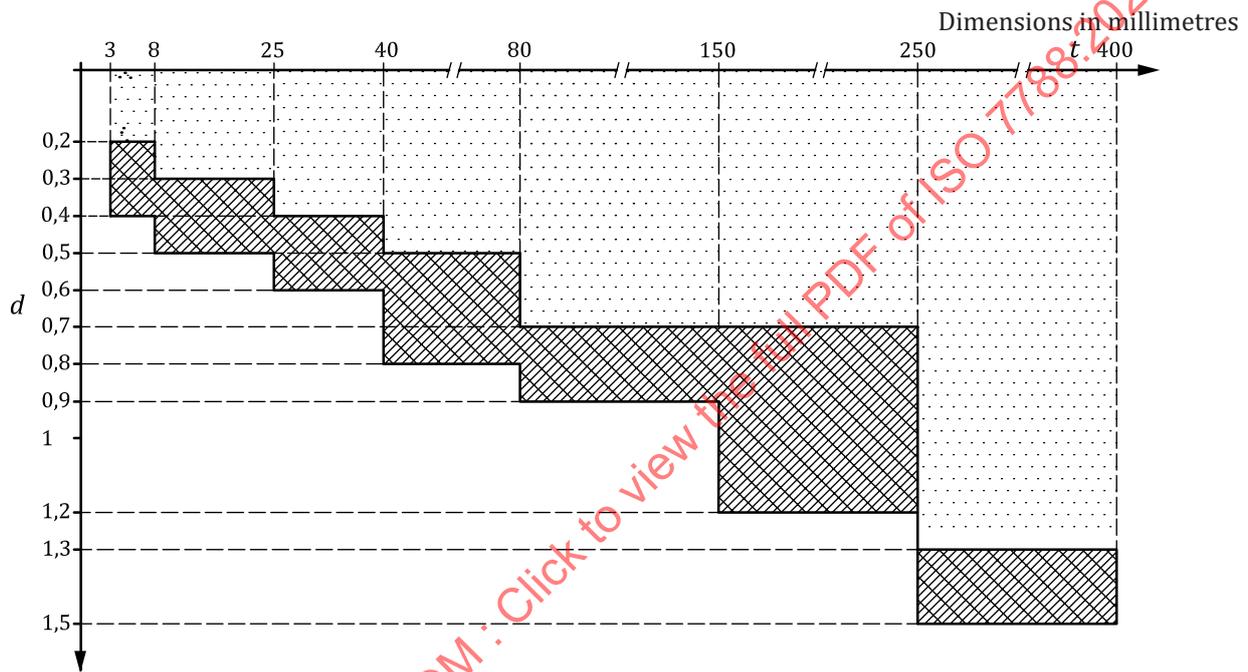
Repair by welding is not allowed.

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## Annex A (informative)

### Action to undertake in function of the depth of discontinuities and nominal thickness of the products

Figure A.1 represents the action to undertake in function of the class, the depth of discontinuities and nominal thickness of the product.

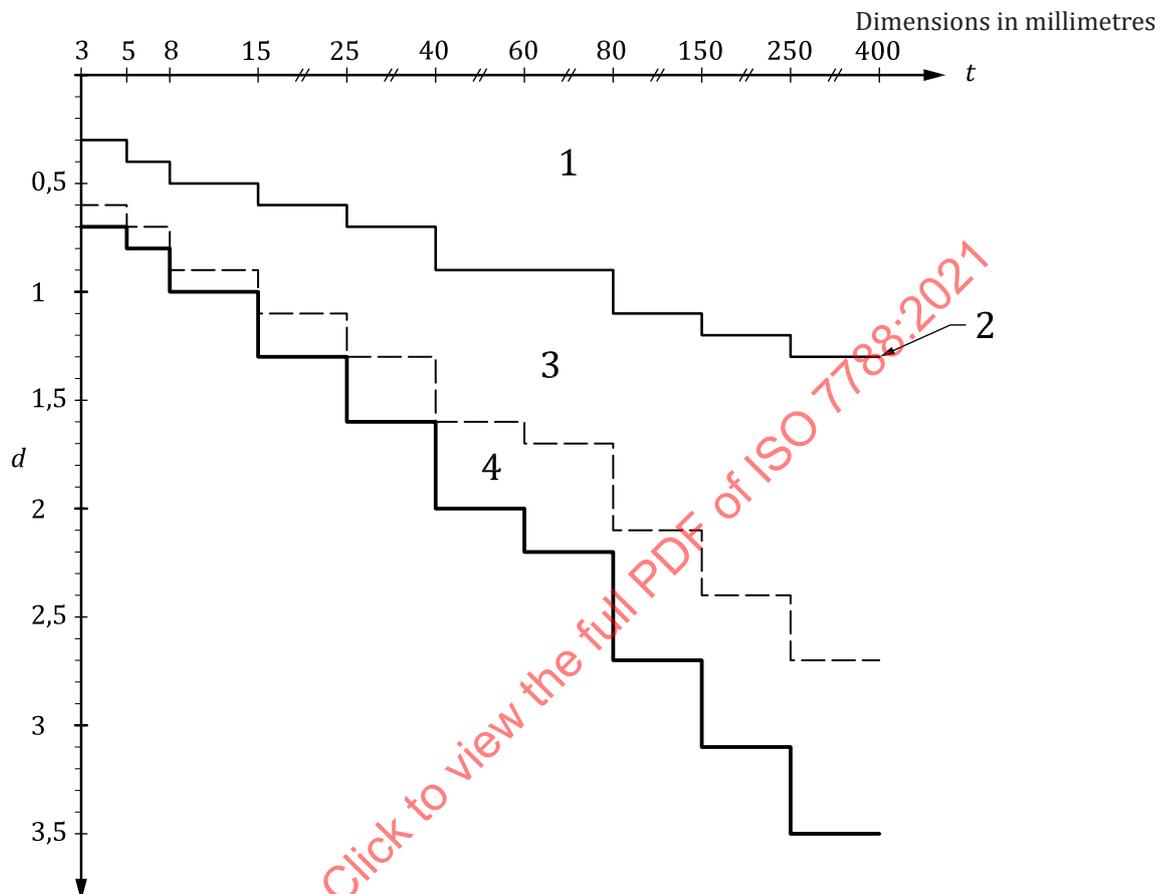


**Key**

- $t$  nominal thickness of the product
  - $d$  depth of discontinuities measured from the actual plate thickness
  - imperfections inherent in the manufacturing process and always accepted (see 6.2.1.1.1)<sup>a</sup>
  - accepted imperfections in the limit of 5 % of the inspected surface (see 6.2.1.1.2)<sup>b</sup>
  - defects to repair (defects with an affected surface area of more than 5 % of the inspected surface) (see 6.2.1.2.1)
  - defects to repair or to reject (see 6.2.1.2.2)
- <sup>a</sup> Maximum 15 % of the surface for class A and 0 % for class B can have a remaining thickness under the discontinuities less than the minimum thickness as specified in ISO 7452 and ISO 9034.
- <sup>b</sup> Maximum 2 % of the surface for class A and 0 % for class B can have a remaining thickness under the discontinuities less than the minimum thickness as specified in ISO 7452 and ISO 9034.

**Figure A.1 — Limits for discontinuities**

Figure A.2 represents the repair possibilities in function of the class and nominal thickness of the product, exemplary with the tolerances of ISO 7452 – Class A.



#### Key

- $t$  nominal thickness of the product
- $d$  depth of grinding below nominal thickness
- 1 grinding accepted over 100 % of the surface (see 6.3.1) for classes A and B
- 2 requirements for allowable under thickness tolerance (see ISO 7452 – Class A)
- 3 grinding limited to 15 % of the surface (see 6.3.1.1.1 and 6.3.1.1.2) for class A
- 4 grinding limited to 2 % of the surface (see 6.3.1.1.1 and 6.3.1.1.3) for class A

**Figure A.2 — Repair of defects (grinding or grinding + welding)**

Table A.1 represents the action to undertake in function of the nominal thickness of the product, the class, the nature and the geometrical characteristics of discontinuities.

Table A.1 — Action to undertake in function of the nature and the geometrical characteristics of discontinuities

Category	Depth of discontinuity for nominal plate thickness of mm						Thickness beneath discontinuity less/ not less than that allowed by rolling tolerances	Total area per side <sup>a</sup>	Action (see repair rules)	
	<8	≥8 <25	≥25 <40	≥40 <80	≥80 <150	≥150 <250				≥250 <400
<b>6.2.1.1</b>	<b>Excluding cracks, shells, seams <sup>b</sup></b>									
	≤0,2	≤0,3	≤0,4	≤0,5	≤0,7	≤0,7	≤1,3	< <sup>c</sup>	≤15 %	None
	≤0,4	≤0,5	≤0,6	≤0,8	≤0,9	≤1,2	≤1,5	< <sup>c</sup>	>15 % Any	Repair None
<b>6.2.1.2</b>	≤0,4	≤0,5	≤0,6	≤0,8	≤0,9	≤1,2	≤1,5	≥	≤2 %	None
	>0,4	>0,5	>0,6	>0,8	>0,9	>1,2	>1,5	≥	>2 % ≤5 % >5 %	Repair None Repair
<b>6.2.1.2.3</b>	<b>Cracks, shells, seams <sup>b</sup></b>									
	All depths						—	All	—	Repair

<sup>a</sup> Area is that within a line 20 mm from and around each discontinuity or discontinuity cluster (or plate edge if closer), see 6.1.2.

<sup>b</sup> Or similar sharp, deep defects.

<sup>c</sup> Not permitted for Class B, see 6.2.2.