

Figure 9. Transport structure for shaped sheets

4.8 Square-timber structures

Square timber structures are used for packing items of equipment which are not susceptible to corrosion or mechanical damage as well as for heavy goods for which skids would not offer adequate protection and for which cases or crates would be too costly. This type of packing shall be constructed analogously to that described under section 4.5.

4.9 Packing of piping

4.9.1 Carbon and stainless steel pipes

- up to a diameter of 40 mm = packed in cases
- diameter of 40 to 100 mm = packed in crates with the end completely closed.

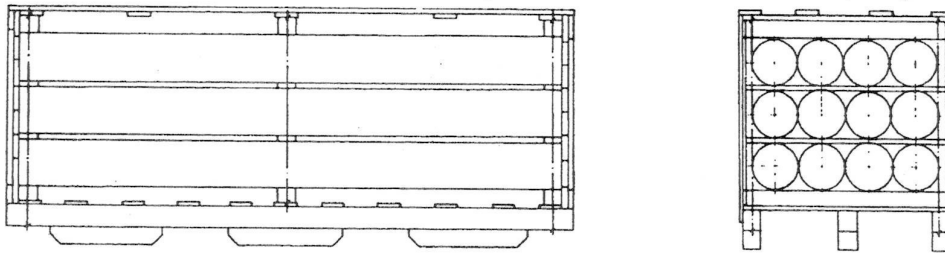


Figure 10. Packing of pipes in crates

- diameter of 100 mm and above = packed in bundles
- diameter of more than 300 mm = consult Uhde

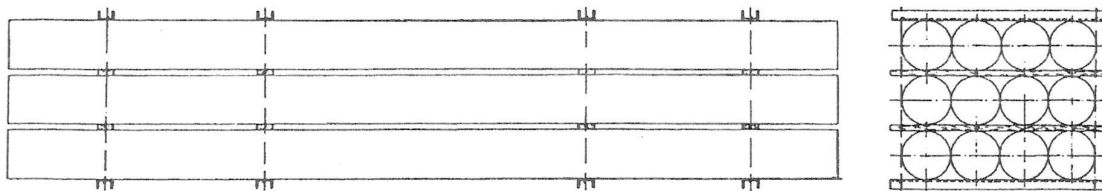


Figure 11. Bundling of pipes

Pipes must be adequately preserved prior to packing according to Uhde's technical specification.

4.9.2 Bituminized pipes

- diameter of up to 40 mm = packed in cases with adequate intermediate layers
- diameter of 40 to 100 mm = packed in crates with the ends completely closed and with adequate intermediate layers
- diameter of 100 mm and above = bundled with adequate intermediate layers
- diameter of more than 300 mm = consult Uhde.

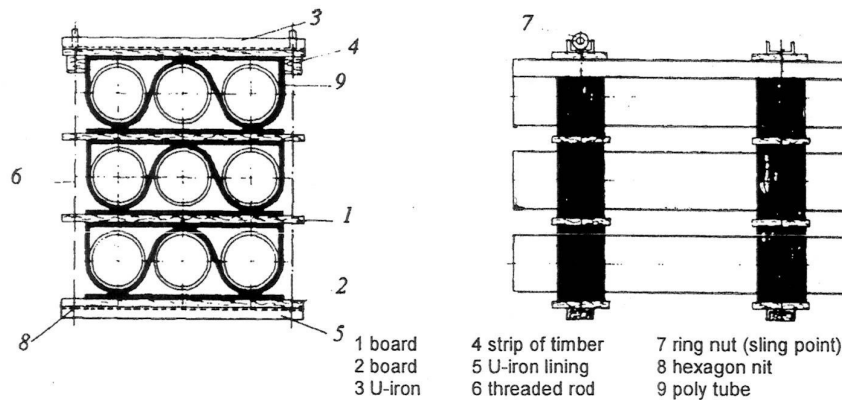


Figure 12. Bundles of bituminized pipes

4.9.3 Plastic pipes

depending on vulnerability

= packed in cases or crates

5 Dangerous goods

The packing and transport of dangerous goods is governed by "Gesetz über die Beförderung gefährlicher Güter" (Law governing the transport of dangerous goods) and the regulations and ordinances applicable to the respective carriers.

The recommendations for the type-testing procedure, allotting the identification and the approval of packing for transporting dangerous goods by sea - RM 001 (national) or Annex I IMDG-CODE (international) - are of particular importance for the packing.

To ensure that the correct procedures are followed for the shipment of the dangerous goods to be supplied, the supplier shall ensure that the packing lists contain the appropriate classification (class, code number, UN number, page of the GGVSee/IMGD code English/German, EmS no. (pamphlet no. for procedures in the event of an accident), MFAG table no. (pamphlet no. for first aid), technical designation (not trademark) and the characteristics of the dangerous goods as well as the flash point for all goods of class 3 and for certain goods of classes 6.1, 8 and 9) for the transport to the port by road/rail and for maritime transport. Furthermore, the supplier/packing contractor shall send to Uhde a 'binding declaration' in accordance with §8 of the GGVSee to the effect that the dangerous materials have been properly packed and marked while observing the certification of approval issued by the Federal Institute for Material Testing (BAM - Bundesanstalt für Materialprüfung), if such a material test is required.

The supplier's/packing contractor's attention is drawn to the fact that he is solely responsible for the correct fulfillment of the above instructions and that he will be held liable for any consequences.

6 Liability

- 6.1** The packing shall be performed using the skill of a professional packing contractor, exclusively using new packing material.
- 6.2** The packing contractor shall take out a third party liability insurance extended to cover damage caused in the course of packing, the coverage being at least 250 000 DM per claim. Uhde may request that evidence be given of such insurance having been taken out.
- 6.3** The supplier/packing contractor is responsible for rendering his service specified in the order and shall be liable for any damage occurred to the goods packed in connection with his services.
- 6.4** In the case of a total loss of the goods packed, the supplier's/packing contractor's liability shall extend to the replacement value; in the case of damage it shall extend to the cost required for the repair, including dismantling, reassembly and for replacement parts plus the cost of packing, freight, storage, travel and transport.
- 6.5** If the packing is performed at the supplier's works, the packing contractor shall bear the risk in respect of the goods to be packed starting from the time at which he has taken charge of the goods concerned.

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V370-03
Part1 (M)

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- 6.6** The packing contractor's liability is limited to 250 000 DM per claim.
- 6.7** Uhde will take out a transport insurance which will come into effect at the time the goods to be packed leave the supplier's scope of responsibility, and shall cover the normal risks that might occur in transit as well as in the course of intermediate storage.
- 6.8** If the seaworthy packing performed by the supplier/packing contractor is defective or inadequate, Uhde is entitled to have repair work carried out in the port of shipment at the supplier's/packing contractor's expense up to 1000 DM without consulting him. In the event of repairs exceeding this amount, Uhde will consult the supplier/packing contractor before having the repairs performed.
- 6.9** Uhde will notify the supplier/packing contractor without delay of any damage found except for defects as mentioned under 6.8, and give him the opportunity - as far as this is within Uhde's power - of eliminating the damage.
- 6.10 Guarantee period**
- 6.10.1** Unless agreed otherwise, the duration of the packing contractor's guarantee is identical to the duration of transport and storage specified in Uhde's shipping instructions.
- 6.10.2** The duration of the supplier's guarantee is derived from the terms contained in the computerized order and/or from any other terms handed over to the supplier.

7 Marking

The packages shall be marked with waterproof, non-fading paint of a contrasting colour using a stencil. The size of the letters depends on the dimension of the package, but, as a rule, must not be smaller than 40 mm.

Chain symbols (sling here) and double arrows (this side up) shall appear in any case.

Metal and plastic plates shall not be used for cases and crates unless permission has been received from Uhde. In the case of non-packed goods and skids, the marking shall be applied directly to the goods.

Bundles shall be marked on the longitudinal sides. The use of metal plates, attached to waterproof plywood or wooden plates is allowed for this purpose. Each plate shall be attached separately.

The marking is specific to the order and contained in the shipping instructions.

8 Inspection of packing

- 8.1** Krupp Uhde reserves the right to examine the packing. The advice of readiness for inspection shall be mailed to:

Uhde GmbH
Division PL-LO
Postfach 10 50 62
44047 Dortmund

Telephone:(02 31) 5 47-0
Telex:8 22 841-30
Telefax:(02 31) 5 47 3162

- 8.2** The lids of the cases shall remain in the open position to permit examination of the internal packing.
- 8.3** At the time of inspection, one set of the packing lists must be available, and the packings must bear the final marking including all pertinent information.
- 8.4** The inspection as outlined above shall not be deemed to limit in any way the manufacturer's responsibility for perfect execution of the packing services.

Reference Standards

DIN standard

DIN 4074 Part 1 Building timber for wood building components; quality conditions for converted building timber (softwood)

DIN 4074 Part 2 Building timber for wood building components; quality conditions for building logs (soft wood)

DIN 55474 Auxiliary packaging means; dessicants in bags, calculation of required dessicant units

[Modified On: 29/08/2008]

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Dimensions in mm

1 Scope

This standard covers the preparation of technical drawings and the requirements relating to the legibility of reproduced documents (transparent and photostat copies, microfilm-reproduced and re-enlarged drawings, etc.) and to a uniform system of representation. Technical drawings are understood to mean documents comprising illustrations, schematic representations and flow diagrams.

2 Drawing sheets

2.1 Size of drawings

The size of the drawings shall comply with DIN 476, series A. The sizes of the sheets (surface area etc.) A4 to A0 shall correspond to DIN 6771 part 6. The standard length shall be observed. If an overlength is required, the width of such drawings shall correspond to the standard width of series A, refer to Fig. 1, dimension C. The standard width A0 (841 mm) shall not be exceeded. Said overlength shall be selected from the lengths of the A series according to DIN 476.

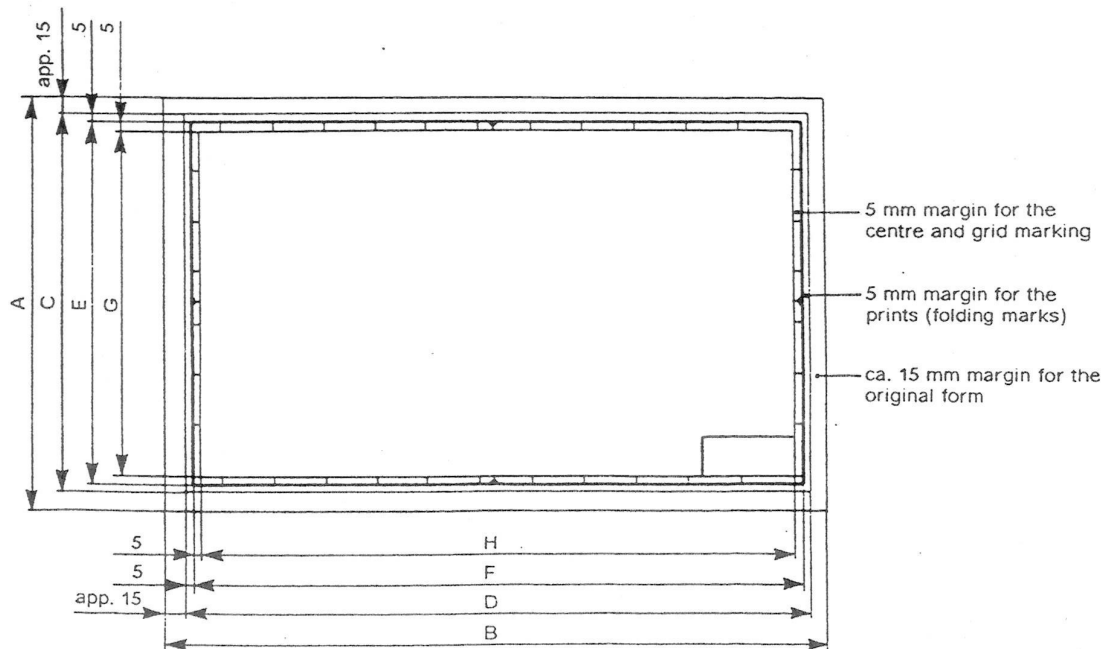


Figure 1. Size of the drawing sheets

Uhde	Technical drawings	UN
	PRINCIPLES OF EXECUTION	V401-01
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Table 1. Sizes

Size	Uhde code ¹⁾	Uhde form no.	A (appr.)	B (appr.)	C	D	E	F	G	H
A0	0	A50	871	1219	841	1189	831	1179	821	1169
A1	1	A51	624	871	594	841	584	831	574	821
A2	2	A52	450	624	420	594	410	584	400	574
A3	3	A53	-	-	297	420	287	395 ²⁾	277	385 ²⁾
A4	4	A60, A54	-	-	297	210	-	-	287	185

1) To be indicated in the Uhde drawing number, 8th character, for example 'D 15960-1'. Refer to Uhde standard UN V401-04 part 1.

2) Due to a filing margin of 20 mm on one side.

2.2 Forms

Forms with title blocks shall be used for drawings of A4 to A0 size (for title blocks, refer to Uhde standard UN V401-01 part 2).

If forms without title blocks are used, adhesive title blocks shall be applied in the right lower section in accordance with Uhde standard UN V401-01 part 2, and in such a manner that the title block does not overlap the first folding mark according to DIN 824. (If the adhesive title block overlaps this part of the drawing, the grid marking shall be eliminated.)

The grids are marked in the margin of the forms. A reference scale of 100 mm each in X and Y direction permits true-to-scale reproduction of the drawings. A centre marking is also provided for proper centering of the drawings when they are micro-filmed. In the case of CAD drawings, the margins, markings and title blocks are plotted automatically.

3 Preparation of the drawings

The drawings shall adequately contrast with the background. Multicolour representations and large black sections are inadmissible. If required, such sections shall be hatched to DIN 201 or adhesive hatched sections shall be used. Transparent drawings prepared by means of pencils and ink pens (mixed representation in a drawing) are inadmissible. Adhesive labels and symbols may be used. Adhesive labels for transparent drawings shall be transparent, non-calendered and non-coloured and applied on the reverse side of the drawing. It is imperative that printed adhesive labels or labels reproduced by Uhde be used because the lines on the labels must be jet black and indelible.

Black ink pads shall be used for stamping.

In order to ensure an adequate black colour and indelibility, the ink pens and pad colours must be suitable for the drawing paper.

Ink pens and similar drawing equipment marked "m" (suitable for microfilming) shall be used.

3.1 Lines in the drawings

DIN 15 parts 1 and 2, shall apply.

Depending on the size and type of drawing, an adequate line width or combination of lines shall be selected. It is imperative that the line width specified for the selected combination be used in the drawing concerned.

Table 2. Types of lines

Types of lines		Combination of lines				
		0.25 ¹⁾	0.35	0.50	0.70	1.00
Solid line (thick)	Widths of lines	0.25	0.35	0.50	0.70	1.00
Solid line (thin)		0.18	0.25	0.25	0.35	0.50
Ruler-drawn line		0.18	0.25	0.35	0.50	0.70
Free-hand line		0.18	0.25	0.25	0.35	0.50

1) This combination is only suitable for copies corresponding to the size of the original document (see table 3).

Uhde	Technical drawings	UN
	PRINCIPLES OF EXECUTION	V401-01
	General Requirements	Part 1 (M)
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3.1.1 Line widths

Depending on the ratio of reduction/microfilm enlargement, the minimum line widths shall be selected from table 3 for the original set of drawings (except for CAD-plotted drawings).

Table 3. Minimum line widths for drawings (DIN 6774 part 1)

		Size of copy				
		A0	A1	A2	A3	A4
Size of original drawing	A4	-	-	-	-	0.18
	A3	-	-	-	0.18	0.25
	A3	-	-	0.18	0.25	0.35
	A1	-	0.18	0.25	0.35	0.50
	A0	0.18	0.25	0.35	0.50	0.70

3.1.2 Minimum inter-line distance

The minimum distance between two lines in the drawing shall be twice the width of the thin line but at least 0.5 mm (except for CAD-plotted drawings).

3.2 Inscriptions, lettering

The inscriptions of drawings shall be made by means of lettering stencils or CAD. Free-hand lettering is also permitted. The minimum size of the letters shall correspond to table 4. Typed inscriptions are admissible if black ribbons are used which ensure adequate contrast. Standard vertical letters shall be used. When using lettering stencils, the letters shall be of the vertical type A shown in DIN 6776 part 1.

Table 4. Minimum width of letters in drawings

Size to DIN		Transp.	Adhesive label
A0		3.5	3.5
A1		3.5 ¹⁾	2.5
A2, A3		2.5	2.5
A4		1.8	1.8
Overlength		Transp.	Adhesive label
Width	Length		
A2, A3, A4	A0	3.5	3.5
A2, A3, A4	A1	3.5 ¹⁾	2.5
A3, A4	A2, A3	2.5 ²⁾	2.5 ²⁾
Title blocks		Transp./adhesive label	
A0 to A2		5.0 (3.5) ³⁾	
A3 and A4		3.5 (2.5) ³⁾	
1) In the case of ink drawings, 2.5 mm is also permitted. 2) In the case of wiring and loop diagrams, 1.8 mm is also permitted. 3) Bracketed dimensions have to be agreed upon.			

4 Arrangement, dimensions

Standard forms shall always correspond to Figure 2, i.e. broadside, title block in the lower section on the right side, except for forms of A4 with upright arrangement (Figure 3).

If the components to be represented in the drawing are very long in relation to their width, the arrangement shown in Figure 4 should be used, i.e. they should be shown in their service position as seen from the title block on the right side. If the position in which the component is shown does not correspond to the service position, it is imperative that the service position of the component be indicated. Dimensions, tolerances, types of fit, etc. shall be indicated as shown in the examples in DIN 406.

The dimensions and inscriptions shall be indicated in the drawing in such a manner that it is possible to read the drawing, starting from the bottom line or right side.

If it is necessary to reduce drawings to A4 size, an adequate filing margin shall be provided.

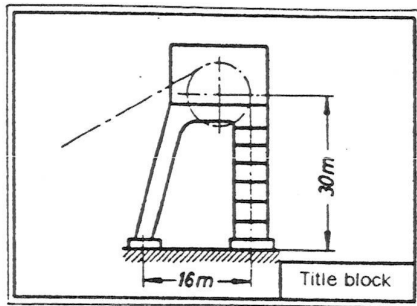


Figure 2.

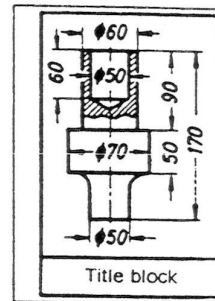


Figure 3.

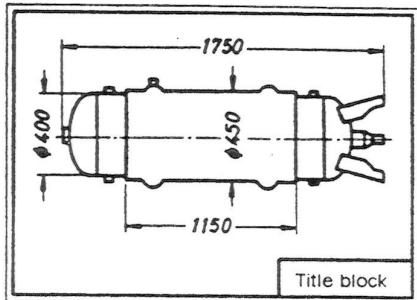


Figure 4.

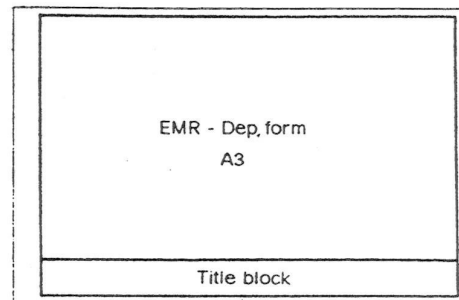


Figure 5.

In order to microfilm drawings with overlength, the drawings shall be sectionalized according to the standard sizes. The centre marking, drawing number and serial number shall be indicated in the related sections, starting with number 1 for the right section (see Fig. 6). It is essential that neither the representations nor other important data be shown in the overlapped sections.

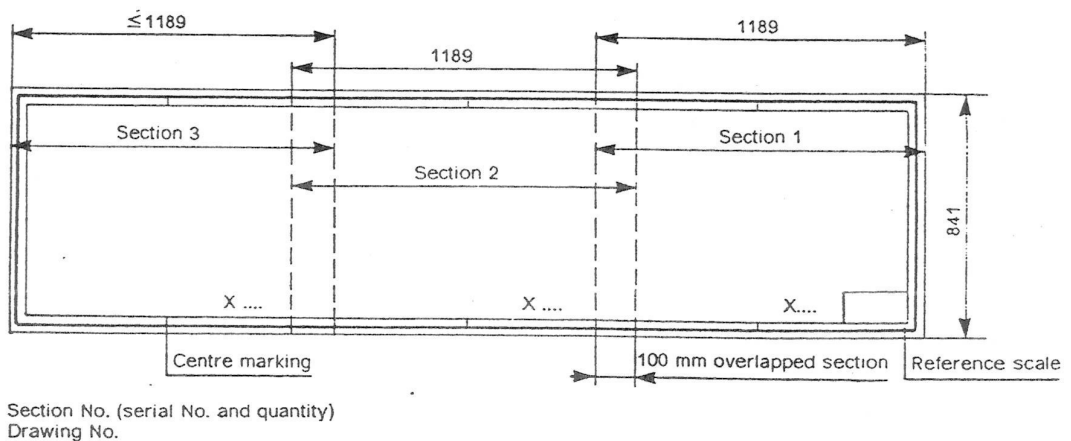


Figure 6. Sectionalized A0 size with overlength

5 Scale

The scale of the drawing shall correspond to DIN/ISO 5455.

Reference standards

DIN standards

DIN 15 part 1	Technical drawings, lines and fundamentals
DIN 15 part 2	Technical drawings, lines, examples for application
DIN 201	Materials to be identified in drawings, using coloured or hatched representation
DIN 406	Dimensions in drawings
DIN 476	Trimmed sizes of paper
DIN 824	Folding and filing of technical drawings
DIN 6771 part 6	Printed forms for technical documents
DIN 6774 part 1	Technical drawings, basic rules for preparation
DIN 6776 part 1	Technical drawings, lettering and characters
DIN/ISO 5455	Technical drawings, scale

Uhde standards

UN V401-01 part 2	Technical drawings, standard practices, title blocks
UN V401-04 part 1	Technical drawings, identification codes

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1 Scope

This Uhde standard outlines the minimum requirements for the welding of vessels and equipment in the workshop and on site. In addition to this standard and the codes and standards indicated in the purchase order, the accepted standards of technology shall apply. Uhde standards UN 2000-01 Part 1 (M) and UN 2100-01 Part 1 (M) to be considered.

If the data contained in this Uhde standard are in contradiction to those specified in the purchase order documents, the latter shall take precedence. If data differ, the more stringent data shall apply. The applicable codes and standards shall in any case be observed.

2 Qualification

Field welding and shop welding shall meet the same quality requirements.

2.1 Manufacturer's qualification

The manufacturer's workshops shall be equipped with the facilities required for the proper processing of the materials and for the performance of the necessary tests. Regarding pressure-bearing components, the manufacturer shall be in possession of the permit required according to the codes and standards. Uhde reserves the right to check whether these requirements are met.

2.2 Procedure qualification test

Welding procedure qualification tests shall be performed according to the applicable codes and standards prior to the start of fabrication unless the manufacturer's qualification permit already covers the materials to be processed, the dimensions and the welding procedures to be used. The procedure qualification test reports shall be submitted to Uhde upon request.

2.3 Welder's qualification test

Only welders tested according to the applicable codes and standards shall be employed. The qualification test certificates shall be submitted to Uhde upon request. An identification symbol shall be allocated to each welder.

2.4 Welding supervisor

To ensure the quality of the welds, the preparation and performance of the welding work shall be supervised by qualified personnel of the manufacturer. Refer to section 6 for further details.

3 Joint details

Butt weld joints shall be preferred. All pressure-bearing welds shall be full-penetration welded or back-welded on the root side. Back-welding shall be preferred for welds which are accessible from both sides.

Unless otherwise specified, fillet welds shall be performed with $a_{\min} = 0.7 \times$ smallest plate thickness. The min. fillet throat thickness shall be $a_{\min} = 3$ mm. Deviations shall be agreed upon for special designs.

Open gaps of any type shall be avoided. Centering rings or insert rings which remain in the component are only permitted if expressly approved by Uhde.

The transition between items of different wall thicknesses, joined by butt welding, shall be adapted by chamfering the larger wall thickness according to the codes and standards.

The minimum spacing between parallel butt welds shall be $6s$ ($s =$ vessel wall thickness) and 50 mm in the case of plate thicknesses of < 10 mm.

For welded joints according to Figure 1, sketches a to e, min. spacing l may be reduced to $2.5s$. Sketch f applies to the spacing between nozzles and shell welds.

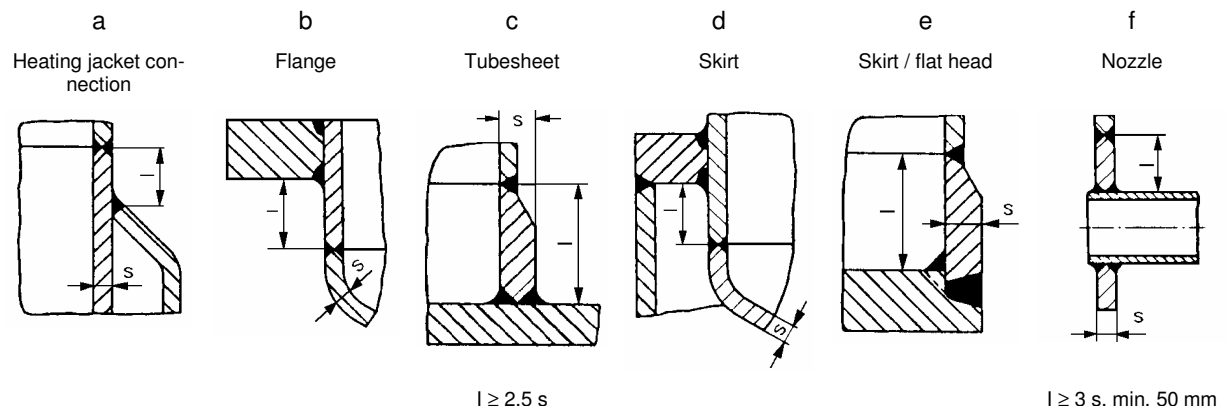


Figure 1. Welded joints

If the joint cannot be performed according to sketch f, the welds shall be arranged in such a manner that the vessel seam is interrupted completely by the nozzle. This type of joint is only permitted if approved by Uhde in writing. In such a case, the welds of pressure vessels shall be subjected to non-destructive testing. In addition, a surface crack test shall be performed on the nozzle-to-shell welds after the pressure test. The test length, measured from the nozzle edge, shall be $d \times s$ (d = nozzle diameter, s = vessel wall thickness in mm), but at least 100 mm. (Refer ASME Section V, Articles 6 and 7).

Cross welds are not permitted on pressure-bearing wall components. When welding stiffeners, connecting plates, etc. within the area of pressure-bearing welds of vessels, the welded-on components shall be provided with cut-outs according to Figure 2.

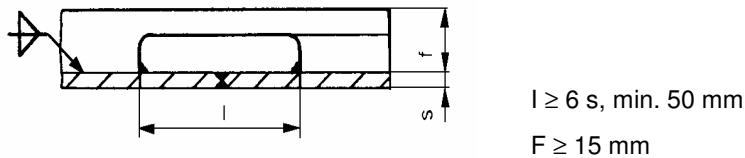


Figure 2. Cut-outs on stiffeners

Pressure-bearing welds (e.g. circumferential and longitudinal seams of pressure vessels) may only be covered by welded-on items if agreed upon with Uhde. Semi-tube coils on vessel walls shall be routed across the vessel welds over the shortest distance possible in order to maintain the testability of the covered welds to the greatest extent possible.

A test hole of $R \frac{1}{8}$ " shall be provided for design-specific, closed cavities, e.g. in the case of reinforcements of cut-outs, welded-on block flanges, sheet metal linings, etc. Any such test holes shall be shown in the workshop drawings. After the test, the test holes on the equipment shall be sealed with greasy paste or wax.

The dimensions and shape of the welds and of the components joined by welding shall correspond to the manufacturer's drawings approved by Uhde.

The manufacturer's drawings shall contain all welding data according to Uhde standard UN 2000-10 Part 1 (M). Field welds shall particularly be marked.

For the welding of clad steel, deposit welding, repair welds, and whenever demanded by Uhde, a welding and testing schedule shall be elaborated on Uhde form UF V360-21 Part 1 (M) and submitted for approval.

The dimensions of the groove shape, the welding procedure, the welding filler metals and the weld build-up per pass shall be described for all welds.

The joint details for vessels and equipment to be coated, lined or brick - lined shall be agreed upon.

4 Materials

4.1 General

The material certificates specified in the purchase order documents shall be furnished for all materials used.

Unless otherwise specified in the purchase order documents, killed steel shall be used and the C content limited to max. 0.25%.

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The materials shall be processed, transported, stored and marked in such a manner that any confusion, damage and corrosion are avoided.

Proper re-stamping of the materials shall be performed prior to cutting and machining. Tests for material conformity shall be performed in cases of doubt.

4.2 Special cases and special materials

It might become necessary to take special measures or to permit deviations from this standard in the following cases:

- Vessels with wall thicknesses of > 30 mm
- Unalloyed steel with a min. tensile strength of > 450 N/mm²
- Alloyed steel such as 13 CrMo 4 4 and higher alloyed steel
- Fine-grained steel with a yield strength of > 320 N/mm²
- Risk of stress corrosion cracking.

5 Preparation for welding

5.1 Weld preparation

The weld may be prepared thermally and/or mechanically. Thermal treatment shall be followed by mechanical treatment to remove any oxides.

Section 3 shall be observed for selecting the groove shape.

When employing thermal processes for preparing the welds on clad materials, the cladding shall be removed mechanically to such an extent that the cladding will not be changed metallurgically during the welding of the base metal.

The skin of a casting shall be removed in the area of the groove faces.

The groove faces shall be free of notches, occlusions, laminations, cracks and impurities.

The procedure shall be as follows:

- Notches caused by flame cutting shall be removed by grinding over a large area.
- Linear non-metallic occlusions which can cause difficulties when evaluating the ultrasonic test of the completed weld or which can cause disintegration of the material shall be removed by grinding and welding (buttering layer).
- It is not permitted to leave large laminations in place. Discontinuities of < 20 cm² may be repaired by grinding and welding (buttering layer). Discontinuities of ≥ 20 cm² shall be eliminated.

The method of repair shall be agreed upon with Uhde.

5.2 Protection of the workplace

The following shall apply when welding and thermal cutting are performed outdoors:

- The workplaces and workpieces shall be protected from inclement weather conditions (moisture, wind, low temperatures) by suitable means.
- Welding shall only be performed on a dry base.
- At workpiece temperatures of < 5°C, outdoor welding shall only be performed after adequate measures have been taken. The preheating temperature according to the welding schedule shall be observed.

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5.3 Aligning and tack welding

After preparation, the seams shall be aligned, tack welded or clamped in such a manner that the misalignment of the edges permitted according to the codes and standards is not exceeded and the specified root gap is observed. Welding-on of erection aids shall be kept to a minimum. After removal of the erection aids, it must be ensured that no cracks or any other type of damage start at these places. This shall be checked and confirmed by a magnetic particle test or a dye penetration test.

6 Welding

The welding procedures shall be adapted to the material, design and operating conditions.

The following are approved welding procedures:

- Shielded metal-arc welding (SMAW)
- Gas tungsten-arc welding (GTAW)
- Active-gas metal-arc welding (GMAW)
- Inert-gas metal-arc welding (GMAW)
- Submerged arc welding (SAW)
- (Tungsten) plasma-arc welding (PAW)
- Other welding procedures:

Other procedures may be employed if procedure qualification tests have been performed and Uhde's approval has been obtained.

Welds performed by the GMAW procedure (active-gas metal-arc welding and inert-gas metal arc welding) on components subjected to high stresses and/or on pressure-bearing components require Uhde's special approval.

6.1 Welding filler metals

The chemical composition of the welding filler metals shall be compatible with the base metal and the operating conditions. The filler and the base metals shall be of the same type as far as this is possible from the metallurgical aspect. Proof of certification shall be furnished for the electrodes used.

It must be ensured that the filler metals specified in the approved documents of the manufacturer are used. Other welding filler metals may only be used if approved by Uhde.

If any confusion of the filler metals is suspected, the manufacturer shall furnish proof of the filler metals used by suitable test methods.

For the joining of components of different ferritic materials, the filler metal corresponding to the lower alloyed base metal shall normally be used. When joining components of different austenitic materials, a filler metal corresponding to the higher alloyed base metal shall be used.

When joining components of ferritic and austenitic materials, an austenitic filler metal of a higher alloy than the base metal or a nickel-based filler metal shall be used. If the workpiece is subjected to operating temperatures of > 300°C or to heat treatment, a nickel-based filler metal shall be used.

6.1.1 Special requirements

In addition to the requirements outlined in this section, special demands can be made on the welding filler metals in special cases as regards analysis, limits of analysis and structural constituents.

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6.1.2 Shielding gas

The following shielding gases shall be used:

- GTAW: argon; welding-grade argon; helium; an Ar-He gas mixture, if necessary. For root protection: argon; helium; Ar-He gas mixtures, if necessary; anti-slag gas (90% N₂, approx. 10% H₂)
- GMAW (active-gas metal-arc welding): CO₂ or a gas mixture of Ar, CO₂ and O₂.
- GMAW (inert-gas metal-arc welding): argon; welding-grade argon or an argon mixture with an oxygen content of max. 1%.

Other types of shielding gas shall be agreed upon with Uhde.

6.1.3 Storage and stock keeping of welding filler metals

It must be ensured that

- the filler metals used are undamaged, that their sheaths are dry and that they are stored in dry rooms,
- the filler metals are free of oil, grease, rust and impurities.

6.1.4 Drying

Prior to use, rod electrodes with mainly basic sheaths, which are used for the welding of unalloyed and low-alloy steel, shall be dried according to the instructions of the manufacturer, but for at least 2 hours at 250°C and temporarily stored at 100 to 150°C. They shall be removed from the drying oven in small quantities and kept in a heated flask at 100 to 150°C until use.

This also applies to rod electrodes of higher alloyed austenitic materials and nickel-based materials with rutile-bearing sheaths. The drying temperature and drying period shall correspond to the manufacturer's specifications. Agglomerated welding flux for submerged-arc welding shall be treated as basic rod electrodes.

6.2 Performance of welding

The specified energy per unit of length, preheating and temporary storage temperatures shall be observed.

Quick cooling shall be avoided. This particularly applies to materials which are susceptible to hardening. Components which are welded at a preheating temperature of > 50°C may only cool down gradually (measures to be taken: e.g. covering by means of insulating mats).

6.2.1 Tack welds

Tack welds need not be removed prior to welding if the starting crowns and end craters are ground and/or the tacks are completely fused during welding. When welding an erection aid to a component, the welding requirements met by the component shall also apply to the erection aid. Welding shall be performed with at least 2 layers.

6.2.2 Welding of root, filler and top passes

Striking the arc on the surface of the workpiece is not permitted. The arc may only be struck on the groove face, the existing bead or on an auxiliary plate.

The root pass of welds which are welded from one side shall be protected from the admission of air by means of shielding gas (e.g. anti-slag gas) and/or treated mechanically after welding.

The root pass of welded joints of austenitic components shall be performed by the GTAW procedure under shielding gas and using an additional welding wire. Deviations herefrom require Uhde's written approval.

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The root pass shall be checked for defects and back-chipped prior to back-welding. In the case of high-tensile steel, steel susceptible to cracking as well as austenitic materials, the back-chipped root shall be subjected to a non-destructive test.

Gouging or grooving out the root pass thermally is only permitted if the root pass is subsequently ground.

Prior to welding the filler and top passes, the preceding passes shall be cleaned from welding slag. Lack of fusion, pores and occlusions shall be eliminated by grinding.

The top pass shall be free of notches and shall only be a little wider than the groove. In special cases, notch – free transitions of the welds may be required. In the weld areas concerned, the working steps shall be performed according to the specifications contained in the manufacturer's drawing (standard symbols or text). Normally, notches shall be removed by grinding.

Special agreements shall be made for the welding of materials coming into contact with hydrogen sulphide, high-pressure hydrogen or urea.

6.2.3 Cleaning and grinding

After completion of the work, slag, scale, annealing colours, welding spatter and other impurities shall be removed from all welds. It must be ensured that the tools used for this purpose do not adversely affect the material of the component concerned (measures to be taken: e.g. only brushes of stainless steel shall be used for cleaning stainless steel; only suitable grinding disks shall be used for austenitic materials - the disks shall not be used for other types of material).

After completion of the workpiece, any inadvertent arc strikes on the surface shall be smoothed by grinding. The wall thickness shall not be less than the specified min. wall thickness. After grinding has been completed, austenitic materials shall normally be subjected to erosive pickling and passivation. Deviations herefrom require a separate agreement.

At Uhde's request, the manufacturer shall furnish proof of the absence of cracks in the ground areas. The erection aids shall not be removed by knocking them off or by flame cutting. After removal of the erection aids, the areas to which they had been welded shall be ground. Proof of the absence of cracks shall be furnished by a surface crack test. (Refer ASME Section V, Articles 6 and 7).

6.2.4 Welding of clad steel

Refer to sections 5.1 and 6.1.

Electrodes for the welding of buttering layers may also be used for the welding of filler passes and, if the corrosion resistance is adequate, for top passes.

An agreement shall be made if treatment of the weld surface is required.

6.2.5 Welding after cold forming

If welding is required on steel which has been cold formed by more than 5%, proof shall be furnished that welding is permissible.

When welding edged plates of C steel, the distance of the welds from the area of cold forming shall be at least $R + 2 \times s$ (R = edge radius, s = wall thickness).

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6.2.6 Tube-to-tubesheet welding

Uhde standard UN V416-02 Part 1 (M) applies to tube-to-tubesheet welding.

6.2.7 Application of heat during welding

When determining the preheating temperature and the filler pass temperature, the special characteristics of the material, the welding parameters, design, wall thickness and the corrosion attack by the process fluid concerned shall be taken into consideration. The temperature ranges to be observed shall be specified in the manufacturer's drawings. The preheating zone beside the weld shall be 4 x wall thickness, but at least 100 mm. During welding, the wall temperature shall be monitored continuously by means of thermochrome crayons, surface thermometers or thermocouples and recorded upon request. The preheating zone shall be cooled in still air. In the case of steel which is sensitive to welding, consideration shall be given to the question as to whether heat treatment is required immediately after welding while the steel is still hot.

The preheating temperature shall be agreed upon for special welding work, e.g. deposit welding, repair welding, etc.

6.2.8 Marking of welds

All welds on pressure-bearing components shall be marked by the welder by means of his stamp. The type of marking to be used on steel which is susceptible to cracking and on components with special surface requirements shall be agreed upon. The marking of austenitic components of wall thicknesses of < 6 mm may only be effected by engraving or with coloured crayons which are free of oil, grease, sulphur, chlorine, tin, zinc, arsenic, lead and copper. Uhde reserves the right to check the works' certificates of the manufacturer of the marking means.

7 Post-weld heat treatment

If post-weld heat treatment is required, the heat treatment temperature shall take into consideration the heat treatment already performed on the blanks. The specified heat treatment data shall be taken into consideration when procuring the blanks.

The annealing process to be used, the annealing temperature, the heating rate, the holding time, and the cooling rate shall be specified in the drawing or in an annealing schedule.

7.1 Stress-relieving and tempering

Stress-relieving shall be performed after all welding work has been completed. The following parameters shall apply to the performance of stress-relieving:

- Deviations from the stress-relieving temperature between the individual measuring points should be kept as small as possible (reference value: $\pm 15^{\circ}\text{C}$).
- Unless otherwise specified in the material data sheets or by Uhde, the following shall apply to temperatures exceeding 400°C :
 - § Heating rate
 - $\leq 70^{\circ}\text{C/h}$ for wall thicknesses up to 50 mm
 - $\leq 50^{\circ}\text{C/h}$ for wall thicknesses exceeding 50 mm
 - § Cooling rate
 - $\leq 50^{\circ}\text{C/h}$ for wall thicknesses up to 50 mm
 - $\leq 30^{\circ}\text{C/h}$ for wall thicknesses exceeding 50 mm
 - § In the case of closed chambers or complex structural components with large differences in wall thickness, the heating and cooling rates shall be determined taking into consideration the max. permissible thermal stresses of the various cross sections of the components. The heating and cooling rates shall be controlled via the max. permissible difference in temperature (e.g. 20 to 30°C).
- The holding time shall be 2 minutes per mm material thickness, but at least 30 minutes.

Stress-relieving schedules shall be prepared for materials which are subjected to high stresses, severe corrosion attacks and multiple stress-relieving. These stress-relieving schedules shall specify the designation of the

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component concerned, position of the temperature measuring points, heating and cooling rates, holding time, position of the test specimens and the furnace atmosphere.

Uhde reserves the right to check the arrangement of the instruments and measuring points prior to the start of stress-relieving.

If production test plates are stress-relieved separately from the workpiece, it must be ensured that the stress-relieving of the production test plate is comparable to that of the workpiece.

If the stress-relieving temperature is controlled by measurements taken in the furnace chamber, Uhde reserves the right to demand that a stress-relieving test be performed when it is doubtful that the temperature in the furnace chamber is uniform. Workpieces may be withdrawn from the furnace at temperatures below 300 °C if cooling in still air is ensured.

Workpieces of very different thicknesses and workpieces of materials which are susceptible to cracking shall remain in the closed furnace for at least ½ h at temperatures below 100 °C before they are withdrawn. The workpieces to which the above applies shall be agreed upon.

Welding and forming work which must be performed after stress-relieving shall be agreed upon in detail and approved by Uhde.

7.2 Partial stress-relieving

Partial stress-relieving of the welds requires Uhde's approval. The width of the zone being stress-relieved shall be at least 6 x wall thickness, but at least 50 mm on either side of the weld. The axial course of heating shall be influenced by means of adequate insulation to prevent the resulting thermal stresses from damaging the base metal. Uhde may demand proof by calculation.

7.3 Normalizing

Normalizing of welded components requires Uhde's written approval.

8 Post-weld surface treatment

8.1 Mechanical treatment

Refer to section 6.2.3.

8.2 Chemical treatment

In the case of high-alloyed steel and nickel-based alloys, the annealing colours shall be removed from the workpiece by pickling.

Depending on the application, either pickling pastes or pickling baths may be used. If approved by Uhde, pickling can be replaced by sand/shot blasting.

The surface treatment shall be performed according to Engineering Standard UN V416-03 Part 1 (M).

9 Repair welds

The welding and testing procedures used in fabrication shall also be used for repair welds. Uhde shall be informed about repair welds with a depth of > 20 mm and a length of > 300 mm on materials according to section 4.2 and when repair welds have to be performed in difficult positions. The last paragraph but two of section 3 applies to deviating welding procedures.

10 Weld quality requirements

The requirements specified in the codes and standards for pressure vessels shall apply.

11 Testing of the welds

Refer to the codes and standards and to the technical specification.

Reference standards

Uhde Standards

UN 2000-01 Part1 (M) Pressure vessels, general specification

UN 2100-01 Part1 (M) Tubular heat exchangers, general specification

UN 2000-10 Part1 (M) Title block's for manufacturers drawings

UN V416-02 Part1 (M) Tube – to – tubesheet joints

UN V416-03 Part1 (M) Surface treatment of austenitic stainless steels after welding

Uhde forms

UF V360-21 Part1 Welding procedure and testing schedule

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1 Scope

This Uhde standard is a supplement to Uhde standard UN V416-01 Part 1(M) "Requirements", and covers the requirements for weld joint of similar and dissimilar steels.

1.1 Handling

Individual sheets of this Uhde standard may be used as specification if a respective note is included. In this case, it is not necessary to change the numbering of the page.

The details marked ● in this Uhde standard require an agreement between purchaser and manufacturer. The latter is requested to make proposals which require written approval prior to the performance of the welds.

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2 Examples for welded joints of similar steels

Item	Figure	Application	Requirements	Notes
U 1 Heads and shells				
U 1.1				For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3
U 1.2		Tapered transition for plates of unequal wall thickness.	1) If cladding is required, the tapered transition shall be arranged on the external side.	
U 1.3		For non-pressure vessels with flat heads.	$a = 0,5 s_1$ but min. 3 mm	If surface protection from inside is required, the surfaces shall be smoothed by grinding.
U 1.4		For non-pressure vessels with conical heads. For pressure vessels in exceptional cases.	For pressure vessels only with double-welded butt joint; the related design standard must be observed.	For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3
U 1.5		When plates of unequal wall thickness are welded and the joint is accessible from one side only.	1) Longitudinal weld: $e_1; e_2 \le 0.1 s_2$ but max. 2 mm Circumferential weld: $e_2 \le 0.1 s_2$; max. 2 mm $e_1 \le 0.2 s_2$; max. 5 mm	For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3. The offset e_2 shall be such that the root pass can be welded properly
U 1.6		When plates of unequal wall thickness are welded and the joint is accessible from both sides .	1) Longitudinal weld: $e_1 \le 0.1 s_2$; max. 2 mm $e_2 \le 0.2 s_2$; max. 4 mm $s_2 - s_1 \le 0.3 s_1$; max. 6 mm Circumferential weld: $e_1 \le 0.2 s_2$; max. 5 mm $e_2 \le 0.4 s_2$; max. 10 mm $s_2 - s_1 \le 0.4 s_1$; max. 10 mm	For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3. If full penetration by the back-welding method and a sufficient transfer of forces is ensured, higher offset values are admissible for non-pressure vessels

Item	Figure	Application	Requirements	Notes
U 1.7		When plates of different wall thicknesses are welded. For pressure vessels refer to the design standards.	1) The values of U 1.5 or U 1.6 are exceeded.	For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3
1) If cladding is required, the admissible offset depends on the cladding thickness.				
U 2 Flanges				
U 2.1		For pressure vessels, process equipment and piping.		The flange face normally needs not be machined after welding. For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3.
U 2.2		Flanged nozzles and piping.	$PN \leq 10 \text{ bar}$ $DN \leq 500$	For type of groove refer to Uhde-Standard UN V416-01 Part 1(M) Section 3.
U 2.3		Non pressure vessels of carbon-steel.	$s_1 \leq 8 \text{ mm}$ $a \geq 3 \text{ mm}$	If necessary, the flange face shall be machined after welding.
U 2.4		Non pressure vessels	For vessel shell flanges: $s_1 \geq 5 \text{ mm}$ (for austenitic steel $\geq 4 \text{ mm}$) $h \leq 6 s_1$ $a = 0.7 s_1 \geq 3 \text{ mm}$ $b \leq 3 \text{ mm}$ for $s_1 \geq 5 \text{ mm}$ $b \leq 2 \text{ mm}$ for $s_1 < 5 \text{ mm}$	If necessary, the flange face shall be machined after welding. This applies also for plain collars of Lap Joint flanges.

Item	Figure	Application	Requirements	Notes															
U 2.5	<p>If $s_1 \geq 16$ mm the joint shall be of the single-J butt type with fillet weld</p> <p>alternatively</p>	Pressure vessels	$s_1 \leq 30$ mm $b \leq 3$ mm if $s_1 < 16$ mm $b \leq 4$ mm if $s_1 \geq 16$ mm Single-bevel groove weld <table border="1" style="font-size: small;"> <tr> <th>a (mm)</th> <th>$p_e \cdot d_i$ (bar mm)</th> </tr> <tr> <td>$0.7 s_1$</td> <td>$\leq 10\ 000$</td> </tr> <tr> <td>$1.0 s_1$</td> <td>$\leq 20\ 000$</td> </tr> </table> Single-J groove weld for $p_e \cdot d_i = \text{unlimited}$ <table border="1" style="font-size: small;"> <tr> <td>s_1</td> <td>≤ 10 mm</td> <td>> 10 mm</td> </tr> <tr> <td>t</td> <td>$= s_1$</td> <td>$= s_1$</td> </tr> <tr> <td>R</td> <td>$= 6$ mm</td> <td>$= 8$ mm</td> </tr> </table>	a (mm)	$p_e \cdot d_i$ (bar mm)	$0.7 s_1$	$\leq 10\ 000$	$1.0 s_1$	$\leq 20\ 000$	s_1	≤ 10 mm	> 10 mm	t	$= s_1$	$= s_1$	R	$= 6$ mm	$= 8$ mm	The flange shall be machined after welding. For temperatures above 150°C a vent bore shall be provided.
a (mm)	$p_e \cdot d_i$ (bar mm)																		
$0.7 s_1$	$\leq 10\ 000$																		
$1.0 s_1$	$\leq 20\ 000$																		
s_1	≤ 10 mm	> 10 mm																	
t	$= s_1$	$= s_1$																	
R	$= 6$ mm	$= 8$ mm																	
U 2.6		see U 2.5	see U 2.5	see U 2.5															

U 3 Nozzles

**Nozzles accessible from both side
Minimum wall thickness of the nozzle pipe $s_1 \geq 3.2$ mm**

U 3.1		2) Nozzles protruding from the internal side for $s_1 \leq 14$ mm $s_2 \leq 30$ mm	$a = 0.7 s_1$ but $a \geq 3$ mm if $s_2 \leq 15$ mm $a \geq 5$ mm if $s_2 > 15$ mm $h \geq s_1$ This requirement only applies to $s_1 < s_2$	
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Item	Figure	Application	Requirements	Notes
U 3.2		<p>2)</p> <p>Nozzles protruding from the internal side for</p> <p>$s_1 > 14 \text{ mm}$ $s_2 \leq 30 \text{ mm}$</p>	<p>$s = 0,5 s_1$ $a = 0,5 s_1$ $h \geq s_1$</p>	<p>If s_1 larger than s_2 the weld dimensions shall comply with s_2.</p> <p>This applies also to $s_1 < 14 \text{ mm}$ if the nozzles are used for the reinforcement of wall cut-outs</p>
U 3.3		<p>2)</p> <p>Nozzles which do not protrude from the internal side (such as drains, internals, lining)</p> <p>$s_1 \leq 14 \text{ mm}$ $s_2 \leq 30 \text{ mm}$</p>	<p>$a = 0,7 s_1$ but $a \geq 3 \text{ mm}$ if $s_2 \leq 15 \text{ mm}$ $a \geq 5 \text{ mm}$ if $s_2 > 15 \text{ mm}$ $m \geq s_1$</p> <p>This applies only to $s_1 < s_2$</p>	
U 3.4	<p style="text-align: left; margin-left: 20px;"><u>alternatively</u></p>	<p>2)</p> <p>Nozzles which do not protrude from the internal side (such as drains, internals, lining)</p> <p>$s_1 > 14 \text{ mm}$ $s_2 \leq 30 \text{ mm}$</p>	<p>$s = 0,5 s_1$ $a = 0,5 s_1$ $m \geq s_1$</p>	<p>If s_1 is larger than s_2, the weld dimensions shall comply with s_2.</p> <p>This applies also to $s_1 < 14 \text{ mm}$ if the nozzles are used for reinforcement of wall cut-outs.</p>

2) These welds shall only be used for atmospheric vessels.

Item	Figure	Application	Requirements	Notes						
U 3.5		Pressure vessels $s_2 \leq 10 \text{ mm}$	$z \approx 0.3 s_2$	Back welding is required; weld with notch-free transition. 3)						
U 3.6		Pressure vessels $s_2 > 10 \text{ mm}$	$z \approx 0.3 s_2$ Ensure adequate wall thickness s_1 . <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px;">β</td> <td style="padding: 2px;">45° to 60°</td> <td style="padding: 2px;">$\geq 30^\circ$</td> </tr> <tr> <td style="padding: 2px;">$\frac{b}{s_1}$ (mm)</td> <td style="padding: 2px;">2 to 4</td> <td style="padding: 2px;">4 to 6</td> </tr> </table>	β	45° to 60°	$\geq 30^\circ$	$\frac{b}{s_1}$ (mm)	2 to 4	4 to 6	Weld with notch-free transition. 3)
β	45° to 60°	$\geq 30^\circ$								
$\frac{b}{s_1}$ (mm)	2 to 4	4 to 6								
U 3.7 ●		Preferred for enameled vessels $s_2 \leq 12 \text{ mm}$	$s_2 > 4 \text{ mm}$ in case it must be enameled	This type requires approval on a case-to-case basis. The necked-out section must be such, that the material properties are not affected. This applies also to cases where the weld is accessible from one side only. 3)						
Nozzle accessible from one side only Minimum wall thickness of nozzle pipes $s_1 \geq 3.2 \text{ mm}$										
U 3.8		$DN \leq 300$ $s_1 \leq 14 \text{ mm}$ $s_2 \leq 30 \text{ mm}$	$s_2 = 3 s_1$ $z \approx 0.3 s_2$ Weld root pass by the gas-shielded method.	If $s_2 > 16 \text{ mm}$, single-J groove is permitted. 3) <div style="text-align: right; margin-top: 10px;"> </div>						

3) The internal edges of the nozzle pipe shall be rounded. For radius refer to Uhde Standard UN 2000-01 Part 1 (M) clause 3.4.3

Item	Figure	Application	Requirements	Notes								
U 3.9 ●		DN ≤ 100 $s_1 \leq 7 \text{ mm}$ $s_2 \leq 30 \text{ mm}$ Permitted only in exceptional cases which require the approval of the purchaser.	$s_2 \leq 3 s_1$ Weld root pass by the gas-shielded method.	The shell section adjacent to the nipple weld shall be subjected to ultrasonic testing. Ensure adequate nipple length ($> 6 s_1$) 3)								
U 3.10 ●	<table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th>s_1 (mm)</th> <th>x (mm)</th> </tr> </thead> <tbody> <tr> <td>≤ 4.5</td> <td>8</td> </tr> <tr> <td>> 4.5 to 8</td> <td>4</td> </tr> <tr> <td>> 8 to 16</td> <td>≈ 2</td> </tr> </tbody> </table>	s_1 (mm)	x (mm)	≤ 4.5	8	> 4.5 to 8	4	> 8 to 16	≈ 2	For nipples and nozzles subjected to higher loads; $d_a < 100 \text{ mm}$ They are subjected to special approval.	Additional measures required for full penetration welding shall be agreed upon on a case-to-case basis. $s_2 \geq t + 3 \text{ mm}$ $t \geq 3 \text{ mm}$ Weld the root pass by the gas-shielded method.	The shell section adjacent to the nipple weld shall be subjected to ultrasonic testing. 3)
s_1 (mm)	x (mm)											
≤ 4.5	8											
> 4.5 to 8	4											
> 8 to 16	≈ 2											
U 3.11 ●		Special type with drilled root for nozzles and nipples which have a diameter ($d < 50 \text{ mm}$). Type normally used for high-pressure vessels. In case of larger diameters, this weld type is subjected to approval of the purchaser.	Hole and weld depth must be arranged such as to ensure proper drilling to the root.	For $s_1 \geq 4 \text{ mm}$, the following dimensions may be used: $\beta = 30^\circ$ $c \geq 1.5 \text{ mm}$ $R \geq 4 \text{ mm}$ $d_1 = d_2 + 2 \text{ mm}$ $d = d_1 + (4 \text{ to } 6 \text{ mm})$ The shell section adjacent to the nipple or nozzle welds shall be subjected to ultrasonic testing. 3)								
Reinforced types of nozzle												
U 3.12		For pressure vessels Nozzle reinforced by means of pipes of larger wall thickness shall be preferred to reinforcing rings.	If the nozzle is accessible from both sides, the weld edge shall correspond to Figures U 3.5 to U 3.6; if it is accessible from one side only, it shall comply with Figure U 3.8.	3)								

3) The internal edges of the nozzle pipe shall be rounded. For radius refer to Uhde Standard UN 2000-01 Part 1 (M) clause 3.4.3

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Item	Figure	Application	Requirements	Notes
U 3.13		Used for nozzles which are accessible from both sides, configuration according to Figures U 3.1 to U 3.4	$s_3 \leq s_2$ $h \geq 0.7 s_3$ $\alpha = 60^\circ$ $a = 0.5 s_3$	For use in hydrogen service, the weld design shall correspond to Figure U 3.14. 3)
U 3.14		Pressure vessels	$s_3 \leq s_2$ $b + s_1 = s_3$ $b \geq 7 \text{ mm}$ $\beta \geq 20^\circ$ $a = 0.5 s_3$ $z \approx 0.3 s_3$	3)

U 4 Pad type connections, inserted

U 4.1	<p>alternatively Standard weld for spherical and flat sections</p>	Non pressure vessels; spherical, cylindrical and flat sections $s_2 = 5 \text{ to } 16 \text{ mm}$	$a = 0,7 s_2$ $h \geq s_2$	If pad type flanges with a larger diameter D are welded to shells, it is essential that an adequate diameter D_a be provided.
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3) The internal edges of the nozzle pipe shall be rounded. For radius refer to Uhde Standard UN 2000-01 Part 1 (M) clause 3.4.3

Item	Figure	Application	Requirements	Notes
U 4.2	<p><u>alternatively</u> standard weld for spherical and flat sections</p>	<p>Spherical, cylindrical and flat sections, $16 < s_2 < 30$ mm</p> <p>If pad type flanges with a larger diameter D are welded to shells, it is essential that an adequate diameter D_a be provided.</p>	<p>$s = 0.35 s_2$ $a = 0.5 s_2$ $h = 1.3 a$</p>	
U 4.3		<p>Pressure vessels $s_2 \leq 30$ mm</p> <p>If pad type flanges with a larger diameter D are welded to shells, it is essential that an adequate diameter D_a be provided.</p>	<p>$z \approx 0.3 s_2$ $b = 2$ to 3 mm</p>	<p>if $s_2 < 16$ mm it is possible to use single-bevel groove welds with back-welding.</p>
U 4.4		<p>Spherical and flat sections, irrespective of the wall thickness s_2.</p>		
U 4.5	<p>If required, the contour shall be adapted to the radius</p>	<p>For spherical, cylindrical and flat section if the flange must be plane with the internal side.</p> <p>$s_2 \leq 30$ mm</p>	<p>$z \approx 0.3 s_2$ $b = 2$ to 3 mm</p>	<p>If $s_2 > 16$ mm, a double-bevel groove weld is required.</p>

Item	Figure	Application	Requirements	Notes
U 4.6		<p>For spherical, cylindrical and flat sections if the joint is accessible from one side only.</p> <p>$s_2 \leq 16 \text{ mm}$</p>	<p>$z \approx 0.3 s_2$ $b = 2 \text{ to } 3 \text{ mm}$</p> <p>Weld root pass by the gas-shielded method.</p>	
Pad type connections, set up				
U 4.7	<p style="text-align: center;"><u>alternatively</u> For spherical and flat section</p>	<p>Non pressure vessels; For spherical, cylindrical and flat sections if</p> <p>$h \leq 3 \text{ mm}$ $s_2 \leq 30 \text{ mm}$</p>	<p>$a = 0.5 s_2 \geq 5 \text{ mm}$ $z = 0.7 s_2$ thereby covering s_2</p>	<p>Tapped hole penetrating the pad or blind hole.</p> <p>For pressure vessels, use tapped blind hole.</p> <p>For $h \leq 1 \text{ mm}$ (such as inspection holes), the following is required: $a = 0.5 s_2 \geq 3 \text{ mm}$</p>
U 4.8	<p style="text-align: center;"><u>alternatively</u> For spherical and flat section</p>	<p>Non pressure vessels; For spherical and cylindrical section if</p> <p>$h_1 \leq 15 \text{ mm}$ $s_2 \leq 30 \text{ mm}$</p>	<p>$h_2 \leq 3 \text{ mm}$, otherwise it must be adapted</p> <p>$a = 0.5 s_2 \geq 5 \text{ mm}$ $z = 0.7 s_2$ thereby covering s_2</p> <p>$e = 0.5 s_2 \geq 10 \text{ mm}$</p>	<p>Tapped hole penetrating the pad or blind hole.</p> <p>For pressure vessels, use tapped blind hole.</p>

Item	Figure	Application	Requirements	Notes
U 4.9		Non pressure vessels; For spherical and cylindrical section if $h_1 > 15 \text{ mm}$ $s_2 \leq 30 \text{ mm}$	$h_2 \leq 3 \text{ mm}$, otherwise it must be adapted. $s_1 \approx s_2$ $a = 0.5 s_2 \geq 5 \text{ mm}$ $a_1 = 0.5 s_2 \leq 6 \text{ mm}$ $z = 0.7 s_2$ thereby covering s_2	Tapped hole penetrating the pad or blind hole. For pressure vessels, use tapped blind hole.

U 5 Jacketed vessels

U 5.1		For vessels if $s_2 \leq 15 \text{ mm}$	$\alpha \approx 45^\circ$ $\beta = 45^\circ \text{ to } 60^\circ$ $b = 2 \text{ to } 3 \text{ mm}$	Full penetration weld for root pass required This type is also used for pipes.
U 5.2		$s_2 \leq 15 \text{ mm}$ 1. for instance, if the shell must be enamelled. 2. for instance, if the vessel must be heat-treated without jacket.		

Item	Figure	Application	Requirements	Notes
U 5.3		$s_2 \leq 15 \text{ mm}$ 1. for instance, if the shell must be enamelled. 2. for instance, if the vessel must be heat-treated without jacket.	$\beta = 45^\circ \text{ to } 60^\circ$ $b = 0 \text{ to } 4 \text{ mm}$	If the stress is low, fillet welds with $a = 0,7 s_2$ are also admissible.
U 5.4		$s_2 > 15 \text{ mm}$	$c =$ according to the design calculation but $> s_2$ $R \geq 5 \text{ mm}$ $h \geq 0,5 s_2$ $b = 0 \text{ to } 4 \text{ mm}$ $\beta = 45^\circ \text{ to } 60^\circ$	This type is also used for pipes. If the stress is low, fillet welds with $a = 0,7 s_2$ is also admissible.
U 5.5 ●		Jacket welded in sections alternatively	$a \geq 0,7 s_2$ $b \geq 1,5 s_2$, but min. 6 mm $\beta \geq 10^\circ$ if $s_2 \geq 10 \text{ mm}$ alternatively: The fillet welds a_1 must be calculated $a_1 \geq 0,7 s_2$	Subject to approval on a case-to-case basis.