General Tolerances

For detailed tolerance information, see → UAB-24201 List of Standards "Tolerances“
→ Extract from standards 2010 (Swissmem)

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Area of applicability

This standard is valid for Bühler worldwide and for all production locations. The standards listed are minimum requirements.

General tolerances

General tolerances apply to dimensions that do not contain any details regarding required dimensional accuracy in the drawings. If smaller tolerances are required or larger tolerances are permitted and economical then these must be indicated in the drawing. The details specified in the following can be achieved within production without any special effort and must be observed.

1. Sheet metal forming

For the supplementary text on special machining and special treatment, see UZB-10018 (old/new names).
For incorporation of standards for the design of sheet metal materials, see UZK-40000.

1.1. Raw material specifications for sheet metal

These tolerances and specifications are required to ensure process reliability within production.

Sheet metal tolerances

a) Surface roughness for standard steel sheeting, scratch-free
≤8 mm = Ra 1.6 µm
≥10 mm = Ra 2 µm

b) Surface roughness for rustproof Cr-/Ni steels, scratch-free
≤6 mm = Ra 0.4 µm
≥8 mm = Ra 4 µm

c) Surface roughness for aluminium (only use EQ sheets)
The surface must be bright and there must be no visible faults during anodising.
DIN EN 485-1, Freedom from defects = section 5.2.4, Surface quality = para. 6.8

d) Flatness tolerance for standard steel sheeting/rustproof Cr-/Ni steels (limited flatness = FS).
See Material works standards, instructions with links.
Flatness tolerance for aluminium, see DIN EN 485-4 paragraph 4.2, table 7, figures 2 - 5.
Flatness must be so that there is no extra effort required during production.

1.2. Cutting process within sheet metal forming

This standard provides information on gas cut parts. In detail, it provides tolerances that can be achieved without extra effort during laser cutting, autogenous gas cutting and plasma cutting.

1.2.1. Laser cutting

Die clearance depending on settings, 0.1 - 0.25.

Area of application depending on the power of the laser.

Max. cutting power in	steel	25 mm
	rustproof steel	20 mm
	aluminium	12 mm

Cutting tolerances of surface/pipe laser cutting machine UZB-30031 page 1+2

Sheet thickness s	Linear measure						
	30	100	500	1000	2000	3000	4000
to 3	±0.1	±0.2	±0.2	±0.3	±0.4	±0.6	±0.8
3 - 6	±0.2	±0.2	±0.3	±0.4	±0.6	±0.8	±1.0
8 - 12	±0.2	±0.3	±0.4	±0.5	±0.8	±1.0	±1.0
15 - (20)	±0.3	±0.4	±0.5	±0.6	±1.0	±1.0	±1.2

Slight bevel cuts occur from 15 mm; however, these are insignificant.

Surfaces of the cut edges	≤10 mm	approx. R_a 3.2
	12 - 18 mm	approx. R_a 6.4
	≥20 mm	approx. R_a 12.5

1.2.2. Autogenes gas cutting

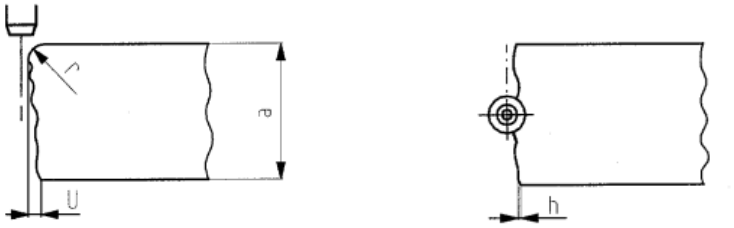
The cutting quality complies with standard DIN EN ISO 9013, Cutting Quality II, Degree of Accuracy B.

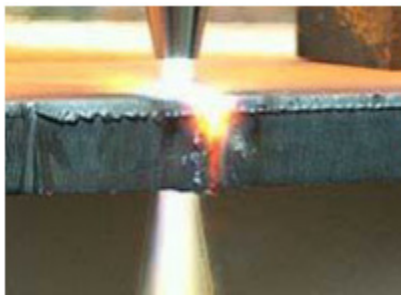
Thickness of workpiece	Nominal size range, outer/inner/centre distance			
	35 - 315	315 - 1000	1000 - 2000	2000 - 4000
to 50	±1.5	±2.5	±3	±3.5
>50 - 100	±2.5	±3.5	±4	±4.5

UZT-30003

Shape deviations from the right angle, from straight lines and in roundness are only permissible within the specified tolerances.

Cutting quality or permissible deviations





Thickness of workpiece a		Initial cutting radius **r** max.	Roughness **u** max.	Depth of drag line **h** max.
over	to			
	20	1	0.5	0.8
20	40	1.5	0.6	1
40	60	2	0.7	1.2
60	80	2.5	1.2	1.4
80	100	3	1.5	1.6

UZT-30003

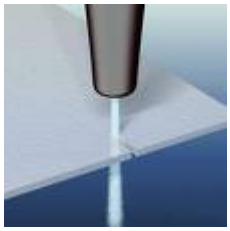
1.2.3. Plasma cutting

Plasma cutting is used for rustproof steels, high-alloy steels, aluminium and copper.
The disadvantage of plasma cutting is the angled cut, which is much larger than in autogenous gas cutting.

Length tolerances	1.5 - 70 mm	= outer 0/+3	inner 0/-3
	70 - 100 mm	= outer 0/+5	inner 0/-5

Angled cut 5 a = approx. 1 mm, 50 a = approx. 3 mm, 100 a = approx. 5 mm a (t) = cutting thickness

1.2.4. Waterjet cutting



Waterjet cutting is a cutting method using a waterjet that cuts the appropriate materials at approx. 4000 bar pressure. The die clearance is approx. 1 mm wide. The advantage is that this is a cold cutting process without heat influence on the cutting zone, edge hardening or structural change.

Depending on the application, pure waterjet cutting or abrasive waterjet cutting, the max. cutting thickness is 200 mm.

Depending on the material, thickness and quality requirements, the tolerances are between 0.1 and 0.5 mm.

1.2.5. Cropping, clipping, punching

General tolerances apply to dimensions that do not contain any details regarding required dimensional accuracy in the drawings. If smaller tolerances are required or larger tolerances are permitted and economical then these must be indicated in the drawing. The details specified in the following can be achieved within production without any special effort, but must be observed at all times (mandatory).

General tolerances, outer or inner (cropping, clipping) UZT-30005

Sheet thickness	Nominal size range			
	0 - 250	250 - 500	500 - 1000	1000 - 1500
0.5 - 3.0	±0.5	±0.8	±1.0	±1.2
3.5 - 8.0	±0.8	±1.0	±1.2	±1.5

General tolerances for straightness and flatness (from template) UZT-30005

Length areas	to 120	>120 - 400	>400 - 1000	>1000 - 2000	>2000 - 4000	>4000 - 8000
Tolerances	0.5	1.0	1.5	2.0	3.0	4.0

General tolerances outer or inner (punching) UZT-30005

Round holes and grooves		3 ≤8	>8 ≤25	>25 ≤50	>50 ≤100	>100 ≤250
Sheet thickness	0.5 <6	±0.2	±0.2	±0.3	±0.4	±0.5
	≥6 - 10	±0.2	±0.4	±0.6	±0.8	±1.0
Hole spacing 1)	1 - 500	±0.2	±0.4	±0.6	±1.0	±1.5
	501 - 1000	±0.4	±0.8	±1.2	±1.5	±2.0

1) For hole spacings for two holes from different hole width areas, the tolerance of the smaller hole width applies.

1.2.6. Deburring, trimming, rounding edges UZB-10015

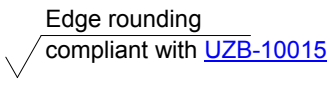
The burrs are removed when deburring.
Burrs are sharp edges, frays or splitters occurring during machining or production, usually caused by a metal workpiece. They may represent a considerable risk of injury.

Definition
Deburring is the breaking of edges from 0.3 - 0.5 mm to eliminate any residual risk of injury. Trimming includes cleaning of the surfaces, such as brushing welded joints or removing weld spatter, etc.

In case of rustproof parts and aluminium parts, deburring is always carried out after laser cutting, plasma cutting and nibbling.
Insert an additional process step in the operation plan. Deburring is not carried out after waterjet cutting.

It is the responsibility of the metalworker to make sure that the assembly he/she has produced is correctly deburred, rounded and trimmed compliant with Bühler specifications.

Drawing specifications



Sheet thickness	Rounding radius
1.0	0.3
1.5 - 2.5	0.5
3.0 - 5	1.0
6.0 - 10	1.5

1.3. Chipless sheet metal forming

1.3.1. Roll straightening

Steel parts subjected to thermal cutting processes must often be subsequently straightened to improve dimensional accuracy (internal stresses).
Roll straightening allows undesired tensions and unevennesses to be eliminated (distributed evenly).
The following should be noted:

- Possibilities are limited by the power and width of the machine.
- Depending on the material, roll straightening depends on the thickness (the higher the yield point, the smaller the parts for roll straightening).
- A clean roller surface is a requirement for sheet metals made of rustproof steels.

The flatness tolerance is to be taken from standard DIN ISO 2768-2, table 1, class L.

1.3.2. Folding

UZB-30044

- Of round pipes made of St 37 sheet plated
  Tolerance for longitudinal fold LF = 0.5 x (3 x FW +1)
  Aspiration structure UZB-30039

D		Sheet thickness	Longitudinal fold		Standing seam		Notch		
over	to		Fold width FW	Tolerance LF 1)	EB	DB	d	f.EB	F.DB
	180	0.56	7	11	5	10	7	6.5	11.5
180	350	0.75	8	12	6	12	7	7.5	13.5
350		1	9	14	7	14	9	8.5	15.5

1) Also applies to transitional element UZB-30045.

For conical transition pieces, the diameter **D** of the smaller cross-section is always decisive when determining the sheet thickness**.**

- Made of St 37 sheet plated (straight sheet metals, square pipe)

d		s
over	to	
	200	0,56
200	350	0.75
350		1

For conical transition pieces, the diameter **D** of the smaller cross-section is always decisive when determining the sheet thickness**.**

- Of transitional pieces made of St 37 sheet plated

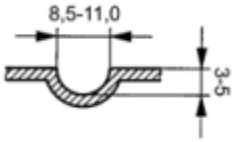
d		s
over	to	
	180	0,56
180	350	0,75
350		1

The diameter of the smaller cross-section is decisive when determining **s**.

1.3.3. Beads

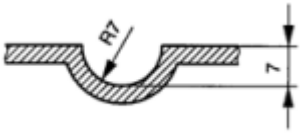
Beads are trough-shaped depressions in the sheet produced manually or by machine.

Flat part beads



	Sheet thicknesses
St 37	2 mm
St rustproof	1.5 mm
PE 300	3 mm
Pe 100 1/2 h	2 mm

Cylindrical part beads



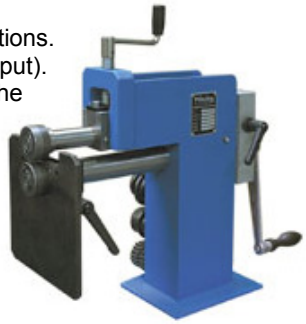
UZB-30030

	Sheet thicknesses
St 37	2.5 mm
St rustproof	1.5 mm
PE 300	2.5 mm
Pe 100 1/2 h	2 mm

The tolerances (linear and angular dimensions) are to be taken from standard specifications sheet UZT-30005. On request, the tolerances can also be defined compliant with DIN ISO 2768-1.

1.3.4. Curling

Curling is a forming method that bends open/closed the edge of a pipe according to specifications. This forming method is used on sheet thicknesses up to approx. 2 mm (depending on the output). It is used in pipe construction, ventilation systems, refrigeration, etc. The maximum angle of the bent edge is 90°.



The tolerances (linear and angular dimensions) are to be taken from standard specifications sheet UZT-30005. On request, the tolerances can also be defined compliant with DIN ISO 2768-1.

1.3.5. Spinning/pressing

Pressing compliant with DIN 8584 (metal spinning, shape pressing) is a production method within forming technology. Various rotational symmetric parts can be pressed into the required shape. The more accurate the pressing block, the more accurate the pressed part. The tolerances are to be taken from standard specifications sheet UZT-30005. On request, the tolerances can also be defined compliant with DIN ISO 2768-1.

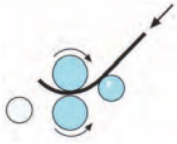
1.3.6. Rolling

Rounding is a forming method used to provide a third, rounded dimension to an initially two-dimensional structure (flat sheeting).

3-roller round bending machine

3-roller round bending machine with two bottom rollers and one top roller. The upper roller determines the radius, depending on the upwards/downwards adjustment between the 2 lower rollers. Here, approx. 200 mm must be bent in steps on each side, depending on the thickness of the roller and the size.

3 or 4-roller round bending machine



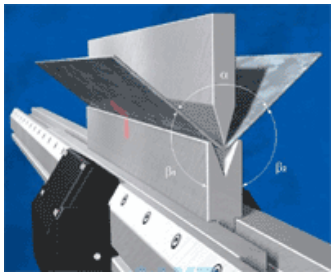
3- or 4-roller round bending machine with one top and bottom roller lying exactly on top of each other (tension rollers), and rollers to the side for circular bending.
Bending in steps is not required here. If a sheet is inserted at the lateral roller, it is precisely bent by the tensioning or adjusting rollers at the side

The sheet thickness and production width depend on the conditions of the rolling machine in question.

The tolerances for linear measures (e.g. outer/inner/shoulder dimensions, diameter, radii, clearances) are to be taken from the standard specifications sheet UZT-30005.

Tolerance class		Nominal size range in mm					
		≤50	50 - 120	120 - 400	400 - 1000	1000 - 200	2000 - 4000
		Limit deviations in mm					
Thickness ≤3	1	±0.5	±0.5	±0.8	±1.2	±1.5	±2.0
Thickness 4, 5, 6	2	±0.8	±1.0	±1.0	±1.5	±2.0	±2.5
Thickness ≥8	3		±1.2	±1.5	±2.0	±2.5	±3.0

1.3.7. Edging



The bending of sheet metal, also referred to as edging, is another forming method in sheet metal forming.

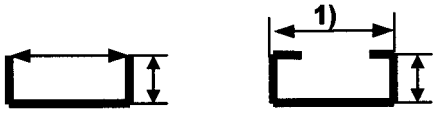
The following parameters must be observed:

- The minimum rounding/edging width of the bent component depends on the punch/die/sheet thickness combination (slipping off into the die). Refer to standard specifications sheet UZB-30000.

- Use of the correct die/punch combination. The radius must be indicated on the drawing. Refer to standard specifications sheet UZB-30008, DIN 6935.

- A simulation should be run if this is permitted by the controller.

The tolerances are to be taken from standard specifications sheet UZT-30005.



1) For a single and twin batch, the tolerance zone is increased by 0.5 mm.

Edging, bending, pressing (linear measures) UZT-30005

Tolerance classes		Nominal size range in mm					
		≤50	50 - 120	120 - 400	400 - 1000	1000 - 2000	2000 - 4000
		Limit deviations in mm					
Thickness ≤3	1	±0.5	±0.5	±0.8	±1.2	±1.5	±2.0
Thickness 4, 5, 6	2	±0.8	±1.0	±1.0	±1.5	±2.0	±2.5
Thickness ≥8	3		±1.2	±1.5	±2.0	±2.5	±3.0

Edging, bending, pressing (angular dimensions)

Tolerance classes		Nominal size range in mm (length of the shorter side piece)			
		≤50	50 - 120	120 - 400	>400
		Limit deviations in minutes (in mm per 100 mm)			
Thickness ≤3	1	±30‘/0.9	±30‘/0.9	±10‘/0.4	±0.5‘/0.3
Thickness 4, 5, 6	2	±45‘/1.3	±30‘/0.9	±15‘/0.5	±10‘/0.4
Thickness ≥8	3		±30‘/0.9	±15‘/0.5	±10‘/0.4

1.4. Metalworking/welding

For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).
For incorporation of standards for the design of sheet metal materials, see UZK-40000.

1.4.1. Machining mild steel (black sheet)

Metalworking/welding refers to assembling mild steel parts into assemblies, containers, etc.
The connections are all welded and can only be separated by local destruction of the component.

The following machining guidelines must be observed:

- Only use original drawings/documents.
- Only use original materials (if not obtainable, then clarify with the supervisor).
- Welding/tacking caliber must be used when available.
- Only use the prescribed filler metals, see UZR-21108.
- Preheating is required for special materials or workpiece thicknesses, see UZB-40001.
- Follow the welding instructions and implement the joint sizes of the appropriate welding designation, see UZS-10033.

Welding (Bühler standard)

- When no special instructions are marked on the drawing.
- Applies to DIN EN ISO 5817, welded connections **quality class C**.
- Applies to the names of the hollow welds DIN EN ISO 2553, **throat thickness a**.

Additional works standards for welding

Welding stud = UZN-10056
Resistance stud welding = UZS-20010
Weld quality levels = UZS-10034
General specifications = UZS-10030
Weld symbol = UZS-10031
Brazing = UZS-30000

Materials that must be prewarmed (mandatory)

Material	Temperature °C			
	>10 mm thickness	**10 - 25 mm** thickness	**25 - 50 mm** thickness	**>50 mm** thickness
St 52-3	---	---	100	200
St 50-2	100	200	300	300
CK 35	100	200	300	300
CK 45	100	200	300	300
16 MnCr5	100	200	300	300

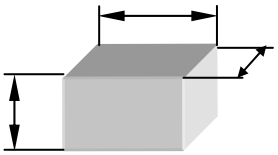
First piece inspection must be carried out compliant with mlmf0022 (mandatory)!

All checks must be carried out compliant with instruction mlmf0023, Checking samples!

The tolerances for welded structures in accordance to UZT-30006 are decisive.

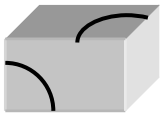
General tolerances for welded structures UZT-30006

Tolerances for linear dimensions



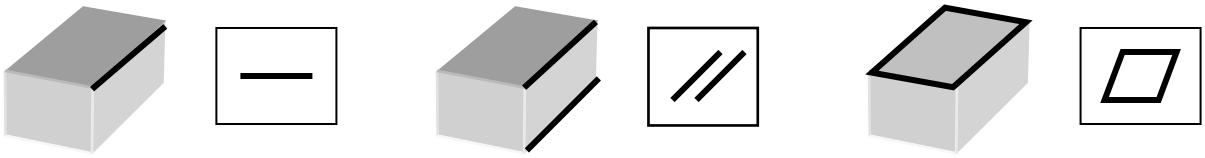
Tolerance class	Nominal size range **l** (in mm)					
	≤200	>200 - 400	>400 - 1000	>1000 - 2000	>2000 - 4000	>4000 - 8000
	Tolerances **t** in mm					
1	±1	±1,5	±2	±2,5	±3	±4

Tolerances for angular dimensions



Tolerance class	Nominal size range **l** (in mm)				
	≤100	>100 - 200	>200 - 400	>400 - 1000	>1000
	Tolerances **t** in mm				
1	±0.5	±1	±1.5	±2	±2.5

Straightness, parallelism and flatness tolerances



Straightness = Class 1 Parallelism = Class 1 Flatness = Class 2

Tolerance class	The nominal size range **l** (in mm) refers to the longer side of the surface					
	≤200	200 - 400	400 - 1000	1000 - 2000	2000 - 4000	4000 - 8000
	Tolerances **t** (in mm)					
1	1	1	1.5	2	3	4
2	1	1,5	3	4,5	6	8

Specifications for surface finishing/additional symbols

All surface finishing specifications must be observed (mandatory).

For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

Thickness of starting surface ≤8 mm, R_a < 1.6 µm Thickness of starting surface 10 mm, R_a <2.0 µm

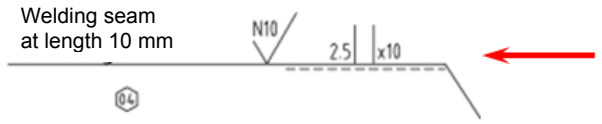
For powder coating without visible stress marks, an R_a value of **1.6** must be observed.
All stress marks from the previous deeper centre punch must be ground out.

	Manual sanding/polishing					
R_a value in µm	12.5	6.3	3.2	**1.6**	1.2	0.8
N value	N10	N9	N8	**N8/N7**	N7	N6
Grain	~20	~40	40	**80/100 1)**	120	150

1) When using orbital sanders the R_a value 1.6 can be achieved with K50 - K60.

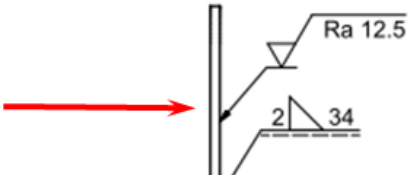
Unevenness (rippling/corrugation) can be prevented using orbital sanders.
CAUTION, the R_a value must be observed.
Old surface designations are located at UZB-10012, UZB-10013, UZB-10018.
New surface specifications are located at UZB-10014.
CAUTION, there are different grinding/sanding products on the market.

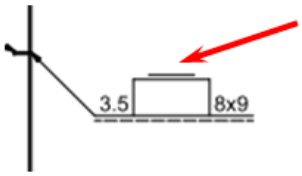
Specifications for processing of welded joint (old and new grinding specifications)

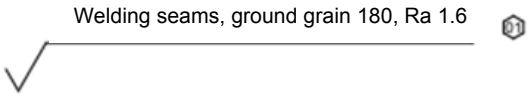


Specifications on the same line as the welding seam size

Grinding specifications in addition to the name of the welding seam with arrow towards the area in question

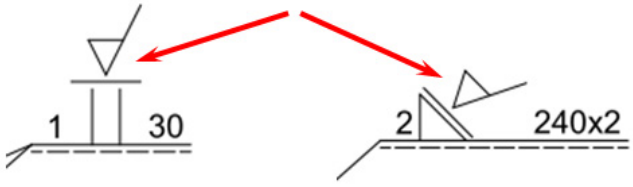


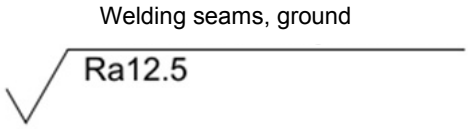




Plug weld with symbol – (normally reworked flat)

Grinding specifications as an additional specification on the drawing (minimum specs)





Name of welding seams with min. specifications – and expanded symbol indicating the required material removal.

Grinding specifications as an additional specification on the drawing.

For additional symbols, see UZS-10031, for graphic symbols, see DIN EN ISO 1302

1.4.2. Processing rustproof steel

The alloys of rustproof steels have been determined so that they are corrosion-proof without any additional coating.
The surfaces must therefore be appropriately protected during production to avoid possible damages (scratching, scoring).
All damage is subsequently visible.

Comply with the following processing guidelines:

- Only use original drawings/documents.
- Only use original materials (if not obtainable, then clarify with the supervisor).
- Welding/tacking caliber must be used when available.
- Only use the prescribed filler metals, see UZR-21108.
- Preheating is required for special metals or workpiece thicknesses, see UZB-40001.
- Follow the welding instructions and implement the joint sizes as indicated on the weld designation, see UZS-10037.
- Considerable welding distortion must be expected, above all in case of thin-walled, rustproof components.
- Construction and the work procedure must be implemented so that the material can always be straightened on conclusion, when necessary. This allows dimensional accuracy to be observed and visual demands to be met.
- All parts must be appropriately protected when being processed and during transport to ensure that they are not damaged.

The welding standard remains the same, as listed above. Observe the guideline compliant with UZB-10030.
The above-listed tolerances for welded structures applies, see UZT-30006.

The following instructions are decisive for production of 1.4003, X2CrNi12 ferritic, rustproof steel:
Qualities of 1.4003, see UZR-21034.

Specifications for surface finishing/additional symbols

All surface finishing specifications must be observed (mandatory).

The additional symbols are always the same.

Starting surface, cold-rolled R_a < 0.4 µm, Starting surface hot-rolled R_a < 400 µm

All stress marks from the previous deeper centre punch must be ground out.

	Manual sanding/polishing									
R_a value in µm	12.5	6.3	4.6	3.2	2.6	2.0	1.6	1.0	0.8	0.4
N value	N10	N9	N9	N8	N8	N8	N7	N7	N6	N5
Grain	20	40	60	80	120	150	180	220	240	400
Mechanical processing 1)	12.5	6.3	3.2	3.2	1.6	1.6	1.6	0.8	0.8	0.4

1) Required roughness value for the mechanical parts that are welded or installed onto rustproof assemblies.

Standard values when grinding for rustproof production are K150, K180, K220.
Min. R_a-value for glass blasting is = R_a 2/K150.
Min. R_a-value for glass blasting, with subsequent electrobrightening is = R_a 1/K220.

1.4.3. Processing aluminium

It has been determined that the alloys of aluminium must be corrosion-proof without any additional coating.
The surfaces must therefore be appropriately protected during production to avoid possible damages (scratching, scoring).
All damage is subsequently visible or the surfaces must be subsequently repaired with great effort.

Comply with the following processing guidelines:

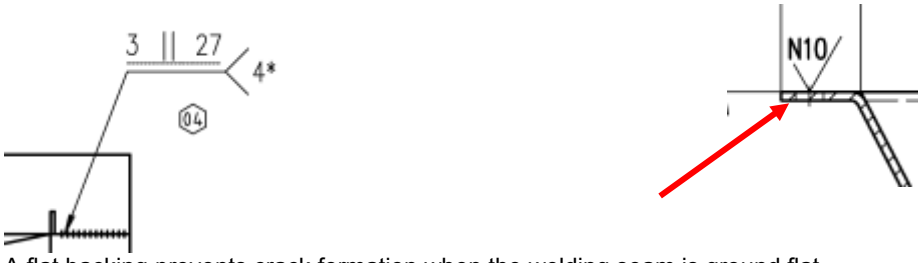
- Only use original drawings/documents.
- Only use original materials.
- Welding/tacking caliber must be used when available.
- Only use the prescribed filler metals, see UZR-21108.
- Preheating is required for special metals or workpiece thicknesses, see UZB-40001.
- Follow the welding instructions and implement the joint size as indicated on the weld designation, see UZS-10060.
- The welding distortion is extremely high for aluminium (significantly higher than for rustproof steel).
- Construction and the work procedure must be implemented so that the material can always be straightened on conclusion, when necessary. This allows dimensional accuracy to be observed and visual demands to be met.

All parts must be appropriately protected during processing (keep on the protective film for as long as possible).

The welding standard remains the same, as listed above. Observe guideline UZB-10030.
The above-listed tolerances for welded structures applies, see UZT-30006.

Surface finishing

If one side of thin-walled flanges or bent sheet metal collars needs to be ground flat then a flat backing should be welded to the edge of the flange. This prevents crack formation.



A flat backing prevents crack formation when the welding seam is ground flat.

1.4.4. Packaging, transport

Packaging must be designed to exclude any reduction in quality of the material/the product during transport.
Depending on transport, the goods must be provided secured/tied onto intact pallets.

The size of the pallet must be adjusted to the material/product. Protruding edges may result in transport damages.
The goods must be secured/tied so that they cannot slip.
When binding thin-walled products, a supporting base must be used to prevent the product from sagging.
Synthetic binding must be used for rustproof products.
A supporting base made of PE must be used for aluminium products; it is placed between the binding material and the product itself.
Corrosion-protection must be considered with regard to ambient temperature/damp and prolonged periods of transport.
The goods being conveyed must be clearly identified and addressed. The shop papers must always accompany the goods.
If transport containers exist then they must be used.
E.g. UNW-84009, UNW-84010, UNW-84011, UNW-84012, Wood-Prisma UNW-84003

2. Mechanical processing

For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

2.1. Specifications of raw materials, bars, sections

The specifications listed on the respective standard specifications sheets (UNR etc.) always apply with regard to the tolerances, qualities, etc., of the raw materials, bars and sections used, or the DIN, EN or ISO standards apply. UZR-11000 applies supplementary to the topic of machining allowances for sections.

2.2. Raw material specifications for casting

The specifications listed on the respective standard specifications sheets (UNR etc.) always apply with regard to the tolerances, qualities, etc., of the raw materials, bars and sections used, or the DIN, EN or ISO standards apply. UZR-11000 applies supplementary to the topic of machining allowances for sections.

For cast parts from dead-mould casting, the casting tolerances stipulated in the drawing specifications or the order apply. If no tolerance specifications are defined, the normal general tolerances for new structures apply compliant with DIN ISO 8062 (or for structures from before August 1998: DIN CEN ISO/TS 8062-2). The VDG Specification P690 applies as the guideline for precision casting.

2.3. Processing

General tolerances for mechanical processing ("machining")

This standard is used to simplify drawings. General tolerances apply to dimensions that do not contain any special details regarding required dimensional accuracy in the drawings.

General tolerance for		Tolerance class
Linear and angular dimensions	DIN ISO 2768-1	m
Broken edges	UZB-10015, UZB-10017, DIN ISO 13715	m
Straightness and flatness	DIN ISO 2768-2	K
Rectangularity	DIN ISO 2768-2	K
True running	DIN ISO 2768-1	---
Symmetry	DIN ISO 2768-2	K
Surface specifications	UZB-10012, UZB-10014	---

This thereby stipulates the general tolerances for mechanical processing at Bühler.

ISO 2768-mK

If smaller tolerances are required or larger tolerances are permitted and economical then these must be indicated in the drawing. Narrower tolerances than those of the general tolerances listed here must only be used in special cases, because they increase the price of production. The following tables contain tolerance values that can be achieved in production without any special effort, and which must be observed.

Rejection

When not otherwise stipulated, workpieces that do not comply with the general tolerances must not be automatically rejected if their function is not impaired (compliant with DIN ISO 2768-1 (Item 6 and A4)).

2.4. General tolerances for linear and angular dimensions, edges

2.4.1. Tolerances for linear dimensions (DIN ISO 2768-1, Table 1, Class m)

Length ranges	from 0.5 - 6	>6 - 30	>30 - 120	>120 - 400	>400 - 1000	>1000 - 2000	>2000 - 4000
Tolerances	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2.0

2.4.2. Tolerances for angular dimensions (DIN ISO 2768-1, Table 3, Class m)

Length range of the shorter side piece	to 10	>10 - 50	>50 - 120	>120 - 400	>400
Tolerances	±1°	±0° 30’	±0° 20’	±0° 10’	±0° 5’

2.4.3. **Tolerances for broken edges, radius of curvature, chamfers** (UZB-10015, UZB-10017, DIN ISO 13715)

Length range	
Tolerance	0.3 - 0.5

During production, the inside radius is machined at a tolerance of ±25 % of the rated value (with the exception of tools). If absolutely exact radii are required, then the radius specification must be provided with a tolerance.
If, for functional reasons, the edge must not be broken, then this must be noted on the drawing ("sharp edge")".

2.5. General tolerances for shape and position

2.5.1. Straightness and flatness tolerances (DIN ISO 2768-2, Table 1, Class K)

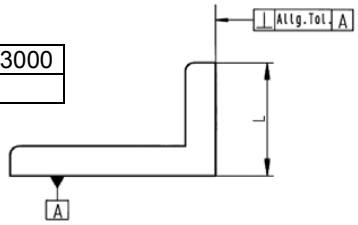
Length ranges	to 10	>10 - 30	>30 - 100	>100 - 300	>300 - 1000	>1000 - 3000
Tolerances	0.05	0.1	0.2	0.4	0.6	0.8

The length of the line in question applies for the straightness tolerances, and the longer side length of the surface applies for the flatness tolerances.

2.5.2. Rectangularity tolerances (DIN ISO 2768-2, Table 2, Class K)

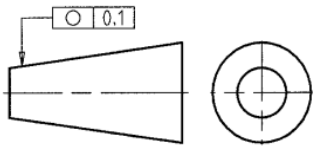
Length ranges of the shorter side piece	to 100	>100 - 300	>300 - 1000	>1000 - 3000
Tolerances	0,4	0,6	0,8	1,0

The longer side piece of the bracket is the point of reference.



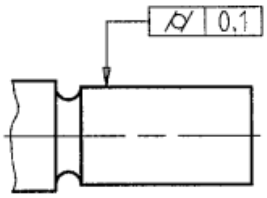
2.5.3. Roundness (DIN ISO 2768-2, Item. 5.1.2)

The general tolerance for roundness is the same as the number for diameter tolerance, but on no account must it be higher than the value stipulated in Table 4 for runout tolerance.



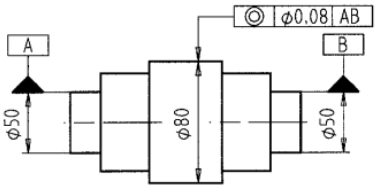
2.5.4. Cylinder shape (DIN ISO 2768-2, Item 5.1.3)

General tolerances have not been specified for the cylinder shape.



2.5.5. Concentricity (DIN ISO 2768-2, Item 5.2.5)

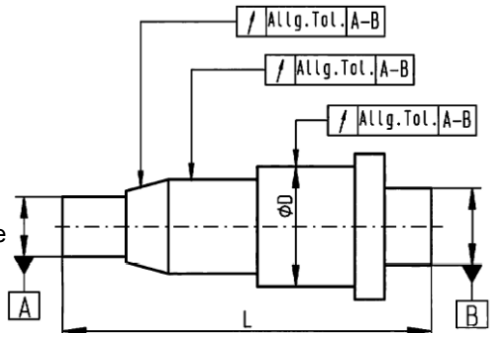
General tolerances have not been specified for concentricity.
Comment
In an extreme case, the error of coaxiality can be as large as the value stipulated for the run-out (Table 4) because the concentricity deviation consists of the error of coaxiality and the concentricity deviation.

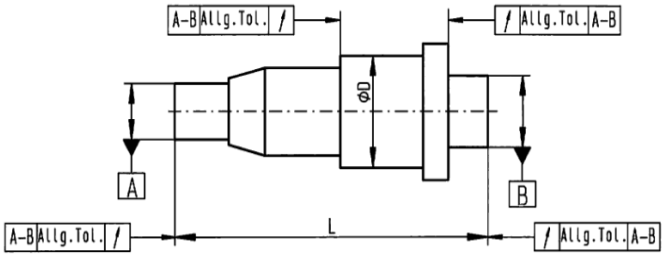


2.5.6. True-running tolerances (DIN ISO 2768-2, Table 4, Class K)

Tolerance class	Run-out tolerances
K	0.2

The bearing surfaces are the reference points for general running tolerances, if they are marked as such. Otherwise, the longer of the two shaped parts is the reference point. When both shaped parts have the same specified size, any of the two may be used as the reference point.

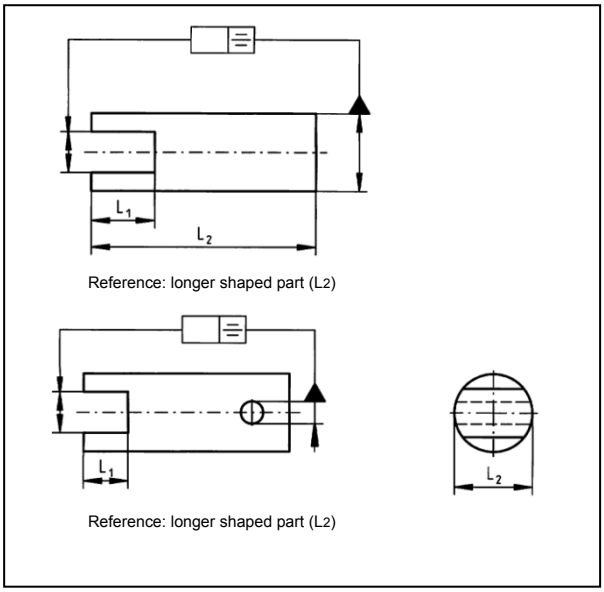


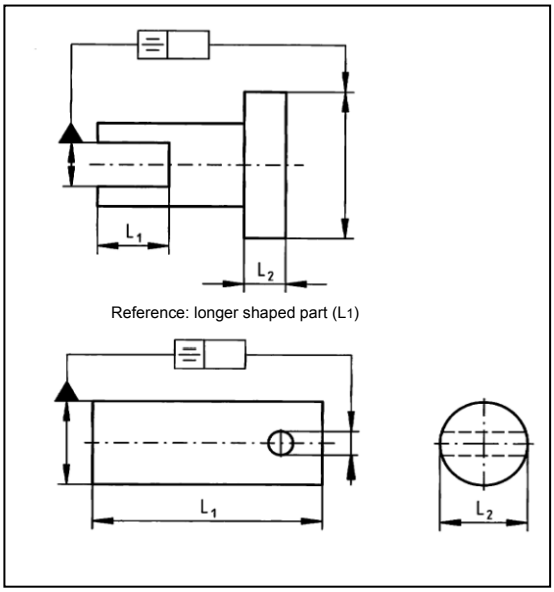


2.5.7. Tolerances for symmetry (DIN ISO 2768-2, Table 3, Class K)

Length ranges	to 300	>300 - 1000	>1000 - 3000
Tolerances	0.6	0.8	1.0

The longer of the two shaped parts applies as the reference point. When both shaped parts have the same specified size, any of the two may be used as the reference point. The general symmetry tolerances apply when at least one of the two shaped parts has a centre plane or the axes of the two shaped parts are at right angles to each other.

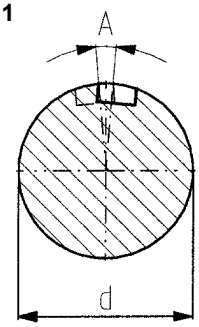




2.6. Positional tolerances for keyways in shafts

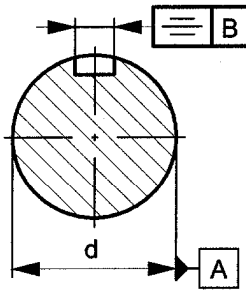
UZT-40010

Fig. 1



to d	max. A
20	2
50	3
100	4
250	6
500	8

Fig. 2



to d	max. B
20	0,05
50	0,09
100	0,13
250	0,22
500	0,30

Fig. 3

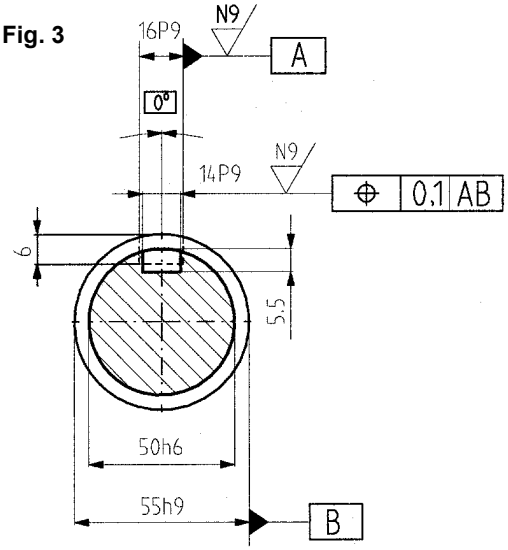
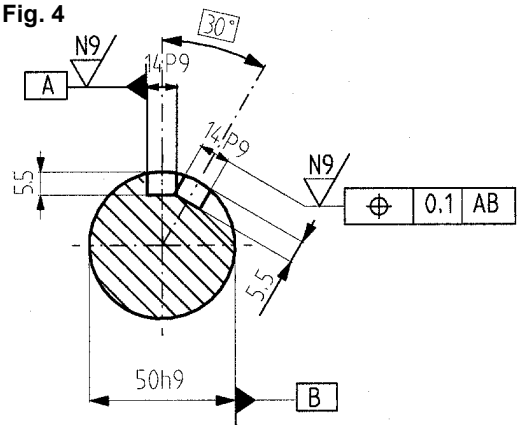


Fig. 4



1. Keyways without positional tolerance specifications

1.1 When there are two or more keyways that are flush or offset at an angle to each other then an angular deviation of max. "A" is permitted at the outer diameter of the shaft, as per the table in Fig. 1.
The maximum angular deviations also apply for keyways that are arranged flush or at an angle to milled surfaces, boreholes, etc.

1.2 The choice of the means used for alignment is optional (eye or angle bracket).

1.3 The centricity deviation of the keyway symmetrical to the shaft axis must lie within the range of values in the table in Fig. 2, without a specification on the drawing, so that a fit is ensured to the counter-keyway in the inner race. For general explanations, refer also to UZT-40000, P. 1, Item 4.

2. Keyways with positional tolerance specification

2.1 In special cases, e.g. in rotor shafts for redress sifters, huskers, etc., the positional tolerance must be indicated on the drawing for keyways that are exactly flush to each other or that are offset at an angle to each other. For an example of exactly flush keyways, see Fig. 3, and for keyways offset at an angle, see Fig. 4.

2.2 Means used to check alignment
Special alignment tool and water level.

2.3 Centricity deviation of the keyway symmetrical to the shaft axis must be within the values in the table in Fig. 2 (for an example, see UZT-40000, Page 8, Fig. 3).

3. Commentary on Fig. 3 and Fig. 4
The position of two or more keyway centre planes relative to each other is related to their common shaft axis.

3.1 Aligned (flush) keyways (example, Fig. 3)
The centre plane of the keyway 14 P9 must lie between two parallel planes at a distance from them of 0.1 mm.
The distance of the planes lies symmetrically around the geometrically prescribed location at the shaft diameter, offset 0° to basal plane A, relative to axis B.

3.2 Offset keyways (example, Fig. 4)
The centre plane of keyway 14 P9 must be between two parallel planes at a distance from them of 0.1 mm.
The distance of the planes lies symmetrically around the geometrically prescribed location at the shaft diameter, offset 30° to basal plane A, relative to axis B (see also UZT-40000, S. 7, Fig. 4).

3.3 The design engineer is responsible for the size of the position tolerance, in agreement with Avor.

2.7. Balancing

2.7.1. Introduction

- There are no "general tolerances" within the correct meaning of the word for balancing.
- In general, the technical drawing, and in exceptional cases the operation plan, stipulates whether or not balancing is required.

2.7.2. Quality class

Balancing quality classes for various groups of typically rigid rotors.

Balancing quality class	Product of the relation $(e_{zul.} \cdot \omega)$ 1), 2) mm/s	Rotor types - General examples
G 250	250	Crank drives of rigidly constructed, fast-running 4-cylinder diesel engines 4)
G 100	100	Crank drives of fast-running diesel engines with six and more cylinders 4), complete (Otto or Diesel) passenger car, truck, locomotive engines 5)
G 40	40	Automobile wheels, rims, wheel sets, drive shafts of flexibly constructed, fast-running four-stroke engines (Otto pt Diesel) with six and more cylinders 4) Drive shafts of passenger car, truck, locomotive engines
G 16	16	Drive shafts (propellor shafts, cardan shafts) with special requirements Parts of shredding machines and agricultural machines Single parts of passenger car, truck, locomotive engines (Otto or Diesel) Drive shafts of engines with six and more cylinders with special requirements
G 6.3	6.3	Parts within process technology; centrifuge rotors Drives for main turbines in cargo vessels Ventilators, flywheels, centrifugal pumps Mechanical engineering and machine tool parts Rollers from paper and printing machines Rotors from jet engines Single engine parts with special requirements, medium and large-sized electric motor anchors (of electric motors with at least 80 mm shaft height) without special requirements Small-power motor anchors, usually in series production, for applications insensitive to vibrations and/or vibration-isolated placement
G 2.5	2.5	Gas and steam turbines, including main turbines in cargo vessels, turbo blowers, rigid turbo generator rotors; machine tool drives, medium and large-sized electric motor anchors with special requirements Pumps with turbine drive Computer storage drums and storage disks Small-power motor anchors, for which one or both requirements of the quality class do not apply
G 1	1	Magnetophone and phono drives Grinding machine drives; small-power motor anchors with special requirements
G 0.4	0.4	Finest-grade grinding machine anchors, shafts and disks; gyros

For typical components from general mechanical engineering, as also occurring at Bühler, quality class G 6.3 must always be applied (observe the exceptions as per the drawing).

2.7.3. Mandatory specifications on the drawing

a) Indication of the balancing method (static or dynamically)
b) Permissible residual unbalance U_{PER}
c) Completed weight G of the rotor
d) Operating speed of the rotor

2.7.4. Additional specifications in the OP, when not indicated on the drawing

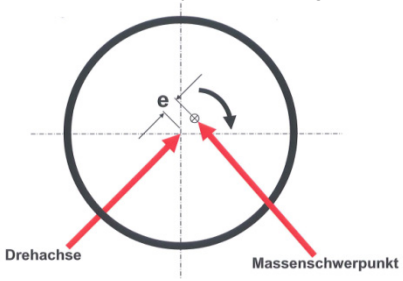
a) Balancing radius/radii
b) Type of unbalance correction (add or remove weights)
c) Logging of balancing results (trackability)

2.7.5. Missing specifications listed in section 2.6.3 or 2.6.4

If specifications are missing as per section 2.6.3 or 2.6.4, then the process engineering department must be called on before commencing work. It is their job to ensure that these specifications are provided.

2.7.6. To be noted and for information

a) The value "U_{PER}" in unit "gmm/kg" also corresponds to eccentricity in "µ".
b) The eccentricity in "µ". designates the distance between the centre of mass and the axis of rotation.



2.7.7. Basics

a) Dynamic and static balancing (UZB-38001)
b) Dynamic balancing, workshop tables (UZB-38002)
c) Balancing - Vocabulary (DIN ISO 1925)
d) Mechanical vibrations (DIN ISO 1940-1) with corrigendum (Corrigendum 1)
e) Balance quality requirements (DIN ISO 21940-14)
f) Methods and criteria for the mechanical balancing of flexible rotors (DIN ISO 11342)

3. Surface specifications

Surface symbols compliant with ISO 1302	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
Surface symbols compliant with ISO 3141	▽▽▽▽					▽▽▽		▽▽		▽		
Key roughness data	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Arithmetical mean deviation of the roughness profile Ra in µm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
Average surface roughness Rz in µm	0.25	0.63	1	1.6	2.5	4-6.3	10	16-25	40	63	100	160
Drawings BMAN (formerly Drais)				z		y		x		w		

For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

The surface symbols always stipulate the final quality of the surfaces, but not the worksteps required to achieve them. Roughness can be checked by measurements using a surface test device (Perthometer stylus instrument) or by a comparison with the commercially available Rugotest surface sample; normally, the latter method is sufficient.

16 % control

When the indicated parameter code does not contain the addition "max." the surfaces are accepted and the test procedure is adjusted, when

a) The first measured value does not exceed 70 % of the set value (indicated on the drawing);
b) The first three measured values do not exceed the set value;
c) No more than one of the first six measured values exceed the set value;
d) No more than two of the first twelve measured values exceed the set value.

Otherwise, the workpiece must be rejected.

Sometimes, such as before having to reject a high-quality workpiece, more than twelve measurements can be carried out, e.g. 25 measurements with up to four values that exceed the set value.

Source: DIN EN ISO 4288 (5.2 ff and A3.1ff).

4. Chemical/galvanic surface refinement

4.1. Surface coatings

Various types of coating are used in steels against attack from corrosion, or for technical reasons.
For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

4.1.1. Hot-dip galvanizing

Coating by hot-dip is achieved by immersing the parts into liquid zinc (approx. 450°).
This results in a solid metal coat with a thickness of approx. 50 µm up to. 100 µm.
The surfaces must be free of mill scales, paint, etc., otherwise the chemical bond and corrosion-resistance cannot be ensured.
See UZB-34007, UZB-34001, DIN EN ISO 1461.
Make sure that the discharge openings are large enough before galvanizing. Threads or smaller openings must also be closed.
After galvanizing, the drawing must be compared to the component to check all openings.
Surface structure

4.1.2. Zinc plating

When coating with a zinc plating, a zinc layer is generated in an electrolytic bath. The layer thickness is around 5 µm to approx. 35 µm. See UZB-34014, DIN EN ISO 2081.
Because the zinc layer is in the µm-range, all surface damages are always visible.
Even the various material surfaces are always visible. The parts are chromated after zinc plating. The Bühler standard is Code A, colourless with a slight blue tone (site-related dip coat) Pa g/m² = Pa ≤0,5). The coat thickness is checked as per the drawing using an optical film thickness monitor. The corrosivity category must be determined compliant with DIN EN ISO 12944. Attention should be paid to hydrogen embrittlement. This should not be underestimated. See UZB-34024.

4.1.3. Tin coating

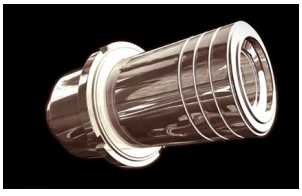
Two coating methods are used.
Tin melt (hot dip tinning) is used as the hot dip.
During tin plating, a tin layer is established by an electrolytic bath. See UZB-34016, DIN 50965.
The layer thicknesses are in the range from approx. 1 µm to approx. 50 µm.
Areas of application are:
- Foodstuffs industry
- Electrical industry
- Mechanical engineering

4.1.4. Chromium plating

A chrome layer is formed by separation of a chrome layer from an electrolyte containing chrome, depending on the parameters and the time limitation. Depending on the applications/requirements, intermediate layers can be applied. See UZB-34009, ISO 6158.
In bright-chrome plating, chrome layers are established with a thickness of up to approx. 5 µm. In hard chromium plating (high build chrome), thicker chrome layers with a thickness of up to approx. 1000 µm are established. Special details are described in UZB-34009.
The thickness tolerances can be checked using an optical film thickness monitor.

4.1.5. Nickel plating

Chemical nickel plating



Currentless chemical nickel plating is a reduction method. The objects to be nickel plated are immersed in a special electrolyte and a nickel plating deposits on the surface of the objects without any electrical current being applied. The benefits of this are even plating and a high level of hardness. To achieve appropriate corrosion resistance, the workpieces must have at least 25 µm layer thickness and a closed surface. See UZB-34013.

Galvanic nickel plating

In galvanic nickel plating the objects to be nickel plated are immersed in a nickel electrolyte after suitable pretreatment and a nickel plate is deposited on the surface of the object after applying an electrical current. See UZB-34012.

4.1.6. Copperplating

Copperplating is usually used to apply an intermediate layer, especially for subsequent chrome or nickel plating. For additional details, refer to UZB-34011, DIN 12540.

4.2. Surface treatments

The surfaces of rustproof steels and aluminium are processed in various ways.
For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

4.2.1. Grinding

For rustproof steels, the surface can be repaired by grinding off the external impurities (weld discolorations, flash rust, other damages). See mechanical cleaning UZB-34008.
It is important that the surface pattern has an even structure and that, when possible, the entire surface is ground (grinding directions).

4.2.2. Glass bead blasting ("sand blasting")

Glass bead blasting is a manual method of mechanical removal.
The surface (cold-rolled rustproof sheet metal) is thereby approx. 3x higher acc. to R_A-values.
The size of the glass beads is stipulated in the Bühler standard at 200 µm.
Glass bead blasting must only be used in a dry environment free of chloride.
See UZB-34057.
Additionally, only austenitic, rustproof steel must be used. Otherwise, the shot is contaminated by ferritic particles. Surface damages such as scratches or scouring tracks must be ground out. The minimum abrasive grit to be applied is K150 (Ra 2) to ensure that scouring tracks are no longer visible. For hot-rolled, rustproof sheet metals, you should consider whether damages really need to be ground out. Any change made to the surface of hot-rolled rustproof sheet metal is visible after blasting. It should also be considered that thin-walled parts warp during blasting. This problem can be kept in check by counterblasting (on both sides).

4.3. Pickling

Pickling is a method of removal using aggressive acids.
Not all surface damages (unevenness, scratches, scouring tracks, etc.) are removed.
The surface is clinically clean after pickling.
The various surface structures of the materials (sheet metals, sections) are then visible.
Only austenitic, rustproof steel must be used. See UZB-34003.
The pickling works must be contacted if you intend to use other materials.
Because all of the surface damages remain visible, the stipulated requirements must be met. Preparatory work and handling must be carried out accordingly.
Pickling spray must be used on large parts.
Parts that only have single, small welded joints or repairs can also be partially processed using a hand-held unit.

4.4. Electropolishing

The stainless steel surfaces are improved by a bath treatment containing anodic solutions. Unevennesses in the surface are broken by removal of the peaks. This smoothes the surface and the gloss level can be increased to specular. See UZB-34004.
Additionally, only austenitic, rustproof steel must be used.
For other rustproof steels, the persons processing the surface must be contacted.
All damage is visible. Small scratches or scouring tracks can be repaired by the fabricator.
Protection of the surface must be guaranteed during the entire production process (mandatory).
If the object is electroplated after glass bead blasting, the surface damages must be ground out before blasting (min. K220). Application of anodes must also be defined; otherwise, anode speckles will be visible on the visible surface.
The tests should be carried out depending on the use of the parts using a polished sample or acc. to the specifications with Ra values. For surface roughness on sheet metal structures, see UZB-10013.

4.5. Anodization

Anodization is an electrochemical process that chemically transforms the surface. Anoxic oxidation or Eloxal transforms the metal surface into a dense and hard oxide layer.
See UZB-34006, for layer thickness see DIN 17611 Table 2.
These applications are for aluminium, and aluminium alloys.
All surface damages remain visible after anodization. If the damages are not too deep then repairs can be initiated by short sign E4 (DIN 17611 Table 1). E4 means that the surface is first ground and then brushed. Protection of the surface must be guaranteed during the entire production process (mandatory).
Various colourings can also be applied. Refer to the plant's own specifications.
If important data are required for the application, such as hardness, coefficient of expansion, abrasion resistance (wear resistance), puncture voltage, dielectric coefficient, etc. then these must be looked up in the literature.

Hard anodization

In hard anodization, certain parameters of normal anodizing are changed, thereby allowing a layer thickness of up to over 100 µm to be achieved. These are especially hard, thick and wear-resistant oxide layers for engineering usage.
Because the oxide layer must be established by approx. 2/3 in the base material and approx. 1/3 outwards, the following point must be noted. The preliminary work of the tolerances must be adjusted to these circumstances (establishment of the oxide layer outwards approx.1/3).

4.6. Burnishing

Burnishing ("black finishing") establishes a thin protective layer against corrosion (approx. 1 µm). A black mixed oxide layer is formed by immersing into an acid/alkaline solution. The parts are oiled to increase corrosion-resistance. This method is no longer used very often.

4.7. Packaging, transport

All parts that have been surface-treated must be protected and packaged. It must be ensured that the packaging is shockproof and weatherproof and that the parts are packed individually, or at least are protected in such a way that they cannot rub against each other. If any of the treated parts come into contact with water then they must be cleaned immediately. Otherwise, stains due to water spotting will result, and some of these may no longer be able to be removed.
The goods must be packaged for secure transport by road.




5. Powder/liquid surface coating

For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

5.1. General specifications

The condition upon delivery determines the surface preparation.
Scaled surfaces must be pre-cleaned by a mechanical procedure. The surface must be scale free. After mechanical cleaning, chemical cleaning is required because the shot is still contaminated.
Chemical cleaning is usually sufficient for parts that are only slightly rusted.
If there is severe rusting (thick-walled, non-visible parts) then mechanical cleaning should first be carried out, followed by chemical cleaning. The rust infestation must be determined for thin-walled parts to define their usability (use or reject).

5.2. Pretreatment processes

The better the pretreatment is carried out, the better is the adhesion of the coating. See UAB-24004.
The surface must be scratch-free (handling damages) for powder coatings.
The roughness value of the scouring tracks must be adhered to as indicated on the drawing. Comparison with Rugotest No. 2
Surface irregularities or indentations that are within the tolerances as per the EN standards for sheet metals should be accepted.

5.2.1. Mechanical procedure

Grinding, brushing and emory polishing are removal procedures. See UZB-34008.
These procedures must be carried out in advance. The roughness value for powder coating is Ra 1.6.

Abrasive blast cleaning

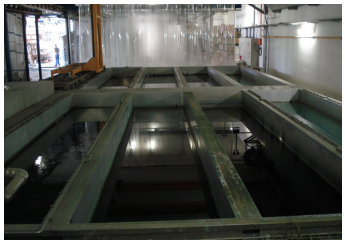
This mechanically cleans the surface. Impurities (scales, rust, but also dirt and dust) are removed by abrasive removal. Simultaneously, a new active surface is created that allows good adhesion of coatings.
See UZB-34017, UZB-34050.
Appropriate standards must be taken into consideration, depending on the requirements.
Compliant with SA 2.5 or SA 3 see DIN EN ISO 12944-4, Annex A.

Evaluation of the prepared surfaces
According to purity, see DIN EN ISO 8501-1.
According to degree of roughness, see DIN EN ISO 8503-2.
According to depth of roughness, see DIN EN ISO 8503-4.

5.2.2. Chemical procedures

General considerations

Make sure that the liquid can always flow out from the parts unimpeded.
Otherwise, discharge openings must be fitted before the treatment.
(consult with the engineering department (or AVOR ML)).



Wet chemical bath and spray preteatment

During wet chemical pretreatment, the surfaces of the respective workpiece are compact-cleaned of disruptive influences such as oil, grease, salt, metal debris, rust, etc., without changing the surface. See UZB-34018.
Preferably, the baths and/or the systems should be monitored using process control charts.
A cloth test can be used to check cleanliness.

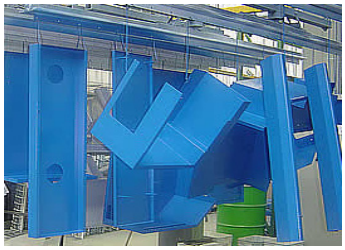
Vapour degreasing

In this method, the surface to be cleaned is blasted with water vapour to which water-based cleaning agent has been added to remove oil and grease..
For the cleaning process, see UZB-34061 and UZB-34031.

5.2.3. **Hydrogen embrittlement** (also occurs during pickling in pretreatment)

Hydrogen embrittlement is purposeful damaging of the material caused by diffusion of the atomic hydrogen into the metal that arises on the surface of the workpiece during certain procedural steps within electroplating. See UZB-34024.

5.3. Powder coating



Powder coating or powder painting is a coating method in which an electrically conductive material is coated with a powder lacquer. These methods are usually based chemically on epoxy or polyester resins.
For the coating, see UZB-34030, For the ordering address, see UAB-24003,
For colour shades, see UAB-24134, Corrosion protection DIN 55633, Evaluation DIN EN 15773, Cross cut tests compliant with DIN EN ISO 2409, GT 0; otherwise, all coating standards in B-Net must be used.
Surface inspections must be made compliant with UZB-34100.
An inspection checklist must also be used through the entire coating process. UQQ-30002, based on BU-00402.
For quality checking of pipework, see UZB-34030 Item 4.5.
Work instruction for coating from colour code A to K = WSOU-86265.

5.4. Wet coating

Wet coating requires priming on the workpieces. See UZB-34026.
Work instruction for coating from colour code A to K = WSOU-86265.

Priming

Priming is a component within wet coating. It requires a clean pretreatment. See UAB-24004. It is also used for corrosion protection and contributes to good adhesion on the base. The minimum layer thickness is 30 mμ and must be checked using random samples.
For colour shades and suppliers, see UAB-24130, UAB-24100.

Intermediate coat

Intermediate coats must be applied, depending on the requirements.
All specifications, including the required layer thicknesses, must be observed compliant with UZB-34035. The layer thicknesses on the workpieces and components must be checked compliant with WSOU-86265.

Filling

All unevenness, irrespective of type, must be filled as per the specifications. The max. filling depth should not exceed 1 mm to avoid risk of breaking.

Finishing

The wet coating is only as good as its base and its surface. The regulations and instructions are listed in B-Net. The surface must be clean and rustproof if clear coating material is used.

The following quality requirements must be met:

IN closed buildings

Condensation test	DIN EN ISO 6270-2	→ Evaluation after 300 hours of test duration including 5 Tests, see UAB-24002
Salt spray test	DIN EN ISO 9227	→ Evaluation after 300 hours of test duration including 5 Tests, see UAB-24002

Outdoors

Condensation test	DIN EN ISO 6270-2	→ Evaluation after 720 hours of test duration including 5 Tests, see UAB-24002
Salt spray test	DIN EN ISO 9227	→ Evaluation after 1440 hours of test duration including 5 Tests, see UAB-24002

The following standards must also be applied:
For the coating, see UZB-34030, Ordering address, see UAB-24003,
For colour shades. see UAB-24134, Corrosion protection DIN 55634,
Evaluation DIN EN 15773,
Cross cut tests compliant with DIN EN ISO 2409, GT 0; otherwise, all coating standards in B-Net must be used.
Surface inspections must be made compliant with UZB-34100.
An inspection checklist must also be used through the entire coating process. UQQ-30002, based on BU-00402.
Work instruction for coating from colour code A to K = WSOU-86265.
The coating for the die casting machine must be stipulated separately. See UZB-34031.

5.5. Rust-proofing

Rust-proofing prevents or delays physical degradation processes as well as chemical degradation processes such as oxidation and hydrolysis. All parts, assemblies, procured parts, and machines must be rust-proofed as per the specifications. See UZB-34038.
Appropriate products must be used depending on the requirements such as transport, storage, and environment.
The products are listed at UAB-24101.

5.6. Packaging, transport

To be used by production

Packaging must be designed to exclude any reduction in quality of the material/the product during transport.
Depending on transport, the goods must be provided secured/tied onto intact pallets.
When possible, deliver parts lying flat and not upright.
The size of the pallet must be adjusted to the material/product. Protruding edges may result in transport damages.
The goods are secured/tied so that slippage can be excluded.
When binding thin-walled products, a supporting base must be used to prevent the product from sagging.
For large parts: Parts must be flush fitted at drive-off end (or offset from it by a few centimetres), with the centre of gravity also at this end.
Do not place any parts directly on the pallet; always place cardboard, oil paper or plastic sheeting on top of the pallet floor.
Synthetic binding must be used for rustproof products..
A supporting base made of PE must be used for aluminium products; it is placed between the binding material and the product itself.
Corrosion-protection must be considered with regard to ambient temperature/damp and prolonged periods of transport.
The goods being conveyed must be clearly identified and addressed. The shop papers must always accompany the goods.
Every pallet or transport unit must be accompanied by a copy of the original documents.
If transport containers exist then they must be used.
E.g. UNW-84009, UNW-84010, UNW-84011, UNW-84012, Wood-Prisma UNW-84003

To be used by dispatch

The packaging is determined based on the conditions that the material to be packaged will be subjected to during transport, from its point of departure to its destination. Make sure that the material to be packed is cleanly rust-proofed. The packing facility must check the correctness of the package and that it is free of external damages. See mlml0007
Various packaging methods can be used. See mlml0008.
Instructions on the labelling and marking of hazardous material are contained at mlml0016.

6. Processing wood/synthetic materials/

For the supplementary text on special machining and special treatment, see UZB-10018 (old names/explanations).

6.1. Materials

Raw material tolerances for synthetic materials

Attention must be paid to the data sheets for all raw materials. Use material according to parts lists and the material standard specifications sheets. The delivery tolerances are listed in the BUZ standard specifications sheets.
The tolerances are only valid for a temperature of 20 °C (room and material).

6.1.1. Thermoplastics, thermoset

Storage

The materials must be stored in an air-conditioned room, when possible at a constant temperature and air humidity (23 °C/50 % relative humidity).
The base supports for storage should also be selected in such a manner that no deformations arise.
Tolerances for rubber, cellular rubber, see DIN ISO 3302-1.

6.1.1.1. Boards

TP-board UHMW-PE, see UNR-51253.
TP-board PMMA, see UNR-51271.
TP-board PETP, see UNR-51257.
TP-board G-HDPE, see UNR-51247.
TP-board PC see, UNR-51295.
TP-board POM, see UNR-51291.

Hard-foam board PUR, see UNR-51708.

6.1.1.2. Bars

TP round bar PETP, see UNR-52257.

6.1.1.3. Pipes

Pipe, hard PVC, see UNR-56233.
PMMA pipe (plexiglass), see UNR-56271.
HD PE-AL pipe, see UNR-56903.

6.1.1.4. Ties, box sections

Polyester webbing (polyester with C-fibre and PUR), see UNR-53801.
Foam sealing tape, PVC, see UXR-53728, UXR-53741.
Fluorine fibreglass strips, extra smooth, self-adhesive, see UXR-53906.

6.1.2. Elastomers (rubber, caoutchouc, silicone)

Storage

The materials must be stored in an air-conditioned room, when possible at a constant temperature and air humidity (23 °C/50 % relative humidity). The base supports for storage should also be selected in such a manner that no deformations arise.

6.1.2.1. Boards

Neoprene sheets CR, see UNR-51634.
Neoprene sheets with polyester inserts CR, see UNR-51635.
Nitrile rubber sheets NBR, see UNR-51635.
Klingersil C-400 NBR and aramid fibres, see UNR-51640.
Rubber sheets, clear, with polyester inserts EPDM, see UXR-51624.
Rubber sheets, black, with polyester inserts EPDM, see UXR-51624.
Foam rubber with one-sided adhesive film, CR, see UXR-51741.
Silicone-caoutchouc sheet, MQ, see UNR-51646.

6.1.2.2. Round sections

Rubber section CR, see UNR-57601.
Rubber section EPDM, see
UNR-57639.
Cellular rubber section NBR, see CR see EPDM see UNR-57744.
Terostat-VII plastic sealant, profile shaped, PIB, see UNR-57639.

6.1.2.3. Square sections

Foam PUR, see UNR-53741.
Foam CR, see UNR-53745.
Natural rubber NR, see UNR-57601.
Cellular rubber section NBR, CR see UNR-57744.
Hollow profile MQ, see UXR-57646.

6.1.3. Hoses, various materials

Storage

The materials must be stored in an air-conditioned room, when possible at a constant temperature and air humidity (23 °C/50 % relative humidity). The base supports for storage should also be selected in such a manner that no deformations arise.

6.1.3.1. Conveying hose for foodstuffs

PVC, soft, see UNR-56223.
NBR ,see UNR-56618, UNR-56619.

6.1.3.2. High-pressure hose

SBR/EPDM and NBR/CR, see UXR-56601.
EPDM, see UNR-56618.
NBR/CR, see UXR-56618.

6.1.3.3. Welding/flexible ducting

SRB/EPDM, see UXR-56601.
PVC-P, see UXR-56618.
NBR/CR, see UNR-56618.
PUR, see UNR-56642.

6.1.3.4. Hose for liquids

PV, soft, see UNR-56225.
EPDM/EPM, UHMW-ER/CR, see UXR-56618.
EPDM, see UNR-56624.

6.1.3.5. Silicone hose

MVQ, see UXR-56646.

6.1.3.6. Pneumatic hose for connections

PA 12 (nylon), see UNR-56207/UXR-56207.
LD-PE, see UNR-56243.
PVC, soft, see UNR-56223.
PUR, see UNR-56641.

6.1.3.7. Hydraulic hose

PA 11 (nylon, black), see UXR-56207.

Selection table for seals, see UZR-21200.

6.1.4. Raw material tolerances for wood

All types of wood can be used as per the parts list (fir, alder, beech, pock wood).
The standard of the wood moisture level is 7 - 8 %. Drying time in the warehouse must be determined based on the negotiated condition on delivery (moisture).

6.1.5. Glues, pastes, artificial resins, accelerators, rolls/bands of splicing tape

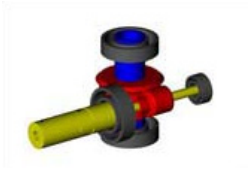
All standard specifications sheets are located in the B-Net at FKT nonmetal materials and glues.
Attention must be paid to the data safety sheets for all of the materials listed above.
All materials listed above must not be used beyond their expiration dates.
Materials whose expiration dates have expired must be disposed of or returned (the consumption rate must be observed).
The area of application must be followed exactly.
Corresponding storage instructions must be strictly adhered to.

6.2. Processing

6.2.1. General tolerances

6.2.2. Synthetic materials

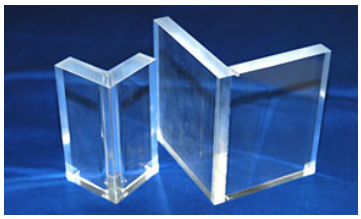
For sawing, drilling, milling and planing, DIN ISO 2768-1 tolerances must be used.
For die cutting, casting and hot bending, UZT-30005 tolerances must be used.
The standard of 0.5 x 45° (synthetics, glass) applies for chamfering.
For deburring and trimming, the base tolerance is standard specifications sheet UZB-10015.
The tolerances for hot bending must be clarified on-site.
For rubber (seals): +/- 1 mm.



6.2.3. Wood

For sawing, drilling, milling and planing, UZT-30005 tolerances must be used.
A standard of 1.0 x 45° applies for chamfering.
For deburring and trimming, the base tolerance is standard specifications sheet UZB-10015.
For wood installation (assembly, pasting), UZT-30005 standards must be used.

6.2.4. Gluing



Grease-free, roughened surfaces are required for clean gluing.
The drying time must be observed as per the data sheets (mandatory).
Standard UZT-30006 must be use for the general tolerances.
The classification of the glues/sealant and the process descriptions are located under standard UZB-34060 .

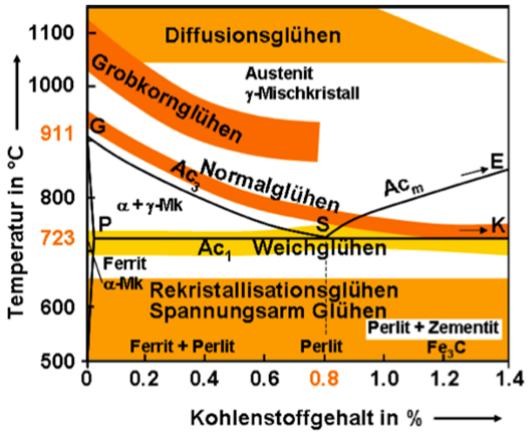
6.3. Packaging, transport

The parts must be protected in such a way that the following effects do not result in any damages.
Protection against shock, indentation, surface damages.
Protection against moisture.
Protection against UV radiation.
Protection against heat or cold.

7. Heat treatments DIN EN 10052

7.1. Annealing

The aim is to improve formability, to reduce internal stresses and homogenization.



- Diffusionsglühen / Diffusion annealing
- Grobkornglühen / Coarse-grain annealing
- Normalglühen / Normalizing
- Weichglühen / Soft annealing
- Rekristallisationsglühen / Recrystallization annealing
- Spannungsarmglühen / Stress relief annealing
- Austenit / Austenite
- y-Mischkristall / y-mixed crystal
- Kohlenstoffgehalt in % / Carbon content in %

No tests without any annealing specifications.

7.1.1. Diffusion annealing (homogenization)

Temperature 1050 – 1300 °C
Used for high-quality parts or high-alloy tool steels that are difficult to homogenize.

Hardness test (Brinell) when required; metallographic examination (tensile strength test).
Otherwise no standard test is possible; no tolerances/standards.

7.1.2. Coarse-grain annealing

Temperature 950 – 1100 °C
Used for low-carbon, tough steels, e.g. case hardening steel

Hardness test (Brinell) when required; metallographic examination (tensile strength test).
Otherwise no standard test is possible; no tolerances/standards.

7.1.3. Normalizing

Temperature In austenite area directly over AC3 or Ac1
Used for cast-forgings with uneven structure, almost only steels where C<0.8 %, after coarse-grain annealing

Hardness test (Brinell) when required; metallographic examination (tensile strength test).
Otherwise no standard test is possible; no tolerances/standards.

7.1.4. Soft annealing

Temperature Just under Ac1, approx. 680 – 720 °C
Used for steels with more than 0.5 % C content, containing plate cementites and which must be machined (for removal)

Hardness test (Brinell) when required; metallographic examination (tensile strength test).
Otherwise no standard test is possible; no tolerances/standards.

7.1.5. Stress relief annealing

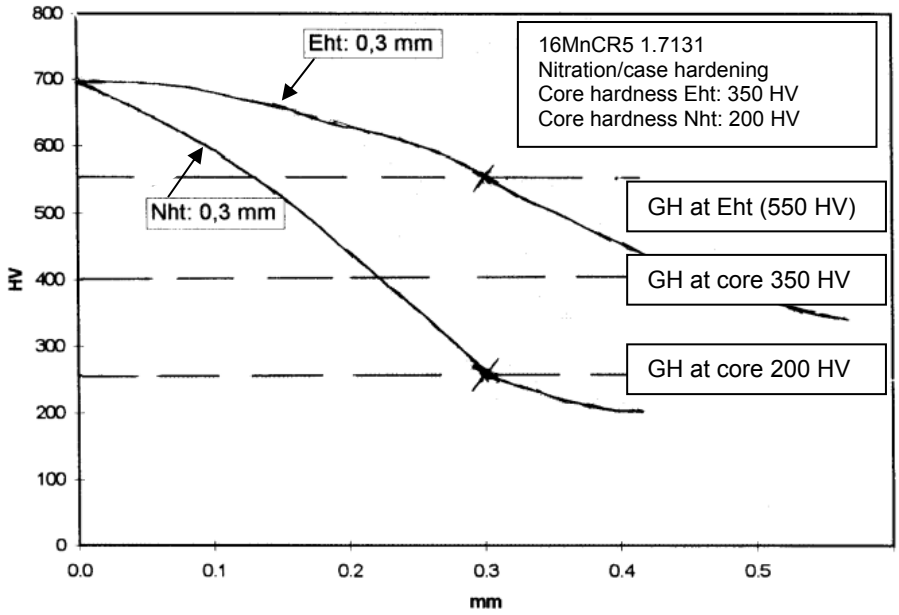
Temperature 450 – 650 °C, T < tempering temperature, slow furnace cooling
Used for forged-castings with irregular cooling
After welding
After cold forming or heavy processing (rough machining, adjoining)

Hardness test (Brinell) when required; metallographic examination (tensile strength test).
Otherwise no standard test is possible; no tolerances/standards.

7.2. Hardening

The aim is to reduce formability and thereby prevent dislocation motion.
For the drawing specifications standard, see DIN 6773.

The following standards are relevant for tests:
DIN EN ISO 6505 Brinell hardness test Part 1 - 3
DIN EN ISO 6507 Vickers hardness test Part 1 - 3
DIN EN ISO 6508 Rockwell hardness test Part 1 - 3
DIN 50150 Conversion of hardness tests



7.3. Case hardening

Materials All iron materials with a C content of at least 0.2 – 0.3 %. To minimize crack formation and residual austenite, the maximum C content must not be more than 0.75 %.
Test values as per specifications on the drawing = surface hardness and penetration depth.

Observe 7.4.3

7.3.1. Flame hardening

Heating the barrier layer with a blower and quenching with water.
Is used when larger (deeper) barrier layers are required and on larger parts.
Test values as per specifications on the drawing = surface hardness and penetration depth. Observe 7.4.3

7.3.2. Induction hardening

A current is induced via an electrical magnetic field on the workpiece in question. The workpiece is heated-up by this current. The penetration depth can be controlled in a targeted manner via the frequency.

Test values as per specifications on the drawing = surface hardness and penetration depth. Observe 7.4.3

7.4. Thermochemical treatment

Aim
Workpieces are always subjected to a temperature-time curve and a chemically active fluid medium. Due to the diffusion into or out of one or more elements, the composition of the barrier layer is purposefully changed.

7.4.1. Pack hardening

During pack hardening, the boundary layer is carbonized in the first step and then hardened in the second step.
Materials Low-carbon steels (<0.25 % C)
Is used for highly-stressed parts.
Test values as per specifications on the drawing = surface hardness and penetration depth. Observe 7.4.3

7.4.2. Nitration and Nitrocarbonization

Principle There is no subsequent heat treatment after nitration and nitrocarbonization.
Specifics
- Enormous hardness up to 1500 HV (the nitrate layer is harder than martensite) and very good wear characteristics.
- High hot hardness, nitrate layer remains stable even at 500 °C.
- Hardly any change in size or shape due to slow cooling. Attention: for dimensional tolerances in the IT7 range (e.g. H7, g7 etc.) or exact shape and positional tolerances, this process cannot be considered as having been assured.

Test values as per specifications on the drawing = surface hardness and penetration depth.
Observe 7.4.3

Nitrocarburization
The only difference between nitrocarburization and nitration is that in addition to nitrogen, carbon is also diffused into the boundary layer.
Test values as per specifications on the drawing = surface hardness and penetration depth.

7.4.3. Comment on the topic of test values and their measurement

All case depths - from pack hardening, flame hardening, induction hardening and effective nitridic are "ambulant". The appropriate hardness testers must therefore be used. A "laboratory" (test lab) must be called on for any examinations (mandatory). It should be noted in particular here that the measurement of the hardness depth is normally accompanied by destruction of the part (i.e. usually is a destructive test).

8. Installation

8.1. Instructions

Make sure that all required assembly drawings, test documents and work instructions are available.

All screw connections must be tightened as per torque table WSOU-86098.
In particular, the stipulated torques must be observed for the weld studs.

The torque applies to greased screws/weld studs.

The following resistances (in Nm) should be considered for the lock nuts.

M6	= 1.5 Nm	M8	= 2.0 Nm	M10	= 4.0 Nm
M12	= 5.5 Nm	M16	= 8.0 Nm		

When glues are used on screw locking, the data of UZB-34080 must be used.
To assemble taper-lock retaining bushes, the instructions of the supplier must be used.
When installing AirLoc precision levellers, the instructions of the manufacturer must be used.

8.2. Cleaning, conservation, transport

The machines and assemblies must be cleaned thoroughly. Depending on the object being cleaned, soapwater, soft cleaning agent or Inox spray should be used.

The following documents must be taken into consideration for conservation:

Conservation/corrosion-protection agent as per UAB-24101.
Conservation of bare steel as per UZB-34037.
Conservation of single parts for assembly as per UZB-34038.

Stable floors should be used for transport (suitable for transport by fork-lift).
The following packaging guidelines must be observed:

Creation and marking of packing units compliant with mlml0009.
Packing of goods to be dispatched compliant with mlml0008.
Packing methods for BUZ, BBS and BMAD
Anticorrosion agent compliant with UXB-34001.