TOLERANCE STANDARD

This document sets out the dimensional and geometric tolerances applied and observed by the TMA group.

It is used when no overall specifications or tolerances are indicated in the drawing.

It also sets out good design practices and the inspection methods for cut and bent parts.

It refers to industry standards ISO and NF EN for the different processes. Unless otherwise indicated, the dimensions stated are in millimetres (*mm*)

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I. CUTTING

The TMA group uses 7 cutting processes adapted to different thickness.

- Oxycutting (8 - 300 *mm* thick)
- Plasma cutting (0.5 to 45 *mm*)
- Laser cutting (0.5 to 25 *mm*)
- Water jet cutting (0.5 to 280 *mm*)
- Punching (0.5 to 5 *mm*)
- Machining (part measuring 3000 x 800 *mm* maximum)
- Sawing (section 450 x 450 *mm* maximum)

1. Dimensional tolerances

The tolerances stated here do not include the starting point, which is to be treated as a defect inherent to the process that is independent from dimensional tolerances. For information about measuring a dimension, please refer to paragraph **VI.4: Measurements for cutting.**

The following tolerance tables are indicated for metal cutting:

LASER CUTTING								***ISO 9013 CLASS 1***		
Sheet thickness in *mm*	Nominal dimensions in *mm*									
	0 to 3 exclusive	3 to 10	10 to 35	35 to 125	125 to 315	315 to 1000	1000 to 2000	2000 to 4000	4000 to 6000	6000 to 8000
	Tolerances in *mm*									
0 to 1 inclusive	± 0.075	± 0.1	± 0.1	± 0.2	± 0.2	± 0.3	± 0.4	± 0.65	± 0.9	± 1.6
1 to 3.15	± 0.1	± 0.15	± 0.2	± 0.25	± 0.25	± 0.35	± 0.4	± 0.65	± 1	± 1.75
3.15 to 6.3	± 0.2	± 0.2	± 0.25	± 0.25	± 0.3	± 0.4	± 0.45	± 0.7	± 1.1	± 1.9
6.3 to 10	—	± 0.25	± 0.3	± 0.3	± 0.35	± 0.45	± 0.55	± 0.75	± 1.25	± 2.2
10 to 15	—	± 0.3	± 0.35	± 0.4	± 0.45	± 0.55	± 0.65	± 0.85	± 1.5	± 2.5
15 to 20	—	± 0.4	± 0.4	± 0.45	± 0.55	± 0.75	± 0.85	± 1.2	± 1.9	± 2.8
20 to 25	—	± 0.45	± 0.5	± 0.6	± 0.7	± 0.9	± 1.1	± 1.6	± 2.4	± 3.25
25 to 32	—	—	± 0.7	± 0.7	± 0.8	± 1	± 1.6	± 2.25	± 3	± 4
32 to 50	—	—	± 0.7	± 0.7	± 0.8	± 1	± 1.6	± 2.5	± 3.8	± 5

WATER JET	***Quality 3 - Internal standard***			
Sheet thickness in *mm*	Nominal dimensions in *mm*			
	0.5 to 30 inclusive	30 to 120	120 to 400	400 to 3000
0 to 10 inclusive	± 0.1	± 0.15	± 0.2	± 0.5
10 to 50	± 0.15	± 0.3	± 0.4	± 0.8
50 to 100	± 0.3	± 0.5	± 0.8	± 1.4

OXYCUTTING AND PLASMA CUTTING										***ISO 9013: 2017 CLASS 2***
Sheet thickness in *mm*	Nominal dimensions in *mm*									
	0 to 3 exclusive	3 to 10	10 to 35	35 to 125	125 to 315	315 to 1000	1000 to 2000	2000 to 4000	4000 to 6000	6000 to 8000
	Tolerances in *mm*									
thickness 6.3 to 10	—	± 1	± 1.1	± 1.3	± 1.4	± 1.5	± 1.6	± 1.7	± 1.9	± 2
10 to 15 inclusive	—	± 1.8	± 1.8	± 1.8	± 1.9	± 2.3	± 3	± 4.2	± 4.3	± 4.5
15 to 20	—	± 1.8	± 1.8	± 1.8	± 1.9	± 2.3	± 3	± 4.2	± 4.3	± 4.5
20 to 25	—	± 1.8	± 1.8	± 1.8	± 1.9	± 2.3	± 3	± 4.2	± 4.3	± 4.5
25 to 32	—	± 1.8	± 1.8	± 1.8	± 1.9	± 2.3	± 3	± 4.2	± 4.3	± 4.5
32 to 50	—	± 1.8	± 1.8	± 1.8	± 1.9	± 2.3	± 3	± 4.2	± 4.3	± 4.5
50 to 100	—	—	± 2.5	± 2.5	± 2.6	± 3	± 3.7	± 4.9	± 5.3	± 5.6
100 to 150	—	—	± 3.2	± 3.3	± 3.4	± 3.7	± 4.4	± 5.7	± 6.1	± 6.4
150 to 200	—	—	± 4	± 4	± 4.1	± 4.5	± 5.2	± 6.4	± 6.8	± 7.1
200 to 250	—	—	—	—	—	± 5.2	± 5.9	± 7.2	± 7.6	± 7.9
250 to 300	—	—	—	—	—	± 6	± 6.7	± 7.9	± 8.3	± 8.6

PUNCHING			***DIN 6930 - m***
Nominal dimensions in *mm*	Sheet thickness in mm		
	0 to 1 inclusive	1 to 3	3 to 6
0 to 6 inclusive	± 0.1	± 0.15	± 0.2
6 to 10	± 0.15	± 0.2	± 0.25
10 to 25	± 0.2	± 0.25	± 0.3
25 to 63	± 0.25	± 0.3	± 0.4
63 to 160	± 0.3	± 0.4	± 0.5
160 to 400	± 0.5	± 0.6	± 0.6
400 to 1000	± 0.8	± 0.8	± 1
1000 to 6300	± 1.2	± 1.5	± 1.5

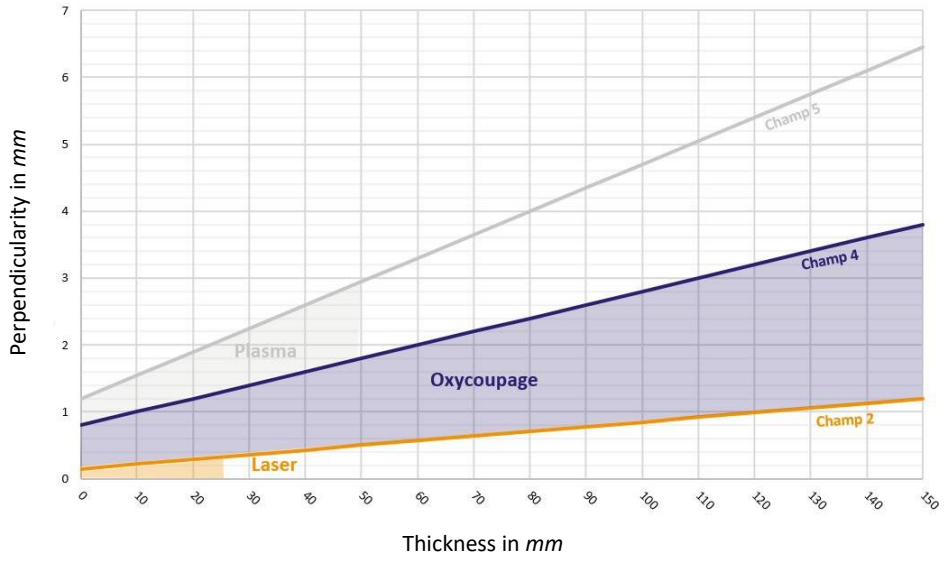
MACHINING							***ISO 2768-m***
Nominal dimensions in *mm*							
0.5 to 3 inclusive	3 to 6	6 to 30	30 to 120	120 to 400	400 to 1000	1000 to 2000	200 to 4000
Tolerances in *mm*							
± 0.1	± 0.1	± 0.2	± 0.3	± 0.5	± 0.8	± 1.2	± 2

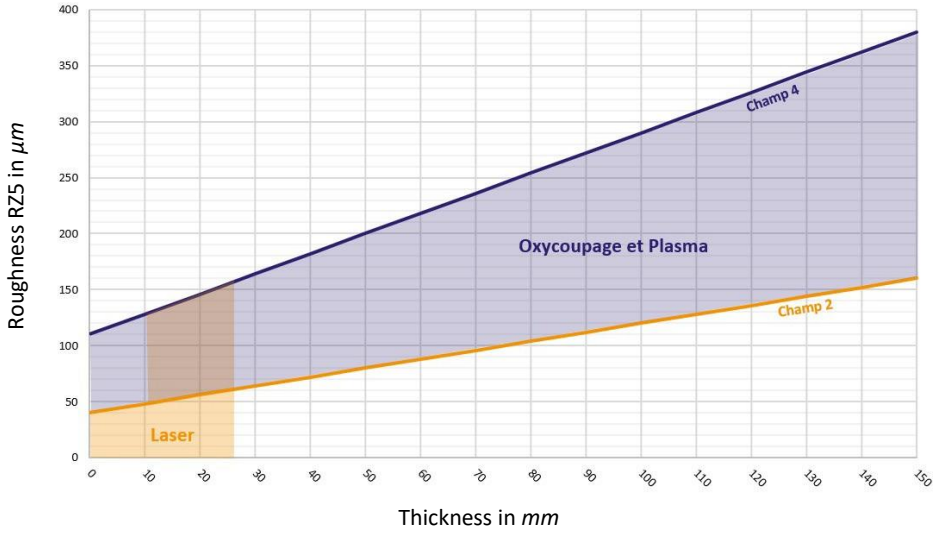
BAND SAWING	*Internal standard*
Lengths in *mm*	Tolerances in *mm*
0 to 1500 exclusive	± 0.3
1500 to 3000	± 0.6
3000 to 4500	± 0.9
4500 to 6000	± 1.2
6000 to 7500	± 1.5
7500 to 9000	± 1.8

2. Roughness/Perpendicularity

Perpendicularity and roughness of the cutting surfaces are derived from standard ISO 9013 relating to thermal cutting.

See paragraph **VI: Inspection indications** for measuring perpendicularity.



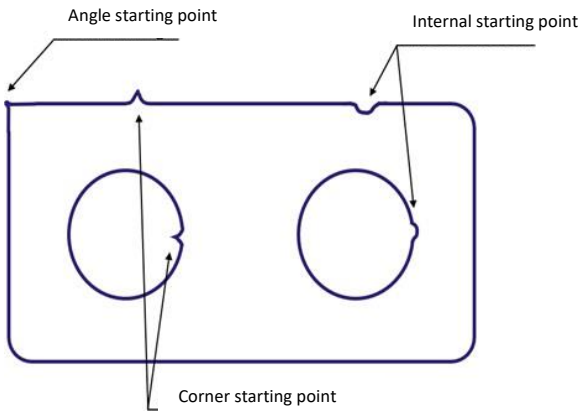


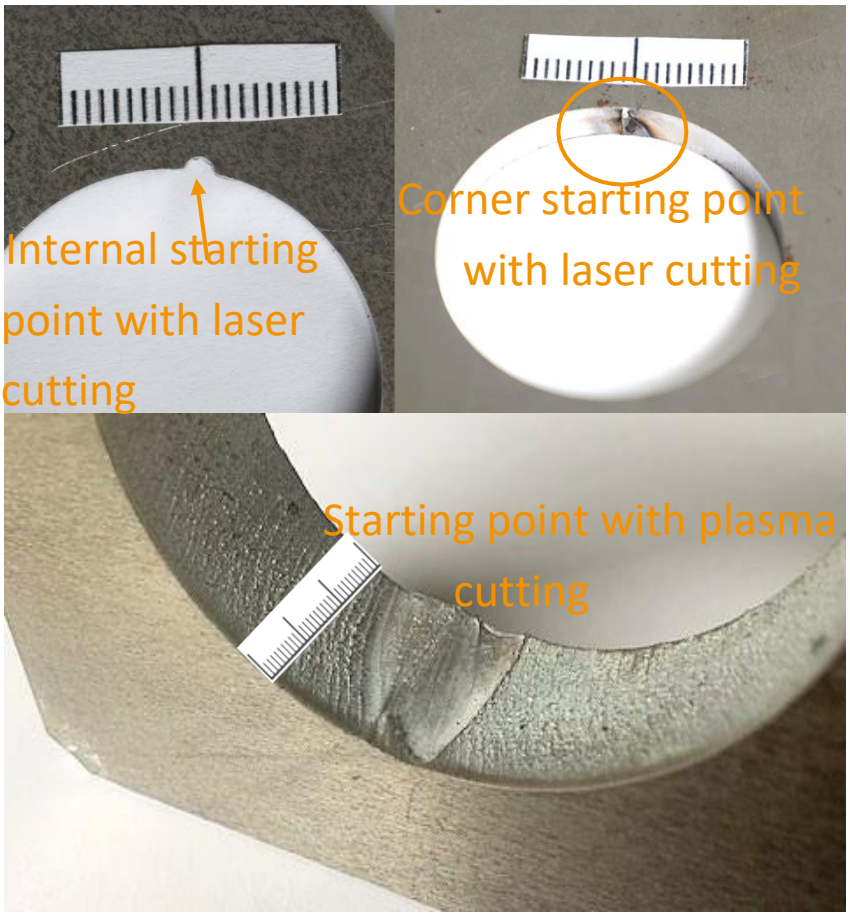
3. Cut edges (surface)

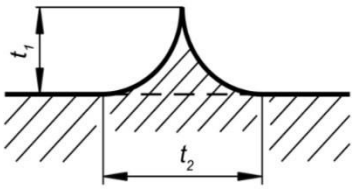
STARTING POINTS

A starting point is the place where the cutting of the part starts. Starting points can be found in all cuts, but their appearance depends on the selected process.

Starting points are inherent to cutting. However, the type of starting point and location can be selected to fulfil technical requirements.

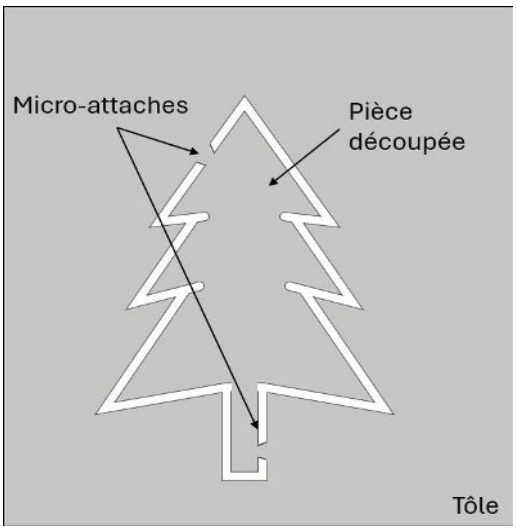






- With laser cutting, tt_1 = 0.4 *mm*
- With oxycutting, tt_1 = 2 *mm*
- With plasma cutting, tt_1 = 1 *mm*
- With water jet cutting, see **particularity of water jet cutting**

MICRO JUNCTIONS



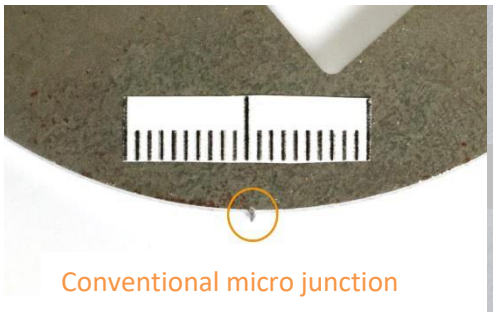
These junctions hold the parts in place during the **laser** or **water jet** cutting process, thus allowing precise high-quality cutting. However, micro junctions leave surplus material, which may be sharp. They are indispensable for parts measuring below 200x200 *mm* or 150x500 *mm* with **laser cutting** and parts with lengths below 150 *mm* with **water jet cutting**.

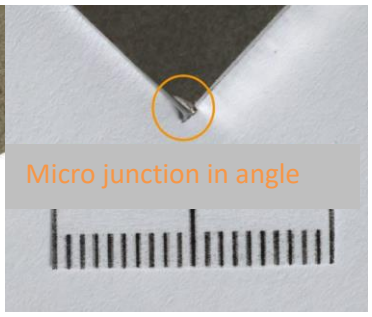
The length tt_1 of the micro junction is 1.5 *mm* with laser cutting, regardless of the size and shape of the part.

Even though the tab can be minimised by post processing, it is indispensable to take it into account while designing the part.

The location of the micro junction can be defined precisely at a place that is suitable for the technical needs of the part.

Laser programmers may for instance place the micro junction in the internal starting point; seen in previous paragraph.


Conventional micro junction


Micro junction in angle

DIFFERENT LASER CUTTING PROCESSES: OXYGEN AND NITROGEN

Oxygen cutting

Nitrogen cutting

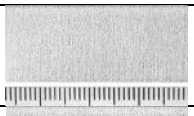
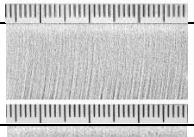
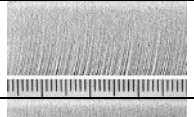
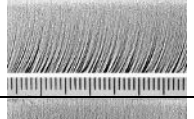
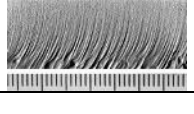
Laser cutting can use two different cutting gases, namely nitrogen and oxygen. Oxygen cutting makes it possible to cut steels up to 25 *mm* thick. It leaves behind a layer of oxide and calamine, black in colour, as in the photograph above.

Calamine can be removed by vibratory finishing or sand blasting (see paragraph **IV: Finishing process**).

Nitrogen cutting is called 'white' cutting, meaning that the metal is not covered in oxide and calamine. However, the thickness of the material that can be cut using nitrogen is not as great as that using oxygen. Nitrogen cutting is chiefly used for making parts that are welded and painted.

PARTICULARITY OF WATER JET CUTTING

Water jet cutting may be carried out with five different cutting qualities, ranging from medium cutting (Q1) to very clean cutting (Q5).

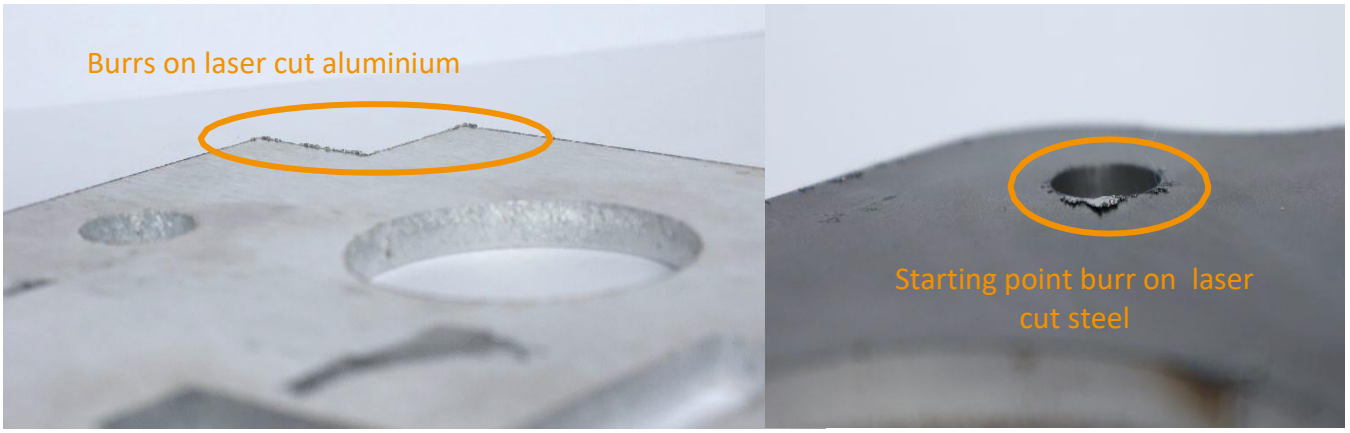
CUTTING QUALITIES				SN 214001
Quality level	Roughness Ra in µm	Perpendicularity error	Error at start and end of cut tt_1 and tt_2	Cut surface
Q5	3.2	< 0.05	< 0.1	
Q4	6.3	< 0.10	< 0.25	
Q3	12.5	< 0.20	< 0.5	
Q2	25	< 0.3	< 1	
Q1	50	> 0.3	> 1	

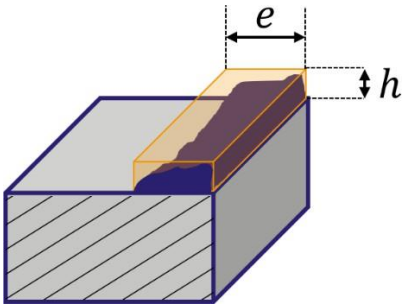
4. Edges

Each cutting process results in disparities of varying significance on the edge of the part. **Laser** and **water jet** cutting and **punching** lead to burrs. **Oxycutting** and **plasma** cutting create a protruding edge. It is important to know that edge defects are located on the underside.

BURRS

Laser cutting and **plasma cutting** result in burrs, which are droplets of molten metal that remain attached to the underside of the part.

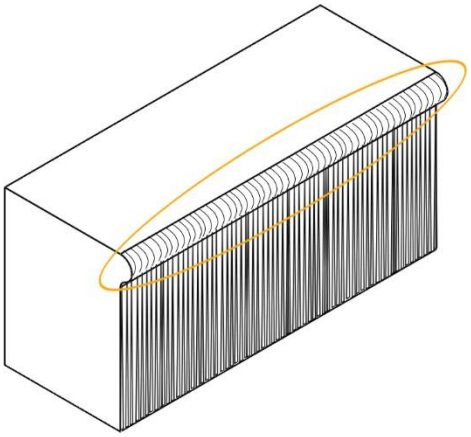




Punching burrs may not exceed **1/10th** of the sheet thickness.

PROTRUDING EDGES

Protruding edges are run-outs of the upper edge due to the high temperature used for cutting. They may run out over up to 2 *mm* depending on the thickness.



5. Minimum diameters achievable (excluding machining) according to internal standard

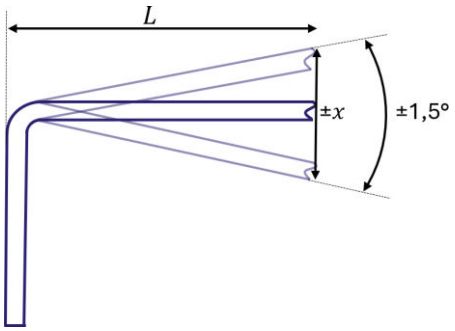
Steel																		
Thickness in *mm*		0.5	1	1.5	2	2.5	3	3.5	4	5	6	8	10	12	14	15	20	25
Min. Ø	OXYCUTTING															20	20	25
	LASER	1	1	1	1	1.5	1.5	2	2	2.5	2.5	3.5	4	5	7	8	12	
	PLASMA										7	9	11	14	16	17	22	28
	WATER JET		2	2	2	2	2	3	3	3	3	4	4	4	4	4	4	4
	PUNCHING	0.5	1	1.5	2	2.5	3	3.5	4	5								
Thickness in *mm*		30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
Min. Ø	OXYCUTTING	30	35	35	35	40	40	40	45	45	50	50	50	50	60	60	60	60
	PLASMA	33	39	44	50													
	WATER JET	4	4	5	5	5	5	6	6	6	6	8	8	8	8	10	10	10
Thickness in *mm*		115	120	125	130	135	140	145	150	160	170	180	200	220	240	260	280	300
Min. Ø	OXYCUTTING	60	60	70	70	70	70	70	70	80	80	80	80	80				
	WATER JET	10	10	10	10	10	10	10	15	15	15	15	20	20	20	20	20	20

Other grades to analyse depending on different processes and machine characteristics (CO2, fibre etc.)

II. BENDING

1. Tolerances for angles

Permissible deviations for angular dimensions NF E02-352 medium class (m)	± 1.5°



The dimensional tolerance x on the bend can be found using the formula below:

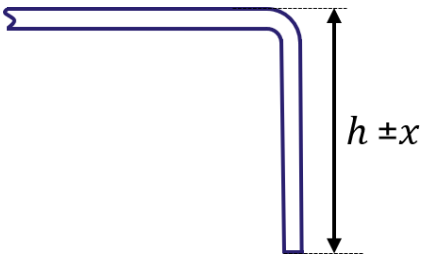
$$x = LL \times \tan(1.5°)$$

Where L = 1 metre: $x = 1 \times \tan(1.5°) = 0.026\ m = 26\ mm.$

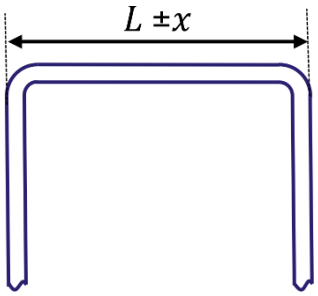
The tolerance for 1 metre is thus ±26 mm.

2. Tolerances for bent edge

Height of a bent edge			***NF E02-352 Normal class (n)***		
Nominal dimensions in *mm*	Thickness in *mm*				
	0.1 to 0.35 included	0.35 to 1	1 to 3	3 to 6	6 to 10
1 to 6 inclusive	± 0.3	± 0.3	± 0.4	—	—
6 to 10	± 0.3	± 0.3	± 0.4	± 0.6	—
10 to 25	± 0.4	± 0.4	± 0.5	± 0.6	± 0.8
25 to 63	± 0.5	± 0.5	± 0.6	± 0.7	± 0.8
63 to 160	± 0.6	± 0.6	± 0.7	± 0.7	± 1
160 to 400	± 0.7	± 0.7	± 0.8	± 0.8	± 1
400 to 1000	± 0.8	± 0.8	± 1	± 1.2	± 2
1000 to 3000	—	± 1.5	± 2	± 3	± 4



Tolerances between two bent edges			***NF E02-352 Normal class (n)***		
Nominal dimensions in *mm*	Thickness in *mm*				
	0.1 to 0.35 included	0.35 to 1	1 to 3	3 to 6	6 to 10
1 to 6 inclusive	± 0.4	± 0.4	± 0.5	—	—
6 to 10	± 0.4	± 0.4	± 0.5	—	—
10 to 25	± 0.5	± 0.5	± 0.5	± 0.7	—
25 to 63	± 0.6	± 0.6	± 0.6	± 0.8	± 0.9
63 to 160	± 0.7	± 0.7	± 0.8	± 0.9	± 1.2
160 to 400	± 0.8	± 0.8	± 0.9	± 1	± 1.4
400 to 1000	± 1	± 1	± 1	± 1.5	± 1.8
1000 to 3000	—	± 1.7	± 2	± 3	± 4

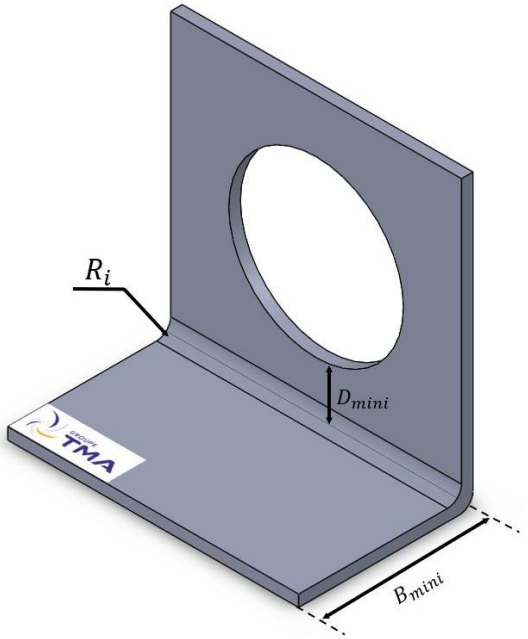


These tolerances are measured as indicated in paragraph **VI: Inspection indications**.

3. Feasibility and technical solutions

In order to provide high-quality service, the TMA group researches the feasibility of bending. Most of the bends made internally are air bends with a pointed punch, that is to say the sheet is not pushed against the bottom of the die. In order to produce specific shapes, we need to use appropriate tools. Also, deformation may occur when openings are located close to the bending area.

We present the different possibilities and solutions that address customers' needs.



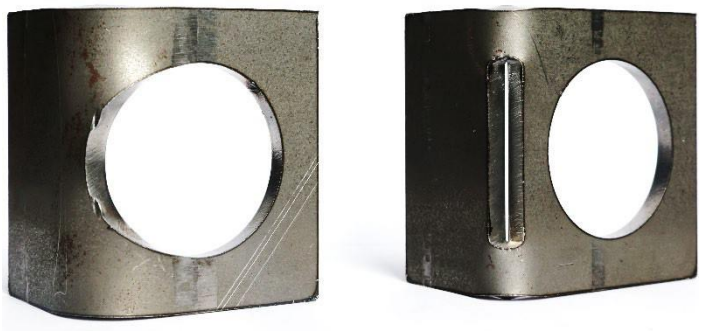
Feasibility, tolerances for radii and deformation for 90° air bent steel

B_{mini}	R_m	Thickness in *mm*																				D_{mini}	
		0.5	1	1.2	1.5	2	2.5	3	4	5	6	8	10	12	14	15	16	18	20	25	30	Perfect circles	Other shapes
2.9	0.6 ±1	■																				2.2	4.95
4.6	1 ±1	▒	▒	▒																			
5.8	1.2 ±1		■	▒	▒																	4.4	7.7
6.9	1.5 ±1		▒	■	▒																	5.5	8.8
8.1	1.8 ±1		▒	▒	■	▒																6.6	9.9
12.1	2.4 ±1				▒	■	▒	▒														8.8	13.2
13.8	3 ±1.5				▒	▒	■	▒														11	15.4
17.3	3.6 ±1.5					▒	▒	■	▒													13.2	18.7
21.9	4.5 ±1.5						▒	▒	▒	▒													
23.0	4.5 ±2							▒	■	▒												17.6	24.2
28.8	5.5 ±2							▒	▒	■	▒											22	29.7
36.8	6.8 ±2								▒	▒	■	▒										27.5	37.4
44	7.4 ±2									▒	▒	▒											
59	10 ±2.5											■	▒									44	58.3
71	13 ±3											▒	■	▒								55	70.4
84	15 ±3												▒	■	▒	■						66	82.5
113	20.4 ±4																▒	▒	▒				
145	25.5 ±4																▒	▒	■	■	▒	110	140.8

▒	Bend achievable
■	Boundary area guaranteed free from deformation

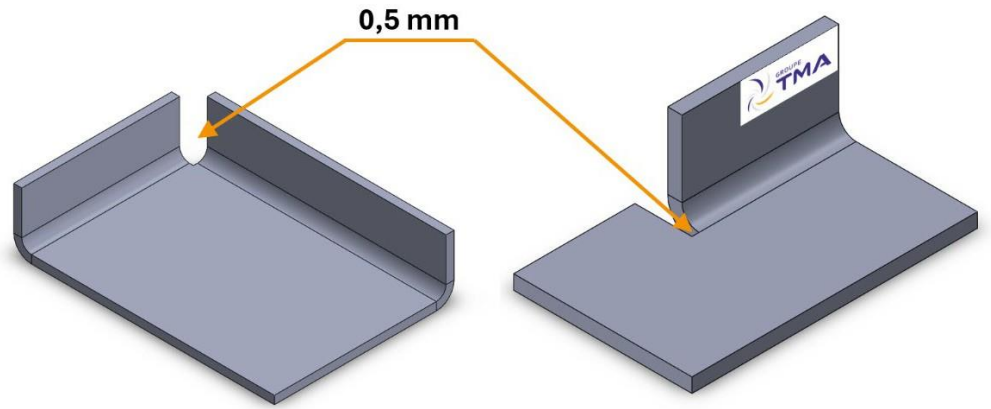
Let us take the example of a 3 *mm* thick sheet; there are 6 ways of making the bend. If we take $B_{mini} = 17.3\ mm$ with a radius 3.6 ±1.5 *mm*, a 13.2 *mm* hole can be placed in the bend area with no deformation.

Another solution to avoid the deformation of holes is to make a cut in the bend line. In that case, holes are no longer deformed, at the cost of reduced strength.



On the left, the hole is deformed by the bend; on the right, the hole is protected by the cut

We recommend leaving 0.5 *mm* between the flaps of 'box' type parts when they are designed. However, the two edges can be squeezed for sealing or for appearance reasons, but the bend takes longer to make.



III. WELDING

Standard ISO 13 920 specified here applies to welded constructions.

1. Dimensional tolerances

Dimensional tolerances for welding							***ISO 13 920 Class B***			
Nominal dimensions in *mm*										
2 to 30 included	30 to 120	120 to 400	400 to 1000	1000 to 2000	2000 to 4000	4000 to 8000	8000 to 12000	12000 to 16000	16000 to 20000	20000
± 1	± 2	± 2	± 3	± 4	± 6	± 8	± 10	± 12	± 14	± 16

2. Angular tolerances

Angular tolerances		***ISO 13 920 Class B***	
Nominal dimensions	Up to 400 inclusive	400 à1000	Above 1000
Tolerances in °	± 45’	± 30’	± 20’
Tolerances in *mm/m*	± 13	± 9	± 6

3. Straightness, flatness and parallel alignment

Straightness, flatness and parallel alignment for welding								***ISO 13 920 Class F***		
Nominal dimensions	30 to 120 included	120 to 400	400 to 1000	1000 to 2000	2000 to 4000	4000 to 8000	8000 to 12000	12000 to 16000	16000 to 20000	Above 20000
Tolerances	1	1.5	3	4.5	6	8	10	12	14	16

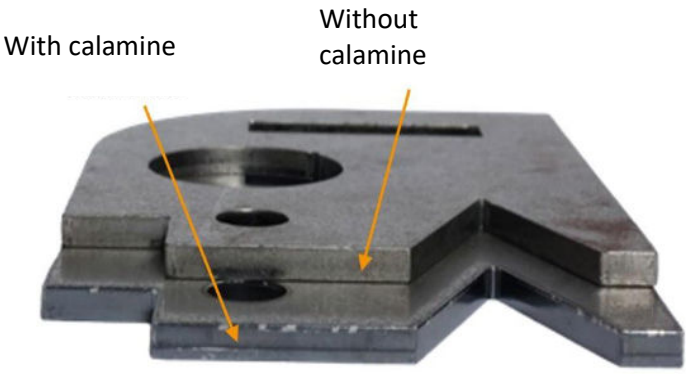
Flatness also depends on the material standard (see paragraph **V: Raw material**). The wider of the two must be taken into account in this case.

IV. FINISHING PROCESSES

The TMA group offers several finishing processes:

- **Sand blasting** consists in blasting sand at high speed on the part, which must be at least 8 *mm* thick.
  It is always applied on oxycut parts. Sand blasting cleans the part very thoroughly, removes calamine and guarantees Sa 2½ (very thorough) cleanliness according to standard ISO 8501-1.

- **Vibratory finishing** makes it possible to obtain less sharp edges (about 0.2 *mm* radius) and a cleaner surface. The parts (maximum 120 x 100 *mm*) are placed in a container filled with moving abrasive.
  Vibratory finishing also removes calamine on the perimeter of the part.



- **LISSMAC® deburring** cleans the surfaces of the part with abrasive belts. That rounds the edges and removes surplus material. We can obtain an edge radius of 0.5 mm which makes it less sharp and allows a potential coat to paint to adhere. Parts up to 1 *m* wide can be deburred.

- **Manual grinding** using an angle grinder

V. RAW MATERIAL

Thickness and flatness depend directly on the metal in which the part is cut. Each type of sheet is standardised, see paragraph **References** at the end of the standard for more details about standards and their area of application.

The **normal** tolerance class is used for each of the following standards. Two types of sheet will be available:

- Quarto sheets used mainly for oxycutting,

- sheets from coils used for laser cutting and punching.

Quarto sheets for oxycutting		
Material description	**Chemical composition**	**Dimensional tolerances for thickness and flatness**
S235JR S235JRG1 S235JRG2 S235JO S355J2G3 S355J2G3C	NF EN 10 025	NF EN 10 029
S 690QL	NF EN 10025-2	NF EN 10 029
P265 to P690	NF EN 10 028	NF EN 10 029

Uncoiled sheets for laser cutting and punching		
Material description	**Chemical composition**	**Dimensional tolerances for thickness and flatness**
S235JR S235JRG1 S235JRG2 S235JO S355J2G3 S355J2G3C	NF EN 10 025	NF EN 10 051
S315MC to S700MC	NF EN 10 149	NF EN 10 051
DD11	NF EN 10 111	NF EN 10 051
P265 to P690	NF EN 10 028	NF EN 10 051
DC01 DC03 DC04	NF EN 10 130	NF EN 10 031
DC01+ZE DC03+ZE DC04+ZE	NF EN 10 152	NF EN 10 031
DX51D+Z DX52D+Z DX53D+Z DX54D+Z	NF EN 10 327	NF EN 10 143
301 (1.4310) 304-304L (1.4301-1.4307) 316L (1.4404) 316TI (1.4571) 321 (1.4541) 410-420 (1.4021) 430 (1.4016) 310 (1.4845)	NF EN 10 088	NF EN ISO 9445

1. Quarto steel sheets for oxycutting

- S235/S355 and variants
- S690QL
- P265 to P690

THICKNESS TOLERANCES					NF EN 10 029			
Nominal thickness	Class A		Class B		Class C		Class D	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
3 to 5 exclusive	- 0.3	+ 0.7	- 0.3	+ 0.7	0	+ 1.00	- 0.5	+ 0.5
3 to 8	- 0.4	+ 0.8	- 0.3	+ 0.9	0	+ 1.20	- 0.6	+ 0.6
8 to 15	- 0.5	+ 0.9	- 0.3	+ 1.1	0	+ 1.40	- 0.7	+ 0.7
15 to 25	- 0.6	+ 1	- 0.3	+ 1.3	0	+ 1.60	- 0.8	+ 0.8
25 to 40	- 0.7	+ 1.3	- 0.3	+ 1.7	0	+ 2.00	- 1	+ 1
40 to 80	- 0.9	+ 1.7	- 0.3	+ 2.3	0	+ 2.60	- 1.3	+ 1.3
80 to 150	- 1.1	+ 2.1	- 0.3	+ 2.9	0	+ 3.20	- 1.6	+ 1.6
150 to 250	- 1.2	+ 2.4	- 0.3	+ 3.3	0	+ 3.60	- 1.8	+ 1.8
250 to 400	- 1.3	+ 3.5	- 0.3	+ 4.5	0	+ 4.80	- 2.4	+ 2.4

FLATNESS			NF EN 10 029	
Nominal thickness in *mm*	Steel quality L		Steel quality H	
	Measurement length in *mm*			
	1000	2000	1000	2000
3 to 5 exclusive	9	14	12	17
5 to 8	8	12	11	15
8 to 15	7	11	1	14
15 to 25	7	10	10	13
25 to 40	6	9	9	12
40 to 250	5	8	8	12
250 to 400	6	9	9	13
L quality: products with minimum elastic limit specified ≤ 460 N/mm², not quenched or quenched and tempered				
H quality: products with minimum elastic limit specified > 460 N/mm2 and < 700 N/mm2, and products in all grades, quenched and quenched and tempered.				

2. Uncoiled steel sheets for laser cutting and punching

- S235/S355 and variants
- S315MC to S700MC
- DD11
- P265 to P690

THICKNESS TOLERANCES							NF EN 10 051	
Re ≤ 300MPa Category A and 300 < Re ≤ 360MPa Category B								
Nominal thickness in *mm*	Tolerances for nominal width in *mm*							
	≤ 1200		1200 to 1500 inclusive		1500 à1800		> 1800	
	A	B	A	B	A	B	A	B
≤ 2	± 0.17	± 0.2	± 0.19	± 0.22	± 0.21	± 0.24	—	—
2 to 2.5 inclusive	± 0.18	± 0.21	± 0.21	± 0.24	± 0.23	± 0.26	± 0.25	± 0.29
2.5 to 3	± 0.2	± 0.23	± 0.22	± 0.25	± 0.24	± 0.28	± 0.26	± 0.3
3 to 4	± 0.22	± 0.25	± 0.24	± 0.28	± 0.26	± 0.3	± 0.27	± 0.31
4 to 5	± 0.24	± 0.28	± 0.26	± 0.3	± 0.28	± 0.32	± 0.29	± 0.33
5 to 6	± 0.26	± 0.3	± 0.28	± 0.32	± 0.29	± 0.33	± 0.31	± 0.36
6 to 8	± 0.29	± 0.33	± 0.3	± 0.35	± 0.31	± 0.36	± 0.35	± 0.4
8 to 10	± 0.32	± 0.37	± 0.33	± 0.38	± 34	± 0.39	± 0.4	± 0.46
10 to 12.5	± 0.35	± 0.4	± 0.36	± 0.41	± 0.37	± 0.43	± 0.43	± 0.49
12.5 to 15	± 0.37	± 0.43	± 0.38	± 0.44	± 0.4	± 0.46	± 0.46	± 0.53
15 to 25	± 0.4	± 0.46	± 0.42	± 0.48	± 0.45	± 0.52	± 0.5	± 0.58

FLATNESS						NF EN 10 051
Re ≤ 300MPa Category A and 300 < Re ≤ 360MPa Category B						
Thickness in *mm*	Tolerances for nominal width in *mm*					
	≤ 1200		1200 to 1500		> 1500	
	A	B	A	B	A	B
≤ 2	18	18	20	23	25	28
2 to 25	15		18		23	

3. Hot dip galvanised steel sheets

THICKNESS TOLERANCES						NF EN 10 143
Thickness in *mm*	Tolerances for nominal width in *mm*					
	≤ 1200		1200 to 1500 inclusive		> 1500	
	Re < 260MPa	260 ≤ Re < 360	Re < 260MPa	260 ≤ Re < 360	Re < 260MPa	260 ≤ Re < 360
0.2 to 0.4 inclusive	± 0.04	± 0.05	± 0.05	± 0.06	± 0.06	± 0.07
0.4 to 0.6	± 0.04	± 0.05	± 0.05	± 0.06	± 0.06	± 0.07
0.6 to 0.8	± 0.05	± 0.06	± 0.06	± 0.07	± 0.07	± 0.08
0.8 to 1	± 0.06	± 0.07	± 0.07	± 0.08	± 0.08	± 0.09
1 to 1.2	± 0.07	± 0.08	± 0.08	± 0.09	± 0.09	± 0.11
1.2 to 1.6	± 0.1	± 0.11	± 0.11	± 0.12	± 0.12	± 0.14
1.6 to 2	± 0.12	± 0.14	± 0.13	± 0.15	± 0.14	± 0.16
2 to 2.5	± 0.14	± 0.16	± 0.15	± 0.17	± 0.16	± 0.18
2.5 to 3	± 0.17	± 0.19	± 0.17	± 0.2	± 0.18	± 0.2
3 to 5	± 0.2	± 0.22	± 0.2	± 0.24	± 0.21	± 0.25
5 to 6.5	± 0.22	± 0.24	± 0.22	± 0.25	± 0.23	± 0.26

FLATNESS TOLERANCES						NF EN 10 143
Thickness in *mm*	Tolerances for nominal width in *mm*					
	≤ 1200		1200 to 1500 inclusive		> 1500	
	Re < 260MPa	260 ≤ Re < 360	Re < 260MPa	260 ≤ Re < 360	Re < 260MPa	260 ≤ Re < 360
< 0.7	± 10	± 13	± 12	± 15	± 17	± 20
0.7 to 1.6 exclusive	± 8	± 10	± 10	± 13	± 15	± 19
1.6 to 3	± 8	± 10	± 10	± 13	± 15	± 19
3 to 6.5	± 15	± 18	± 18	± 25	± 23	± 28

4. Cold rolled steel sheets for cold forming and electro-galvanised sheets

- DC01(+ ZE)
- DC03 (+ ZE)
- DC04 (+ ZE)

THICKNESS TOLERANCES					NF EN 10 131	
Nominal thickness in *mm*	Tolerances for nominal width in *mm*					
	≤ 1200		1200 to 1500 inclusive		> 1500	
	Re < 260MPa	260 ≤ Re < 340	Re < 260MPa	260 ≤ Re < 340	Re < 260MPa	260 ≤ Re < 340
0.35 to 0.4 inclusive	± 0.03	± 0.04	± 0.04	± 0.05	± 0.05	± 0.06
0.4 to 0.6	± 0.03	± 0.04	± 0.04	± 0.05	± 0.05	± 0.06
0.6 to 0.8	± 0.04	± 0.05	± 0.05	± 0.6	± 0.06	± 0.07
0.8 to 1	± 0.05	± 0.06	± 0.6	± 0.07	± 0.07	± 0.08
1 to 1.2	± 0.06	± 0.07	± 0.7	± 0.08	± 0.08	± 0.1
1.2 to 1.6	± 0.08	± 0.09	± 0.9	± 0.11	± 0.1	± 0.12
1.6 to 2	± 0.1	± 0.12	± 0.11	± 0.13	± 0.12	± 0.14
2 to 2.5	± 0.12	± 0.14	± 0.13	± 0.15	± 0.14	± 0.16
2.5 to 3	± 0.15	± 0.17	± 0.15	± 0.18	± 0.16	± 0.18

FLATNESS TOLERANCES					NF EN 10 131	
Nominal thickness in *mm*	Tolerances for nominal width in *mm*					
	600 to 1200 exclusive		1200 to 1500		≥1500	
	Re < 260MPa	260 ≤ Re < 340	Re < 260MPa	260 ≤ Re < 340	Re < 260MPa	260 ≤ Re < 340
< 0.7	10	13	12	15	17	20
0.7 to 1.2 exclusive	8	10	10	13	15	19
≥ 1.2	7	8	8	11	13	17

5. Stainless steels

THICKNESS ISO 9 445-2	
Nominal thickness	Tolerances
0.3 to 0.5 exclusive	± 0.04
0.5 to 0.6	± 0.05
0.6 to 0.8	± 0.05
0.8 to 1	± 0.06
1 to 1.2	± 0.07
1.2 to 1.5	± 0.8
1.5 to 2	± 0.09
2 to 2.5	± 0.1
2.5 to 3	± 0.12
3 to 4	± 0.14
4 to 5	± 0.15
5 to 6.5	± 0.15
6.5 to 8	± 0.17
Thickness measured more than 30 *mm* from the edge	

FLATNESS ISO 9 445-2	
LENGTH	TOLERANCES
< 3000	10
≥ 3000	12

6. Other raw materials

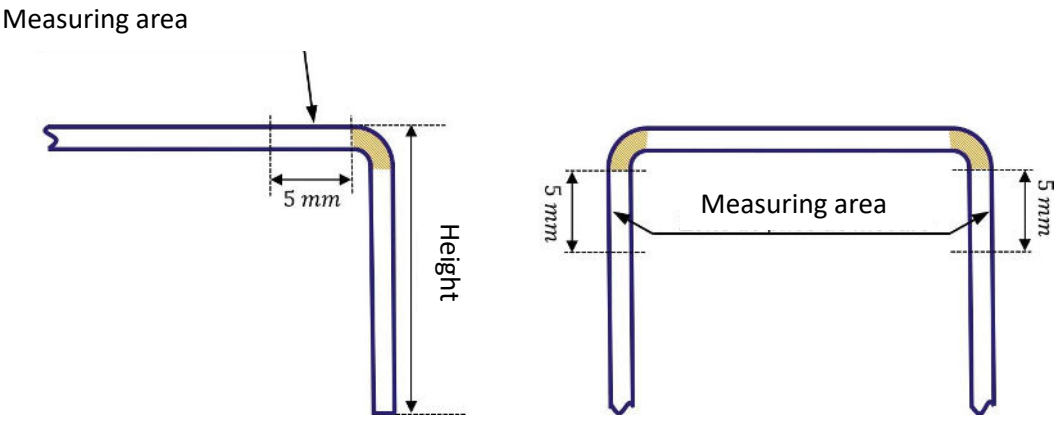
The tolerances for the bar steel raw materials used in our products are provided in the following standards.

- NF EN 10 056 for angles
- NF EN 10 058 for flat steel bars
- NF EN 10 059 for square steel bars

VI. INSPECTION INDICATIONS

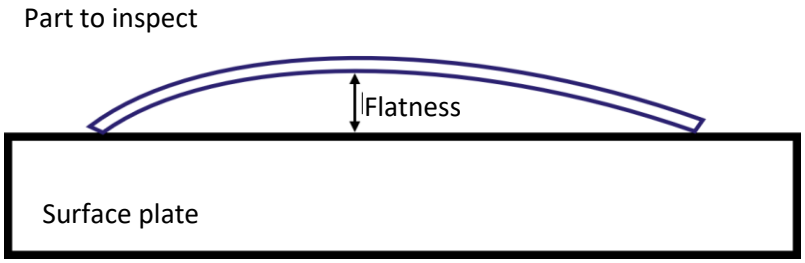
1. Bending

The measurement of a distance from one or both bent edges must be not affected by an angle error. The measurement must therefore be taken as close to the bend as possible, without being located in the rounded area. The measuring instrument must be located in the 5 *mm* area indicated in the drawings.



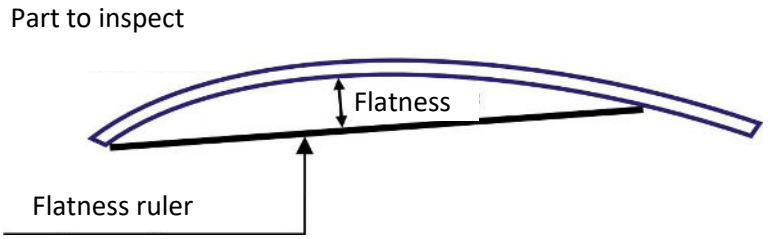
2. Flatness

If the surface plate or ruler is longer than the part, the measured distance is the absolute flatness error.



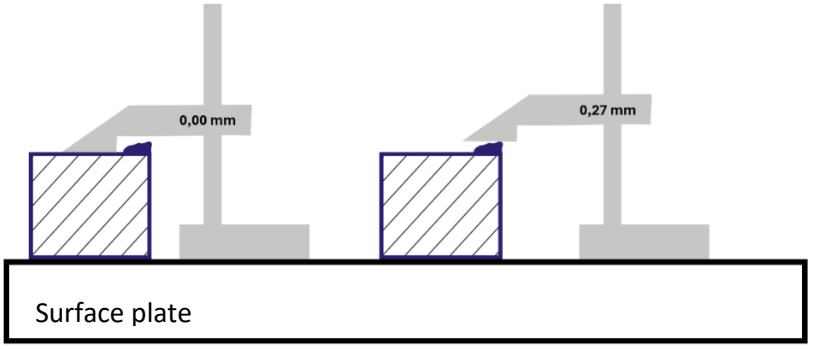
If the ruler is shorter than the part, the measured distance is the flatness error per unit of length of the ruler.

Example: the ruler is 1.5 m long and the error is 18mm. Thus, the flatness is $\frac{18}{1.5} = 12\text{mm/m}$.



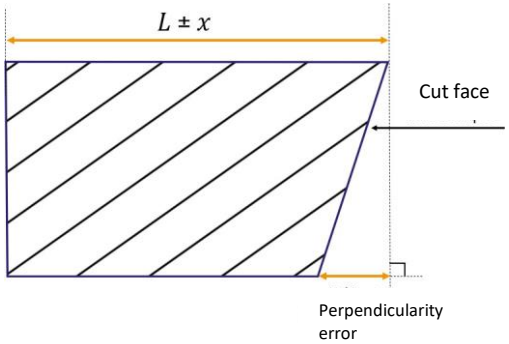
3. Burrs

Two measurements are made of burrs: height, which is measured using a surface gauge and depth, with a vernier calliper.



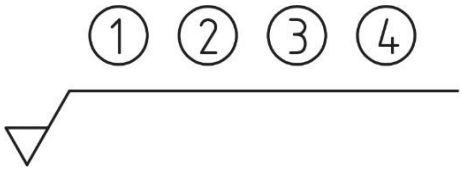
4. Measurements for cutting

Measurements must be made without taking account of perpendicularity errors or any defects on the edges (e.g. starting points).

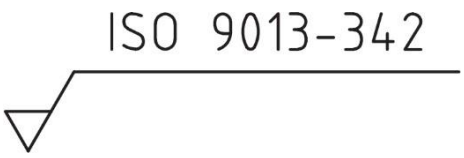


5. Information in technical documents

Quality indications of the cut face and the tolerance class. The quality and tolerance classes required for thermal cutting and water jet cutting must be indicated using the following symbols in accordance with ISO 1302 as follows:



① Indication of the main revision of this international standard
② Indication of perpendicularity or angle tolerances
③ Indication of the mean height of the Rz5 profile
④ Indication of the tolerance class



Example: The tables and the different quality classes of ISO 9013 are used. Reference is made to class 3 for perpendicularity and class 4 for roughness. Dimensional tolerances refer to class 2.

Quality classes are called “fields” in ISO 9013.

REFERENCES

ISO 9013: 2017 Standard for dimensional tolerances, perpendicularity and roughness of thermal cutting (oxycutting, plasma and laser)

SN 214001: 2010 Swiss standard for water jet cutting. Images of water jet cut surfaces are extracted from this standard.

ISO 2768 – 1: 1989 Standard for general dimensional tolerances

NF E02-352: 2013 Standard for general tolerances for bent cut parts

ISO 13920: 2023 Standard for general welding tolerances

ISO 8501-1: 2007 Standard for the quality of cleanliness of sand blasted parts

NF EN 10029: 2011 Standard for tolerances on dimensions and shape for hot rolled steel sheets 3 to 400 *mm* thick, 600 *mm* wide or above. It does not apply to stainless steels.

NF EN 10051: 2011 standard for tolerances on dimensions and shape for hot rolled alloyed and non-alloy steel sheets up to 25 *mm* thick, no more than 2200 *mm* wide.

NF EN 10143: 2006 Standard for tolerances on dimensions and shape for hot dip galvanised steel sheets.

ISO 9445-2: 2010 Standard for tolerances on dimensions and shape of cold-rolled stainless steel wide strip and plates/sheets with thickness between 0.3 to 8 *mm* and width 600 to 2100 *mm*.

NF EN 10056: 1994 Standard on angles in construction

NF EN 10058: 2018 Standard for flat bars in hot rolled steel.

NF EN 10059: 2004 Standard for square bars in hot rolled steel.

Version	Date	Modification	Written by	Reviewed by	Approved by
INS 033.5	18/11/2024	Document completely rewritten	M.GOERKE	F.MELHINGER	M.BLUNDEN