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Dimensions in mm

1 Scope

This Linde Standard (LS) applies to the welding of aluminium both for pre-fabrication and on site

- circumferential welds in pipes,
- branch welds for pipe nozzles and T-pieces,
- fillet welds.

2 Normative references

This LS contains provisions which, through dated or undated references in this text, constitute provisions of other publications. The normative references are cited at the respective place in the text and the publications are listed below. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the issues valid at the effective date of contract shall apply.

LS 419-01 Backing rings for welding of Al-pipes

LS 419-80*) Backing rings for welding of Al-pipes and components according to China National GB code

LS 145-22: 10.2010 Welding end preparation, figures, pipe wall thickness adjustment

*) LS 419-80 may be applied alternatively to LS 419-01 for application in the People's Republic of China

3 Terms, abbreviations and definitions

Branch A piping component diverging from a run pipe (reinforced, unreinforced, tangential nozzles, welded T-pieces)

4 General

Deviations from weld bevel preparations specified in this LS are only permitted with prior written approval from Linde AG.

Pressure bearing welds are to be carried out with full penetration and with at least two passes. If internal access is possible, a GTAW welding seam is to be applied simultaneously from both sides. If not possible, a GTAW counter pass can be made from the inside as an alternative.

Pipes with different wall thicknesses to be welded together shall be adapted in accordance with Para. 10.

5 Welding process

Manual GTAW welding for root, filler and cover passes.

6 Types of welding seams

6.1 Circumferential seams

Table 1: Seam selection for circumferential welds

Circumferential welds	Diameter	Wall thickness [mm]	Weld detail acc. to Para. 8	Welding process	
Prefabrication *)	≤ DN 100 / NPS 4	all	25	GTAW	on backing ring acc. to LS 419-01
	> DN 100 / NPS 4 ≤ DN 600 / NPS 24	≤ 3	1		one-sided weld, on rotating device
		> 3 ≤ 5	41		
		> 5	42		
	> DN 600 / NPS 24	≤ 7	3	GTAW	both sides simultaneously
		> 7 < 9	4	GTAW (root pass)	
				GTAW (filler/cover pass)	single-sided
		≥ 9	35	GTAW (root pass)	both sides simultaneously
				GTAW (filler/cover pass)	single-sided
Site assembly welds (fixed position)	≤ DN 100 / NPS 4	all	25	GTAW	on backing ring acc. to LS 419-01
	> DN 100 / NPS 4	≤ 6	31		
		> 6	32		

*) Depending on the project, CrNi backing rings can also be provided for prefabrication welds >DN 100 / NPS 4. In this case prefabrication seams shall be welded on backing rings, if the welding both sides simultaneously or counter welding from the inside is not possible.

6.2 Branch welds

- Branch pipes are to be set on the run pipe:
 - for run pipes \leq DN 150 / NPS 6,
 - for run pipes $>$ DN 150 / NPS 6, when the branch wall thickness \leq run pipe thickness and/or DN branch = DN run pipe.
- Branch pipes are to be set in the run pipe:
 - for run pipes \geq DN 200 / NPS 8 with branch wall thickness $>$ run pipe wall thickness and DN branch $<$ DN run pipe.
- If, according to Table 2, welding on a backing ring is not foreseen, then access to the inside shall be guaranteed either through the branch or the run pipe. The branch or run pipe shall be cut at the required distances if necessary:
 - run pipe on one side at a distance of run pipe DN + branch DN/2 from the branch axis,
 - branch at a distance of run pipe DN/2 + branch DN from the run pipe axis.

Branches $\geq 60^\circ$ shall be made as defined in Table 2. In case of doubt, the Linde AG site management shall be contacted.

Branches $< 60^\circ$ are not permitted, as the fabrication of a proper welding seam in the acute angle between run pipe and branch is not possible. Permissible DN run pipe / DN branch combinations for tangential branches are given in Table 3.

Table 2: Seam selection for branch welds

Branch (90°)	Nominal diameter	Wall thickness [mm]	Weld detail acc. to Para. 8	Welding process
set on	Branch ≥ DN 100 / NPS 4	≥ 3 ≤ 5 *)	103	GTAW both sides simultaneously
		> 5 ≤ 10 *)	112	
		> 10 *)	116	
	Branch < DN 100 / NPS 4	All*)	108 or 109 or 123	GTAW single-side on backing ring acc. to LS 419-01
set in (inserted)	-	> 3 ≤ 8 **)	181	GTAW both sides simultaneously
		> 8 **)	185	
*) Branch wall thickness **) Run pipe wall thickness				

Table 3: Permitted DN-combinations for tangential branches

Run pipe	DN	100	150	200	250	300	400	500	600	700	800	900	1000
	NPS	4	6	8	10	12	16	20	24	28	32	36	40
Branch	DN min.	25	40	50	65	80	100	150	150	200	200	200	250
	NPS min	1	1 1/2	2	2 1/2	3	4	6	6	8	8	8	10

6.3 Fillet welds

Fillet welds are always shall be carried out as flat or concave fillet welds with the specified "a" dimension.

7 Welding with CrNi-backing ring

7.1 Weld seam preparation

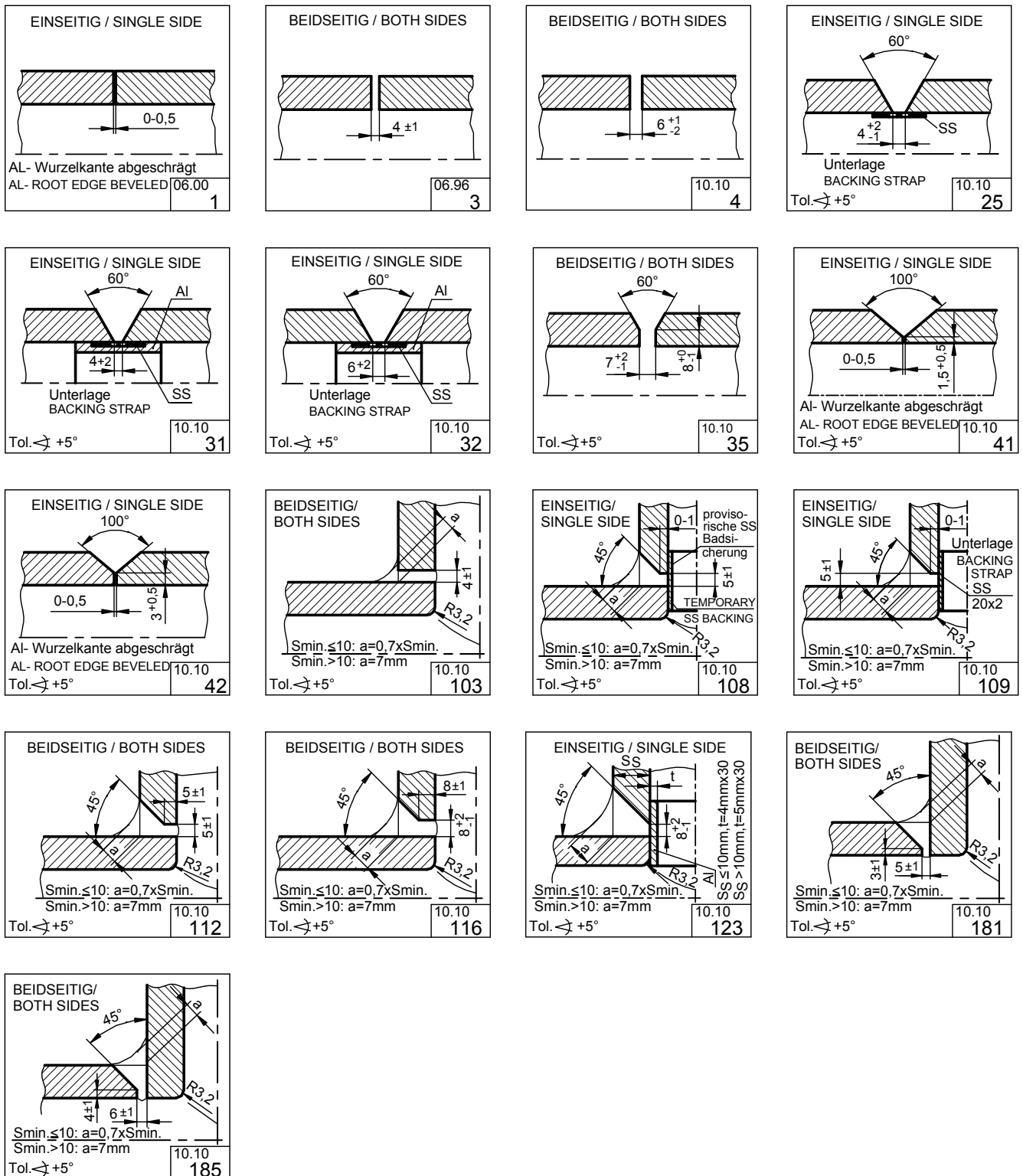
The pipe ends to be connected shall, if necessary, be worked by adjusting the inner diameters and ovality, in welded pipes by removal of the root up to a length of 15 mm from the end of the pipe so that the backing ring can be slid in using only light pressure.

7.2 Installation of backing ring

- a) Into pipes \leq DN 100 / NPS 4 (acc. Para. 8, Fig. 25). Position the ring in the pipe end so that the middle of the drilled hole in the ring lies exactly in line with the middle of the welding seam. With a horizontal pipe axis, locate the drilled hole in the welding position between 10 and 2 o'clock. Make sure that the ring does not move during further preparation work.
- b) Into pipes $>$ DN 100 / NPS 4 (acc. Para. 8, Figs. 31, 32). Take the aluminium ring, measure exactly to fit in the pipe and cut to length. Weld the two ends together and smooth off any excess weld metal in the circumferential groove of the ring. Take a length of CrNi steel strap and measure off so that it will be a tight fit in the groove of the aluminium ring. Cut to length, lay the strap around the ring and weld the two ends of the strap in a butt joint. Smooth off excess weld metal. The CrNi steel strap may not protrude out of the groove at any place on the aluminium support. Insert the backing ring into the end of the smaller diameter pipe (middle of the backing ring = middle of the welding seam) and tack weld the aluminium ring to the pipe: at least 6 tack welds, each 20 mm long, seam thickness $a \approx 0.7 \times$ ring thickness.
- c) Preheat the second pipe end to approx. 100°C and slide it onto the backing ring. For very large pipe diameters, temporary thin sheet metal shims provide assistance for assembly. Any pipe ovality is evened out by the use of clamps.
- d) Adjust the pipe ends for the gap acc. to the appropriate welding figure and tack weld 3 to 6 times depending on the pipe diameter.
- e) Strike the arc at a seam bevel and move the arc commuting towards the inserted welding rod, until a melt pool has formed. Avoid under all circumstances when tacking and welding that the arc burns through to the CrNi steel strap. If the CrNi steel ring starts to melt or burns through, stop the welding immediately and assess the contaminated seam area. Eventually remove any porous weld metal by carefully filing or machining away.
- f) Clean the welding area and the tack points again using a CrNi steel brush just before starting the welding. With a horizontal pipe axis, start to weld slightly ahead of the overhead position. Fuse the tack welds completely into the seam and remove any faulty or bridging tacks.
- g) If repairs are required remove all swarf and remove any remaining weld metal if ≤ 1 mm thickness to avoid porosity when welding the first repair pass.
- h) Prevent any marks (e.g. scratches, pressure marks, grinding marks) on the surface of backing rings, since these may cause unacceptable indications on radiographs.

8 Weld details

The weld details defined in this LS have been taken from LS 145-22.



9 Recommendations for the avoidance of porosity

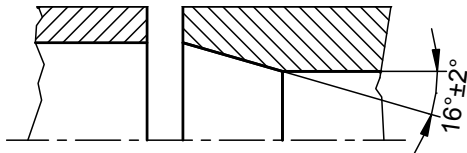
Following work flow should be carried out:

- a) Keep the working area dry, dust-free and protected from wind;
- b) Wear clean working clothes (especially gloves); do not touch welding rods or weld edges with your bare hands;
- c) Keep the preparation and welding areas apart, if possible;
- d) Avoid draughts in the welding area, especially inside the pipes;
- e) Avoid pneumatically powered tools to prevent the introduction of oil into the weld bevel; use special machining tools to prepare the weld edges, where possible;
- f) Keep the argon hose lengths to a minimum (4-metre hose package);
- g) Use new shielding gas hoses of suitable material to the welding machine and to the welding torch, e.g. rubber hoses fibre reinforced; never use PVC hoses;
- h) When changing gas bottles, check the fitted pressure reducer for leaks using a foaming agent;
- i) Use argon with a purity of at least 99.998% (Grade 4.8); the humidity of the shielding gas should be below 10 ppm, which corresponds to a dew point of -60°C;
- j) Before starting the welding work, check the welding equipment for pore-free welding behaviour by welding a two-pass melt run without filler on an aluminium sheet in the overhead position; then grind the weld surface and check visually for porosity;
- k) Purge the argon hoses with N₂ for a period of 15 minutes before start of welding, if necessary; the hoses should be hung up vertically as preference.
- l) Preheat the weld region to 80-100°C, depending on the air humidity and the wall thickness to be welded (>8 mm);
- m) Perform the welding immediately following the weld seam preparation and tack welding to avoid the formation of oxide, and complete it without interruption;
- n) Before starting to weld, and after any interruption in the welding, heat up the torch on aluminium sheet to evaporate and drive off any moisture in the torch;
- o) Enable the shielding gas flow prior and after welding, manually if necessary;
- p) Ensure that no surrounding air can get into the hose package at the torch after switching off. Seal off the nozzle at the end of the shift. Clean the nozzle regularly to remove welding spatter and dirt;
- q) Set the torch angle so, that the arc meets the surface of the work piece at right angles;
- r) Set the shielding gas flow so, that the outgoing gas flow is not too large and doesn't whirl surrounding air into the welding pool.
- s) Melt the tip of the tungsten electrode initially to a ball-shaped form, when welding aluminium; avoid contact with the liquid welding metal;
- t) Never remove the tungsten electrode from the sphere of shielding gas during the welding process;
- u) Make sure of a stable and continuous voltage supply to the welding machines; assign a maximum of 3 welding machines to one generator.

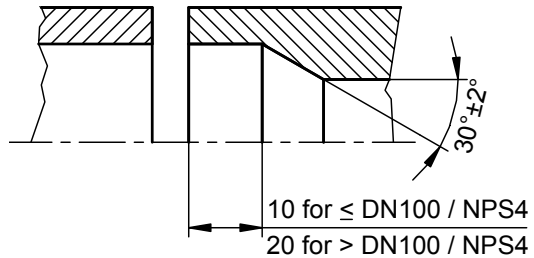
10 Alignment of unequal wall thicknesses

For alignment of unequal wall thicknesses a mechanical adaption are required, so that the inner diameters at the weld bevel shall be aligned and an inner misalignment shall be avoided. The following assemblies are permitted.

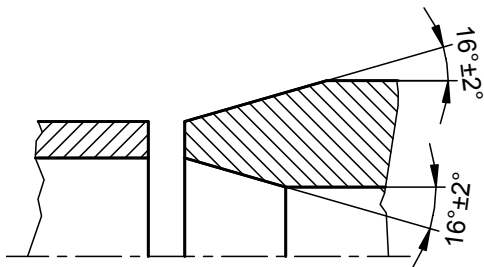
Type A (without backing ring)



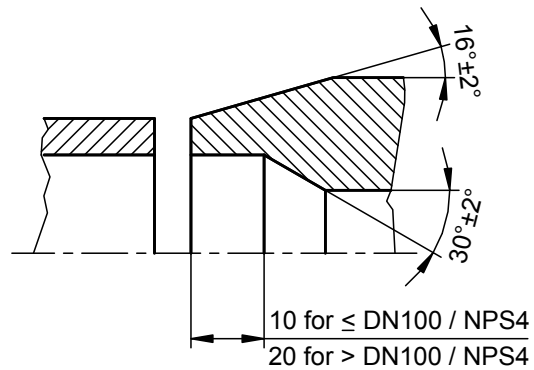
Type B (with backing ring)



Type D (without backing ring)



Type E (with backing ring)



Type C (with and without backing ring)

