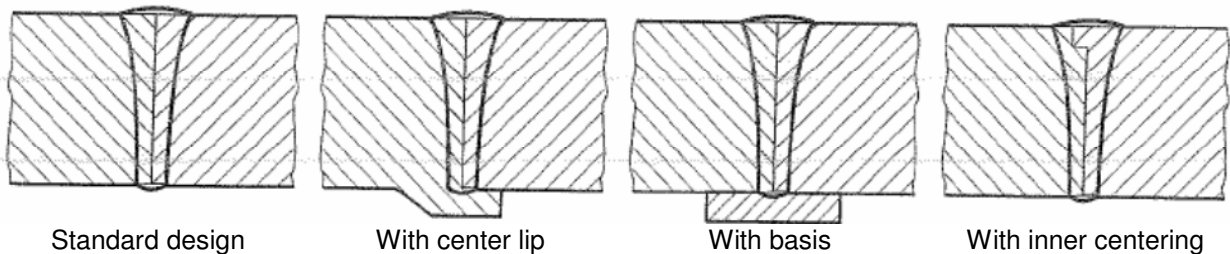


1. Base body

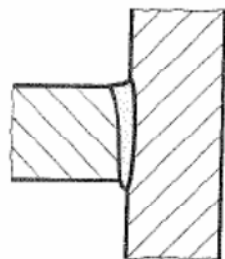
For the manufacture of vacuum chambers, the standard welding procedure is from the inside, i.e. vacuum side of the vacuum chamber; if this is not possible, care has to be taken that the root of the welding seam is always fully penetrating to the vacuum facing surface.

1.1 Construction for electron beam welding

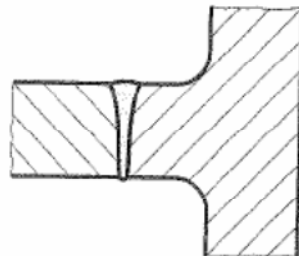
The construction of the welding seam is dependant on the application. No additional filler material is needed for small wall thicknesses (< 10 mm). Filler material which potentially needs to be added must be adapted to the materials to be welded. In particular, the filler material must be chosen according to the requirements of the magnetic permeability. Exterior welding seams must be welded fully penetrating so that no pockets will be created.



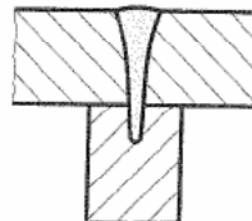
Welding seam construction of I-seams (preparation of welding seam is not necessary):



T-joint with I-seam for high static and medium dynamic loads



T-joint with I-seam for high static and high dynamic loads



T-joint with I-seam for high static and high dynamic loads



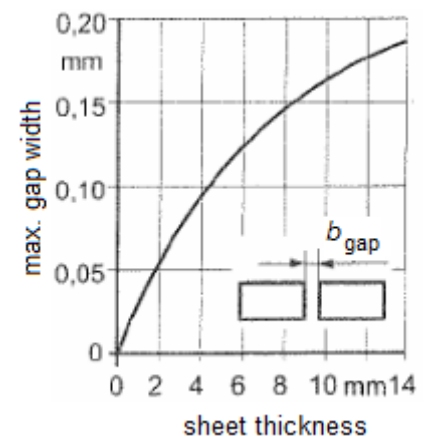
Lap joint; preferential use for thin sheet metal (< 3 mm)

Miscellaneous shape of welding seam



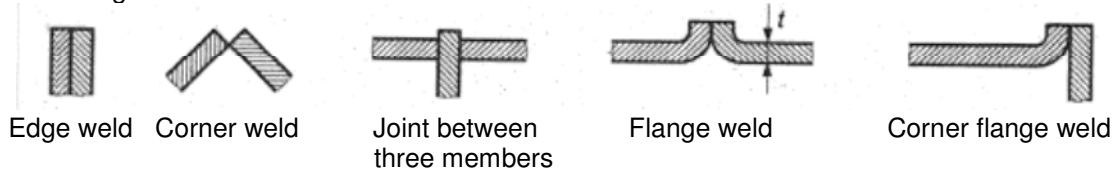
Construction prior to electron beam welding of direct joint, without preparation of welding seam; mould must be pinned prior to welding; construction of pinning must be clarified between contractor and contracting entity.

The quality requirements for electron beam welding are higher than for standard arc welding. The surfaces to be welded and the surfaces where the electron beam is impinging must be clean, smooth and without any residua. If the electron beam welding is being carried out with filler material in a horizontal position of the workpiece, the maximum gap width of the longitudinal I-welds must not exceed the values given in the adjacent graph.



1.2 TIG welding

Shapes of welding seams:



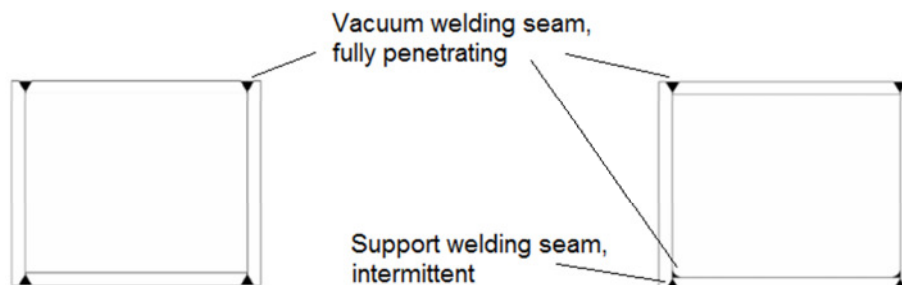
Edge form	Steel					Aluminum				
	Thickness t mm	Opening Angle	Gap width b_{sp} mm	Root face c mm	Comments	Thickness t mm	Opening Angle	Gap width b_{sp} mm	Root face c mm	Comments
	all	-	-	-	-	all	-	-	-	-
	< 4	-	$\approx t$	-	one-sided	< 5	-	-	-	one-sided
	< 8	-	$\approx t/2$	-	two-sided	< 12	-	0...5	-	two-sided
	> 8	$\approx 60^\circ$	0...3	0...4*)	two-sided	> 10	$\approx 70^\circ$	0...6	0...3*)	two-sided
	> 10	$\approx 60^\circ$	0...4	0...6*)	mostly only root run	> 12	$\approx 70^\circ$	0...6	0...4*)	mostly only root run
	> 12	$\approx 8^\circ$	0...3	≈ 3	mostly only root run	> 20	$15^\circ \dots 25^\circ$	0...3	≈ 3	mostly only root run
	-	-	-	-	-	> 10	$20^\circ \dots 30^\circ$	-	≈ 4	mostly only root run

^{*)} These seams are also welded as V- or DV-seams, i.e. root face = 0; in this case the spikes of the edges have to be slightly broken.

Wall thicknesses: (0,5 – 5) mm; larger wall thicknesses must be discussed in advance.

Filler material which potentially needs to be added must be adapted to the materials to be welded. In particular, the filler material must be chosen according to the requirements of the magnetic permeability. Exterior welding seams must be welded fully penetrating so that no pockets will be created.

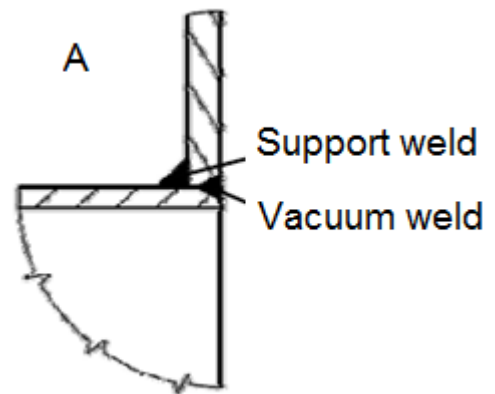
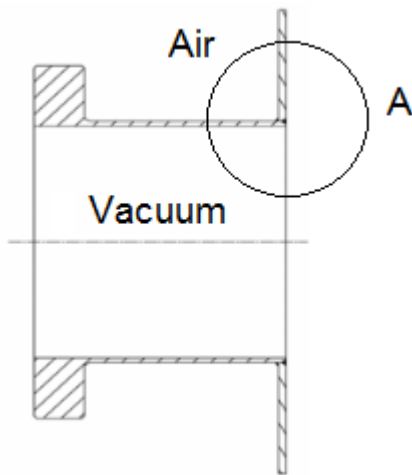
Possible constructions after welding:



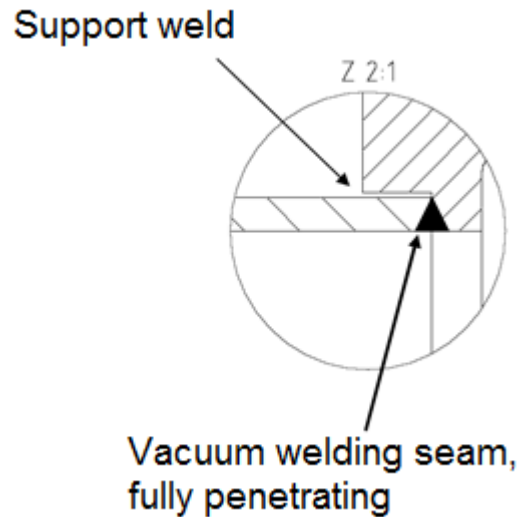
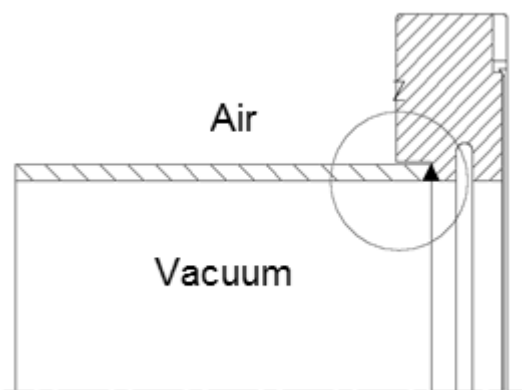
2. Flanges

The specification of the flatness of the flange is mandatory. Prevention of any weld shrinkage or weld stretching lies in the responsibility of the manufacturer.

2.1 CF flanges with tube



2.2 CF flanges without tube



3. General construction rules

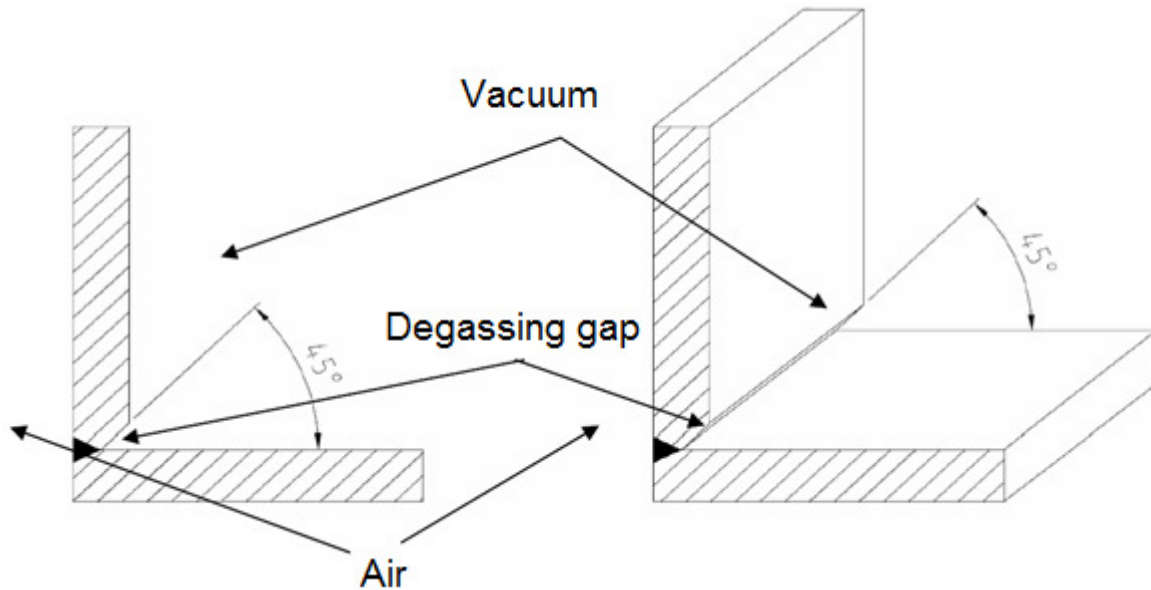
Whenever technically feasible, UHV-tight welding seams must be constructed from the vacuum side. All UHV-tight welding seams must be constructed without any interruptions during the welding process.

If any UHV-tight welding seam has to be constructed from the outside, it must be made sure that the root of the welding seam is flush along the complete length at the vacuum facing surface (i.e. no bulging of the welding seam on the vacuum side is allowed).

Exterior welding seams which are overlaying interior welding seams in order to support mechanical forces (support welding seams) must be sufficiently intermittent (at least three interruptions, for shorter welds, i.e. for weld seam lengths ≤ 100 mm, at least two interruptions) to allow degassing and leak checks of the interior welding seam.

All welding seams must be smooth and without any weld penetration undercuts. Preferable, fillet welds have to be constructed hollow. Ribs and stiffenings on the vacuum side must be welded in such a way so that either no gap remains between the components to be welded, or an open gap of at least 0.5 mm remains, facing the vacuum side for degassing and cleaning purposes.

It is recommended to construct the welding seam for better degassing in the following way:



A chamfer of 45° is optimal. Alternatively, a chamfer of 30° is also possible.

Whenever possible, all welding seams must be constructed without any filler material. If a filler material is required, it has to be according to DIN EN 10088-3 for austenitic stainless steel.

For magnetically sensitive vacuum components (chambers with a relative magnetic permeability of ≤ 1.01), filler material of stainless steel grade 1.4519 must be used.

For a table of filler materials see Technical Guideline F-TG-V-2.19e.

All vacuum side welding seams must be inspected according to ISO 5817 quality level B (visual inspection).

Prepared by:	C. Will	Doc. Name:	F-TG-V-3.1e_Constructive_Design_of_Welding_Seams_for_Vacuum_Chambers_v.2.1.docx
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4. Welding seams for gap free cooling channels

