SMS group

Manufacturing instructions
Thermal cutting and bending

SN 200-3

ICS 25.020

Supersedes SN 200-3:2016-05

Table of contents

Introduction

The manufacturing requirements specified in this part of SN 200 are used to achieve the relevant SMS product quality. Consequently, these requirements must always be satisfied unless otherwise stipulated in drawings, purchase order documents, and/or other manufacturing documents. This standard is indicated as a binding document in drawings (title blocks), contracts and/or purchase order documents. If the requirements cannot be fulfilled, SMS group must be consulted.

1 Scope

This company standard specifies the requirements for parts produced by thermal cutting or by bending and used for the manufacture of SMS group products.

Edited by:
SMS group
Standards Office

2 Normative references

The following documents, which are quoted here either in whole or in part, are required for the application of the present document. Dated references refer only to the dated edition indicated. Undated references refer to the most recent edition of the respective document inclusive of all revisions.

DIN 2413	Seamless steel tubes for oil- and water-hydraulic systems – Calculation rules for pipes and elbows for dynamic loads
DIN 6935:2011-10	Cold bending of flat rolled steel
DIN EN ISO 1101	Geometrical product specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out
DIN EN ISO 9013:2017-03	Thermal cutting; Classification of thermal cuts; Geometrical product specification and quality tolerances
DIN EN ISO 13920:1996-11	Welding; General tolerances for welded constructions; Dimensions for lengths, and angles, shape, and position
SN 200-1	Manufacturing instructions – Requirements and principles
SN 200-4	Manufacturing instructions – Welding

3 Terms and definitions

The following terms and definitions are valid for the application of this document.

Pipes [SN 600-1:2020-04]
Rigid hollow section produced in commercial lengths as a semi-finished product and normally used as starting material:
- for making pipes that carry fluids; or
- as a means of protecting and/or guiding electrical cables; or
- as a weld-in part for steel structures and/or mechanical engineering structures.

Pipeline [SN 600-1:2020-04]
Rigid part in which pipeline components are firmly connected with each other (by welding, pressing etc.). As part of the pipework they usually serve the purpose of conveying fluids (cooling water, air, oil etc.) from the point of provision of the fluid (e.g. pump station) to the point of consumption (e.g. cylinder) or as protection and/or conduits for electrical cables.

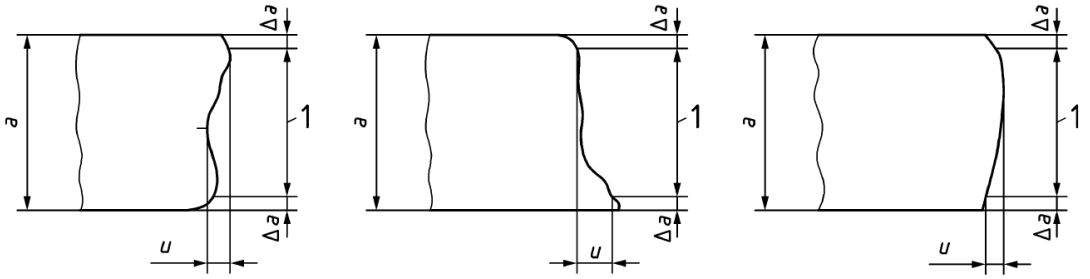
4 Thermal cutting

4.1 Cut surface quality

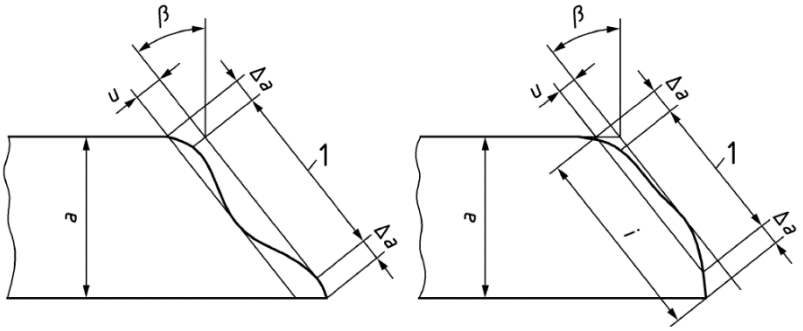
The cut surface quality is the distance between two parallel straight lines between which the cut surface profile lies within the theoretical angle (e.g. 90° for a vertical cut).
The perpendicularity or angularity tolerance includes both the straightness and the flatness deviations. Figure 1 (vertical cut and bevel cut) shows the maximum actual-value deviations within the tolerance class.

4.2 Locations of the measuring points

Table 2: The perpendicularity or angularity tolerance (u) indicated must be observed and be determined within a limited area of the cut surface. On account of the melting at the top edge of the cut, the cut face shall be reduced – according to Figure 1 – from the top and bottom cut face edges by the dimension Δa as shown in Table 1.



a) Vertical cut



b) Bevel cut

Key

1	Distance for determining the perpendicularity or angularity tolerance
a	Workpiece thickness
Δa	Cutting thickness reduction
i	Cutting thickness
u	Perpendicularity or angularity tolerance
β	Cutting flank angle

Figure 1 – perpendicularity or angularity tolerance

Table 1 – Dimensions for Δa (dimensions in mm)

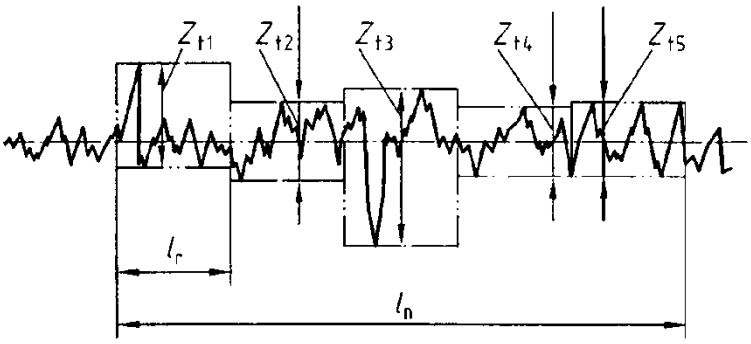
Cutting thickness a	Δa [a)]
≤ 3	0.1 a
> 3 ≤ 6	0.3
> 6 ≤ 10	0.6
> 10 ≤ 20	1
> 20 ≤ 40	1.5
> 40 ≤ 100	2
> 100 ≤ 150	3
> 150 ≤ 200	5
> 200 ≤ 250	8
> 250 ≤ 400	10
Values up to 300 mm correspond to those in table 3 of DIN EN ISO 9013:2017-05. Values > 300 mm are SMS group-specific.	

Table 2 – Perpendicularity or angularity tolerance (dimensions in mm)

Cutting thickness a	to 20	>20 to 40	>40 to 60	>60 to 80	>80 to 100	>100 to 120	>120 to 140	>140 to 160	>160 to 180	>180 to 200	>200 to 220	>220 to 240	>240 to 260	>260 to 280	>280 to 400
u [a)]	1.3	1.6	1.9	2.2	2.5	2.8	3.1	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5
a) Values up to 140 mm correspond to those in section 4 of table 4 in DIN EN ISO 9013:2017-05; values >140 mm are SMS group-specific															

4.3 Mean height of the profile

The mean height of the profile R_{Z5} according to DIN EN ISO 9013 is the arithmetic average of the single profile elements of five adjacent individual measurements; refer to Figure 2. The values specified in Table 3 must be observed.



Key

l_n	sampling length
Z_{t1} to Z_{t5}	single profile elements
l_r	single sampling length (1/5 of l_n)

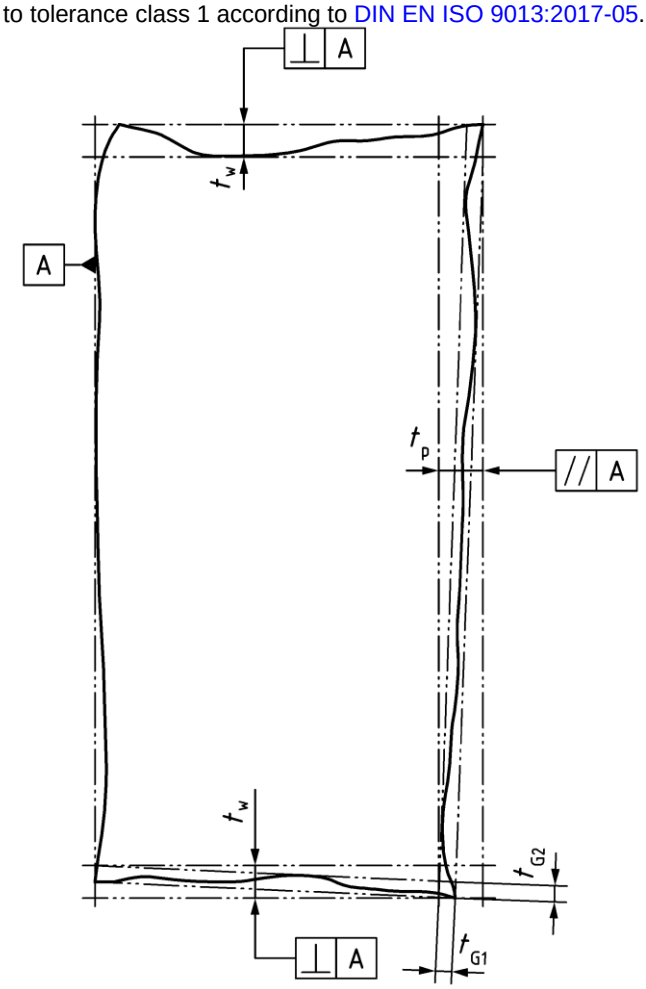
Figure 2 – Mean height of the profile

Table 3 – Mean height of the profile (dimensions in mm)

Cutting thickness a	to 20		>20 to 40	>40 to 60	>60 to 80	>80 to 100	>100 to 120	>120 to 140	>140 to 160	>160 to 180	>180 to 200	>200 to 220	>220 to 240	>240 to 260	>260 to 280	>280 to 400
R_{Z5} [a)]	0.146		0.182	0.218	0.254	0.290	0.326	0.362	0.398	0.434	0.470	0.506	0.542	0.578	0.614	0.650
a) b) Values up to 140 mm correspond to those in section 4 of table 5 in DIN EN ISO 9013:2017-05; values >140 mm are SMS group-specific.																

4.4 Shape and position tolerance

Figure 3 shows the maximum permissible actual-value deviations within the tolerance zones.
The drawing dimension shall be taken as the nominal dimension. The actual dimensions shall be measured on the cut surfaces after cleaning.
The limit deviations for nominal dimensions stated in Table 4 apply to dimensions without tolerance indication.
The limit deviations correspond to tolerance class 1 according to DIN EN ISO 9013:2017-05.



Key

t_w perpendicularity tolerance (see DIN EN ISO 1101) for cutting width related to A
t_p perpendicularity tolerance (see DIN EN ISO 1101) for cutting width related to A in plate plane
t_{G1} straightness tolerance (see DIN EN ISO 1101) for cutting length
t_{G2} straightness tolerance (see DIN EN ISO 1101) for cutting width

Figure 3 – Form and position tolerances (example of a plate)

Table 4 – Limit deviations for nominal dimensions of tolerance class 1 (dimensions in mm)

Workpiece thickness [a]	Nominal dimensions							
	> 0 < 3	≥ 3 < 10	≥ 10 < 35	≥ 35 < 125	≥ 125 < 315	≥ 315 < 1000	≥ 1000 < 2000	≥ 2000 < 4000
	Limit deviations							
> 0 ≤ 1	± 0.04	± 0.1	± 0.1	± 0.2	± 0.2	± 0.3	± 0.3	± 0.3
> 1 ≤ 3.15	± 0.1	± 0.2	± 0.2	± 0.3	± 0.3	± 0.4	± 0.4	± 0.4
> 3.15 ≤ 6.3	± 0.3	± 0.3	± 0.4	± 0.4	± 0.5	± 0.5	± 0.5	± 0.6
> 6.3 ≤ 10	-	± 0.5	± 0.6	± 0.6	± 0.7	± 0.7	± 0.7	± 0.8
> 10 ≤ 50	-	± 0.6	± 0.7	± 0.7	± 0.8	± 1	± 1.6	± 2.5
> 50 ≤ 100	-	-	± 1.3	± 1.3	± 1.4	± 1.7	± 2.2	± 3.1
> 100 ≤ 150	-	-	± 1.9	± 2	± 2.1	± 2.3	± 2.9	± 3.8
> 150 ≤ 200	-	-	± 2.6	± 2.7	± 2.7	± 3	± 3.6	± 4.5
> 200 ≤ 250	-	-	-	-	-	± 3.7	± 4.2	± 5.2
> 250 ≤ 400	-	-	-	-	-	± 4.4	± 4.9	± 5.9

Values up to 300 mm correspond to those in table 6 of DIN EN ISO 9013:2017-03. Values > 300 mm are SMS group-specific.

5 Bending

5.1 Bending of flat products

For bending flat products, the permissible bending radii and leg lengths as specified in Figure 4 and Table 5 must be complied with. For cold-bending flat products, the values specified in Table 5 apply only to steel grades with a minimum tensile strength of R_m 390 MPa. For further specifications, please refer to DIN 6935:2011-10.

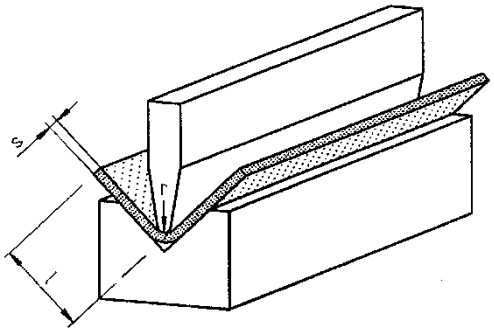


Figure 4 – Arrangement for bending

Table 5 – Bending radius and leg length for a bending angle of 90° (dimensions in mm)

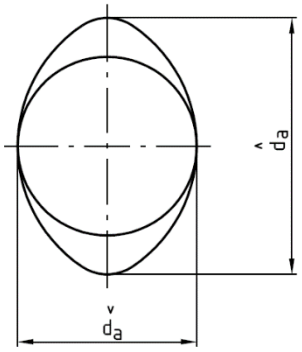
Plate thickness		**s**	**1**	**1.5**	**2**	**2.5**	**3**	**4**	**5**	**6**	**8**	**10**	**12**	**15**	**20**	**25**	**30**	**35**	**40**
Bending radius	min.	r	2.5				3	6	8	10	16	20	24	30	40	50	60	70	100
Leg length	min.	l	10				16	24	32	40	64	80	96	120	160	200	240	280	320

5.2 Cold bending of pipes

The cold-bending of pipes is preferred over welding on pipe bends or using detachable connections (e.g. angular pipe couplings). If drawings show welding elbows which can be replaced with cold-bent pipes when taking into account the larger bending radii, the manufacturing workshop is free to use the cold-bent pipe. When pipes are shown on isometric drawings, compliance with the drawing indications shall be ensured.

5.2.1 Bending radii

Bending radii for cold-bent pipes must be designed according to DIN 2413.
For cold-bent pipes, roundness deviation of ≤ 6 % is acceptable. For inductively (hot) bent pipes, the permissible roundness deviation is ≤ 2.5%. The roundness deviation of a pipe (Figure 5) is calculated with the following formula:



$$U = \frac{2(\hat{d}_a - \check{d}_a)x100}{(\hat{d}_a + \check{d}_a)}$$

Figure 5 – Roundness deviation

5.2.2 General tolerances

The general tolerances are specified in Table 6 according to DIN EN ISO 13920:1996-11. These general tolerances correspond to the welding tolerances and shall be applied to bent parts by analogy.

Tolerance category B according to Table 6 applies to fully dimensioned pipelines (e.g. pipe detail, isometric drawing) and to workpieces produced by bending flat products; tolerance category C according to Table 6 applies to pipelines that are freely laid and not fully dimensioned. Linear dimensions are to be understood as outside, inside, and stepped dimensions, bending diameters and bending radii.

Table 6 – Tolerances for longitudinal dimensions (dimensions in mm)

Tolerance category	Nominal dimension range										
	2 to 30	> 30 to 120	> 120 to 400	> 400 to 1,000	> 1000 to 2000	> 2000 to 4000	> 4000 to 8000	> 8000 to 12000	> 12000 to 16000	> 16000 to 20000	> 20000
B	± 1	± 2	± 2	± 3	± 4	± 6	± 8	± 10	± 12	± 14	± 16
C	± 1	± 3	± 4	± 6	± 8	± 11	± 14	± 18	± 21	± 24	± 27

5.2.3 General tolerances for angular dimensions

The general tolerances for angular dimensions are specified in SN 200-4:2022-06.

6 Inspection

Flame-cut and bent parts shall be checked by the manufacturer for compliance with the specified dimensions and angles. The manufacturer shall also inspect the surface quality (height of the profile Rz5) of flame-cut faces. Documenting of the inspections is not required.

Bibliography

SN 600-1:2020-04 Piping class; Fundamentals

Revisions

Amendments made in comparison with SN 200-3:2016-05:

Editorial changes:	Introduction added Updated normative references; Figures in sections 4.2 and 4.4 adapted to DIN EN ISO 9013:2017-05
Section 3	Terms adapted according to SN 600-1
Section 5.2	Note added "…preferred over welding on pipe bends or using detachable connections (e.g. angular pipe couplings)…"
Section 5.2.1	Bending radii according to DIN 2413 added. Roundness deviation for cold-bent pipe adjusted to ≤ 6%

Previous editions

SN 200:1971-09, 1975-11,1978-01, 1981-01,1985-01, 1992-03, 1996-03, 1999-09, 2003-09, 2007-02, 2010-09
SN 200-3:2016-05