BS EN 1708-3:2012

BSI Standards Publication

Welding — Basic weld joint details in steel

Part 3: Clad, buttered and lined pressurized components

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National foreword

This British Standard is the UK implementation of EN 1708-3:2012.

The UK participation in its preparation was entrusted to Technical Committee WEE/-/1, Briefing committee for welding.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Welding - Basic weld joint details in steel - Part 3: Clad, buttered and lined pressurized components

Soudage - Descriptif de base des assemblages soudés en acier - Partie 3: Composants plaqués, beurrés et doublés soumis à la pression

Schweißen - Verbindungselemente beim Schweißen von Stahl - Teil 3: Plattierungen, Pufferungen, Auskleidungen druckbeanspruchter Bauteile

This European Standard was approved by CEN on 28 January 2012.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 1708-3:2012) has been prepared by Technical Committee CEN/TC 121 “Welding”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2012, and conflicting national standards shall be withdrawn at the latest by September 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

EN 1708, 'Welding - Basic weld joint details in steel' consists of the following parts :

Part 1: Pressurized components

Part 2: Non internal pressurized components

Part 3: Clad, buttered and lined pressurized components

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard complements EN 1708-1 with regard to applications in industrial, chemical and pharmaceutical sectors. It specifies established examples on how to construct claddings, linings and dissimilar joints and complex connections relevant to the welding technology and with regard to pressurized components (e.g. vessels, boilers and piping). In the following text therefore the term pressurized components will be used.

These examples can also be used for other applications provided the relevant requirements are taken into account. For exceptional cases such as specific problems concerning corrosion or materials in need of special processes, other solutions can be necessary which are to be agreed upon between purchaser and manufacturer.

Appropriate national regulations and corresponding design specifications are to be followed when selecting design examples as well as, if applicable, different or further requirements.

This European Standard does not override conditions on dimensioning of welded joints regarding strength (e.g. according to EN 12952, EN 12953, EN 13445 and EN 13480). It is to be applied in accordance with the specified application limits for pressurized components subject to compression stress with bearing wall thicknesses ≤ 30 mm. This limit is chosen for structural reasons and not for the heat treatment that may be required. The wall thickness limit applies to butt welds in the bearing vessel wall only and does not apply to flanges, torispherical heads, flat ends or other similar parts.

This European Standard applies to the following types of steel:

— non alloyed steels with a minimum tensile strength of $R_m \leq 450$ MPa;

— P295GH and 16Mo3 according to EN 10028-2;

— fine-grain steels according to EN 10028-3 with a minimum yield point $R_{eL} \leq 355$ MPa;

— austenitic steels according to EN 10028-7.

This European Standard can also be applied to other steels and/or larger wall thicknesses, provided that an agreement has been made between the manufacturer and the purchaser/operating authority.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1011-5, *Welding — Recommendations for welding of metallic materials — Part 5: Welding of clad steel*

EN 1708-1:2010, *Welding — Basic welded joint details in steel — Part 1: Pressurized components*

EN 10028-2*, Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-7, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

ISO/TR 25901:2007, *Welding and related processes — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 25901:2007 and the following apply.

3.1
heterogeneous joint
welded joint in which the weld metal and parent material have significant differences in mechanical properties and/or chemical composition

[SOURCE: ISO/TR 25901:2007, 2.180]

3.2
homogeneous joint
Welded joint in which the weld metal and parent material have no significant differences in mechanical properties and/or chemical composition

[SOURCE: ISO/TR 25901:2007, 2.186]

3.3
lining
metallic stratum (e. g. sheet, plate, tube or stripe) partly connected to the inner surface of a component

4 Requirements

4.1 General

The examples in Table 1 to Table 4 are based on commonly accepted practice and give general information for design conditions and welding procedures. Other welding or design conditions should be included in the welding procedure specification (WPS) and have to be specified.

NOTE Metallic materials are assigned to groups in Welding Guidelines. Specifications of this grouping system are defined by the Technical Report CEN ISO/TR 15608. For European material designations the material groups with the corresponding material designations or material numbers and the technical delivery conditions can be found in the Technical Report CEN ISO/TR 20172.

In many industrial sectors, in particular corrosion resistance shall also be guaranteed for pressurized components. The selection of appropriate materials and their use in established wall thicknesses or designs thus plays an important role. Knowledge gained through experience has been pivotal regarding the material types and wall thickness ranges mentioned above for applications with design elements described in this European Standard.

4.2 Dissimilar metal joints

Regarding the welding of non alloy steels to austenitic steels, the filler metals to be chosen are determined by one of the following cases:

a) If the weld is not post weld heat-treated and the operating temperature ≤ 300 °C throughout, then austenitic filler metals which have been tested for suitability can be chosen.

b) If the weld is post weld heat-treated and/or subject to operating temperatures > 300 °C, then filler metals which have been tested for suitability, such as nickel-based high alloys or other metals, can be used.

Strength values of the filler metals which differ from that of the base material may need to be taken into account during calculations.

4.3 Welds for clad steel

EN 1011-5 is applicable to the welding of clad steel.

Care shall be taken concerning the suitability of filler metals used when welding the butter positions.

If a post-weld heat treatment is planned, or if the weld is to be applied at operating temperatures > 300 °C, then particular specifications are required.

The welding consumables for buttering can also be applied beyond the filling run, even for final runs, if the corrosion resistance is known to be sufficient.

In general, the weld surface of the buttering does not need to be machined.

Special surface conditions (such as grinded or polished) shall be specified in the manufacturing documents.

4.4 Weld design examples

Examples of weld design are given in Tables 1 through 4.

Table 1— Clad steels

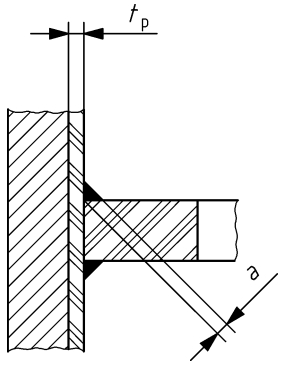
1	**Clad connections** Observe the supplementary design rules according to No 3.1 and No 3.2 in Table 3.			
The thickness of austenitic cladding t_p is in general 2 mm to 4 mm. The proportion of austenitic weld metal in the bearing cross-section has to be taken into account for the calculation according to the calculation rules. Differences in wall thickness are to be compensated on the base material side. NOTE The adhesion quality of the cladding should be checked by ultrasonic test (UT) prior to welding.				
No	**Figure**	**Application**	**Condition**	**Comment**
1.1		For fixing on a clad surface (e.g. bearing rings, apex seals)	$a \approx t_p$	Agreement with purchaser required for low exposure level to stress.

Table 1 *(continued)*

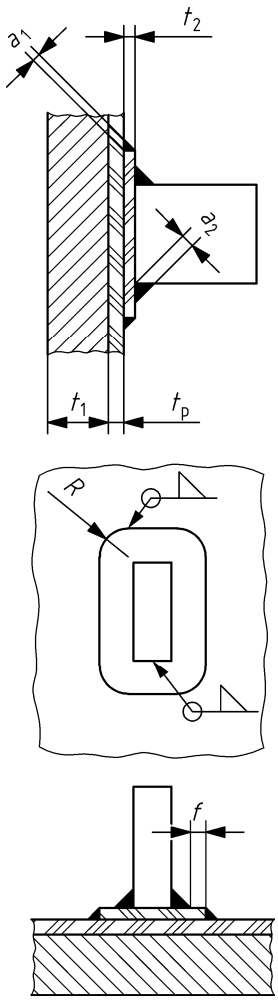
No	Figure	Application	Condition	Comment
1.2		For local introduction of greater strengths (e. g. brackets for flow breakers)	$a_1 \approx t_p$ $a_2 \leq t_2 \times 0{,}7$ $R \geq 10$ mm $t_2 \geq 4$ mm $f \geq t_1$, however 20 mm at a minimum	

Table 2 — Linings

2	**Welds and connections for linings** Observe the supplementary design rules according to No 3.1 and No 3.2 in Table 3.

In case of vacuum stresses, the calculation for the bearing capacity of the lining has to be checked separately; thermal stresses is to be taken into account as well.

As a rule the lining thickness t_l should be 2 mm as a minimum.

When selecting the lining thickness and the weld strip thickness, the root penetration depth and the welding sensitivity of the carrier material, if applicable, have to be taken into account dependent on the welding procedure and the welds.

Cavities between ferritic base metal and austenitic liner shall be avoided for elevated temperature applications.

M is a heterogeneous joint between the ferritic base metal and an austenitic liner

V is a homogeneous joint between two austenitic liners.

Proceed accordingly with casings.

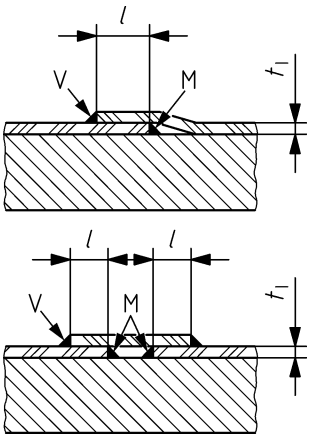
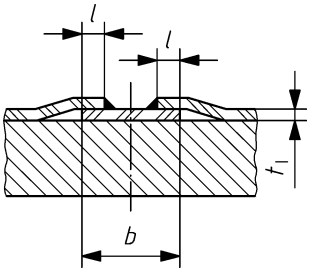
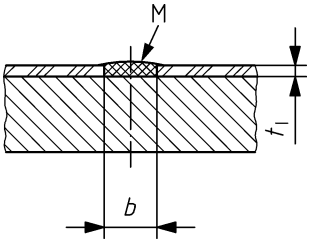
No	Figure	Application	Condition	Comment
2.1			$t_l \leq$ 3 mm $l \geq$ 3 t_l, however 5 mm at a minimum	
2.2			$t_l \leq$ 3 mm $b \geq$ 20 mm $l \geq$ 3 t_l, however 5 mm at a minimum	
2.3		For a low exposure level to corrosion. Do not remove the excess weld metal	$t_l <$ 4 mm $b \approx$ 3 t_l, however 5 mm at a minimum	Applies to $t_l \geq$ 4 mm with multi-run welding, even with normal demands on corrosion resistance

Table 2 *(continued)*

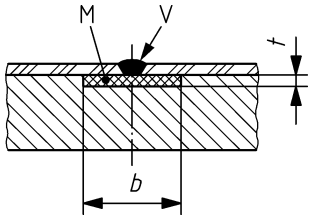
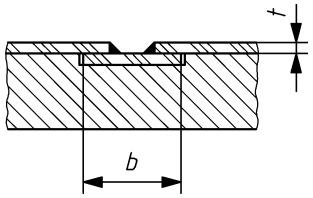
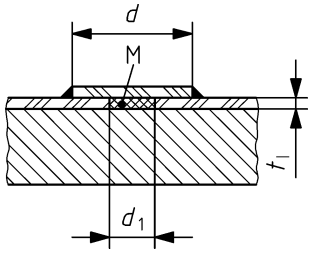
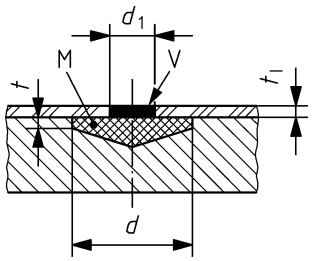
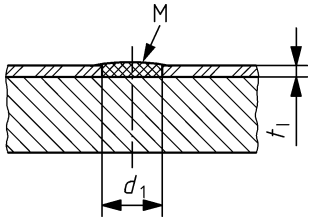
No	Figure	Application	Condition	Comment
2.4	with surface weld  with weld strip  	Tailored blank design required. To be used also if, for instance, a type of heat treatment is to be applied or for higher operating loads	$t \geq$ 3 mm $b \geq$ 20 mm V = at least 2 layers like clad material	Wall thickness weaknesses and stress concentration factors are also to be taken into account, if applicable
2.5	 	Plug welding	$d_1 \geq$ 15 mm $t_1 \geq$ 2 mm $d \approx d_1$ + 10 mm	
2.6	 	Plug welding if tailored blank design is required. To be used also if a type of heat treatment is to be applied	$t \geq$ 3 mm $d_1 \geq$ 15 mm $d \approx d_1$ + 10 mm V = at least 2 layers like lining material	For smaller parts (e.g. blank flanges), $d \approx d_1$ + 5 mm, may be sufficient
2.7	 	Plug welding for low exposure level to corrosion.	$t_1 <$ 4 mm $d_1 \geq$ 15 mm	Applies to $t_1 \geq$ 4 mm with multi-run welding, even with normal demands on corrosion resistance Excess weld metal shall not be removed

Table 2 *(continued)*

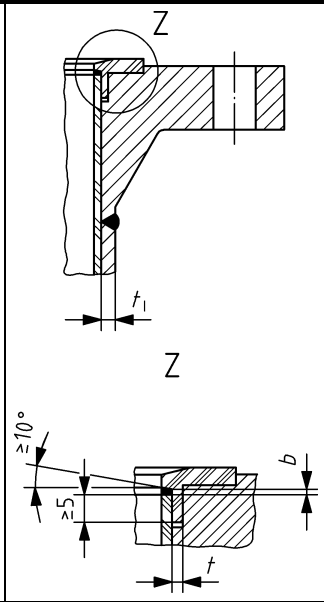
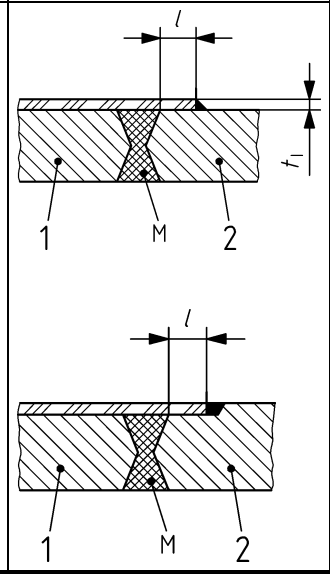
No	Figure	Application	Condition	Comment
2.8		Frame, nozzle or pipe lined for higher operating loads	$t_1 \geq 2$ mm $t \geq 3$ mm $b \geq 5$ mm The applied seal ring can also be designed as a square section for low operating loads	Preferably for elliptical seal rings Flange weakening has to be taken into account
2.9		For lining connections to solid austenitic parts	$l \approx 3\ t_1$, however 5 mm at a minimum	l always in reference to the widest seam of the liner side 1 ferritic 2 austenitic

Table 3 — Dissimilar metal joints

3	**Connections between ferritic and austenitic steels** Supplementary design rules according to No 3.1.

The following specifications for minimum wall thickness are to be complied with if ferritc steel parts are to be welded to the opposite side of walls made of austenitic steel that contact the product.

Austenitic vessel wall:		$t_1 \geq 4{,}0$ mm
Austenitic nozzle neck:	Nominal diameter DN < 32	$t_1 \geq 3{,}2$ mm
	Nominal diameter DN 32 to 50	$t_1 \geq 3{,}6$ mm
	Nominal diameter DN > 50	$t_1 \geq 4{,}0$ mm

Melt-throughs, even locally limited, are not permissible.

The specified minimum wall thicknesses and the thicknesses of butter positions are stipulated in respect of manual metal arc welding and TIG welding.

If other welding processes are to be applied, separate conditions have to be stipulated depending on the case.

M is a heterogeneous joint between the ferritic base metal and an austenitic liner.

Table 3 *(continued)*

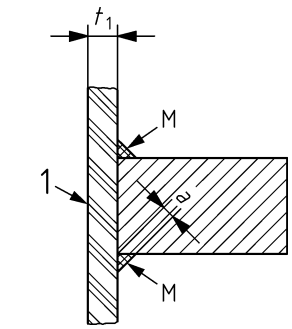
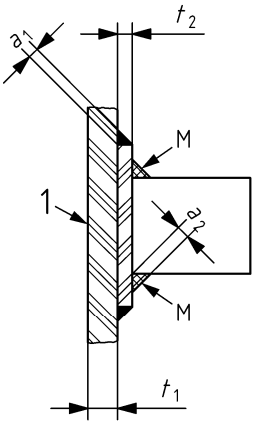
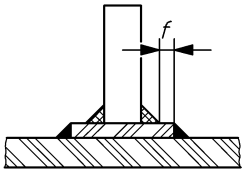
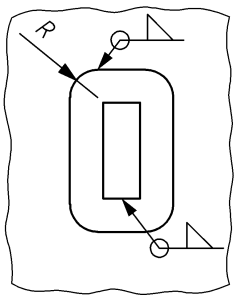
No	Figure	Application	Condition	Comment
3.1	   	For fixings to austenitic wall	$t_1 \geq 4$ mm $a = 0{,}5\ t_1$ $t_1 < 4$ mm $t_2 \geq 3$ mm $t_2 \leq t_1$ $f \geq 20$ mm $a_1 = 0{,}7 \times t_2$ $a_2 \approx t_2$ $R \geq 10$ mm	1 product side

Table 3 *(continued)*

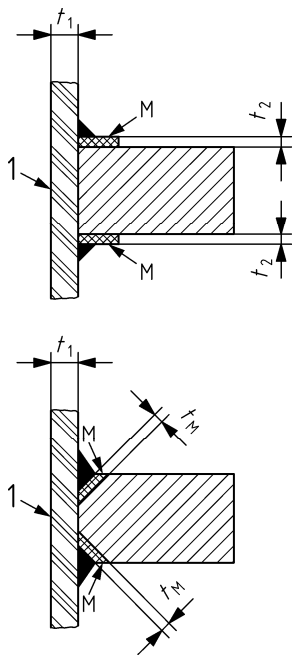
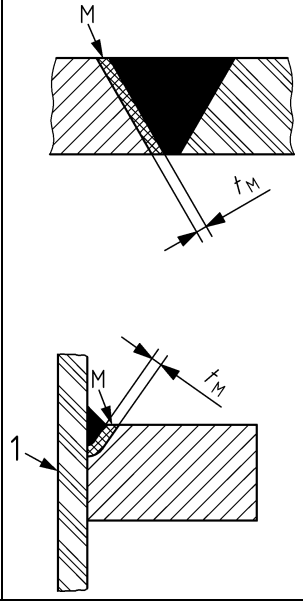
No	Figure	Application	Condition	Comment
3.2		Heterogeneous joint with butter position, with the vessel wall being	t_1 < 4 mm t_2 ≥ 3 mm t_M ≥ 3 mm	1 product side
3.3		Heterogeneous joint with butter positions if a post weld heat treatment is to be applied to non alloy steel prior to welding to the austenitic steel	t_M ≥ 8 mm depending on the welding procedure for the connecting weld	1 product side

Table 4 — Complex connections

4	**Complex connections** Examples Observe the supplementary design rules according to No 3.1 and No 3.2 in Table 3.

The drill holes marked in the following examples are required in any case for reasons of testing and monitoring. They are depicted here schematically and may be differently arranged. If fitting differently designed apex seals (e. g. tongue and groove), the remaining wall thickness has to conform to the specifications for t_1.

M is a heterogeneous joint between the ferritic base metal and an austenitic liner.

V is a homogeneous joint between two austenitic liners.

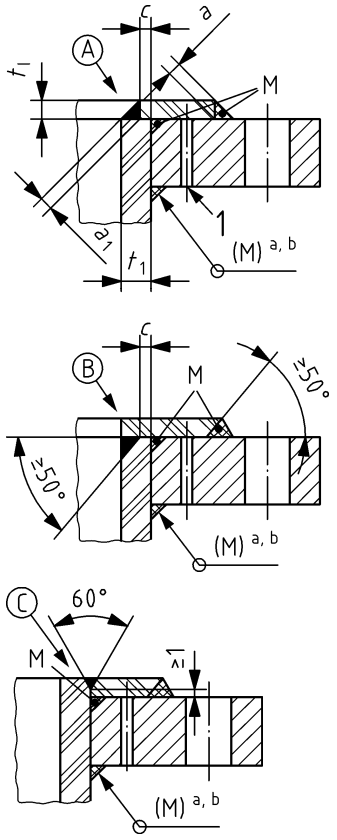
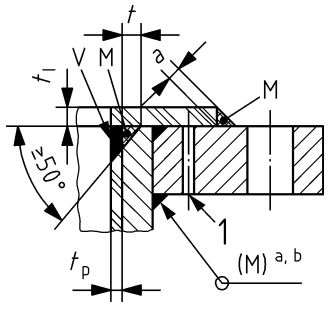
No	Figure	Application	Condition	Comment
4.1		Flange joints, nozzles or frames made of austenitic steel. Flange made of non alloy steel.	$t_1 \geq 4$ mm (finished state) $c \geq 1$ mm $a \approx 3$ mm $a_1 \geq 0{,}7\ t_1$	For the supporting welds at the flange joint, refer to welded connections in compliance with EN 1708-1:2010; Table 5: Flanges. Design A preferably with $t_1 \geq 6$ mm. Design B and C with sufficient thickness of apex seal (e. g. tongue and groove) also as symmetrical single V butt weld. [a] weld [b] to be interrupted 1 test hole
4.2		Clad flange joints, nozzles or frames	$a \approx 3$ mm $t \geq 3$ mm t_p = thickness of cladding $t_1 \geq 4$ mm (finished state) V = at least 2 layers like cladding material	For supporting welds at the flange joint, refer to welded connections in compliance with EN 1708-1:2010; Table 5: Flanges. [a] weld [b] to be interrupted 1 test hole

Table 4 *(continued)*

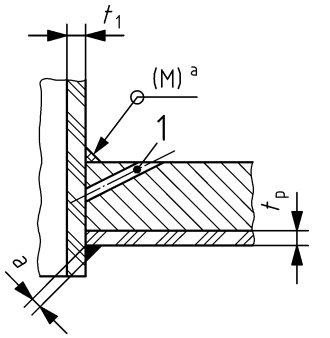
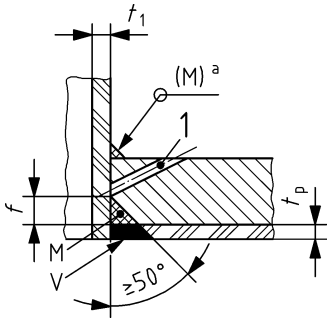
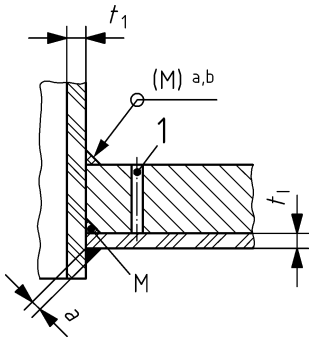
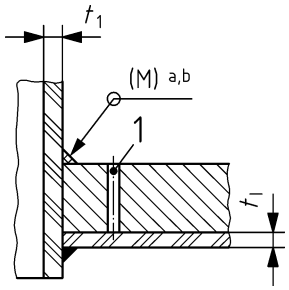
No	Figure	Application	Condition	Comment
4.3	 choice of 	Nozzle made of austenitic steel; clad vessel wall	$a \approx 3$ mm t_1: see welded connection No. 3.1 $a \approx t_p$ $f \geq 3$ mm V = at least 2 layers like clad material	Design supporting welds at nozzle connection based on welded connections in compliance with EN 1708-1:2010; Table 2. [a] weld 1 air extraction hole
4.4	 	Nozzle made of austenitic steel; lined vessel wall	t_1: see welded connection No. 3.1 $a \approx t_1$	Design supporting welds at nozzle connection based on welded connections in compliance with EN 1708-1:2010; Table 2. [a] weld [b] to be interrupted 1 test hole

Table 4 *(continued)*

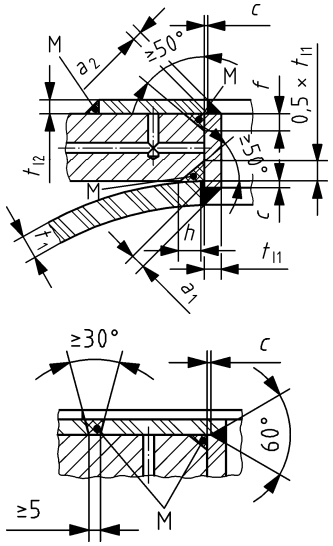
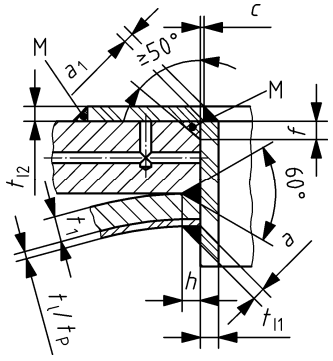
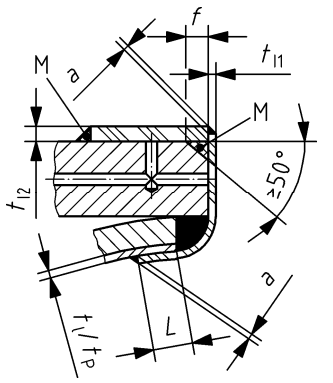
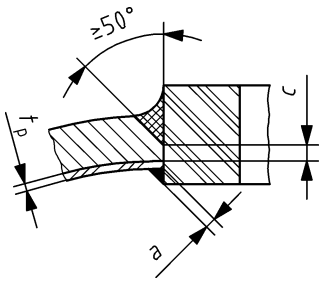
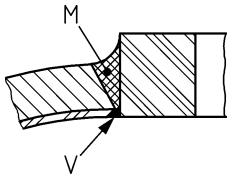
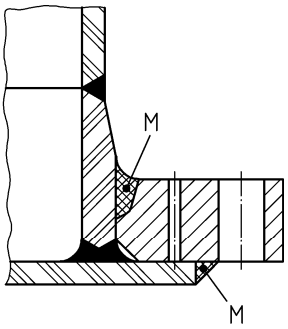
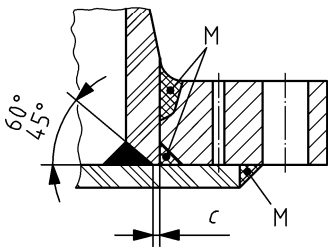
No	Figure	Application	Condition	Comment
4.5		Flange made of non alloy steel; vessel wall made of austenitic steel	$c \geq 1$ mm $a_1 \geq 0{,}7\ t_{l1}$ $a_2 \geq 3$ mm $h \geq 0{,}5 \times t_{l1}$ $t_1 > t_{l1}$ t_{l1} see welded connection No. 3.1 $t_{l2} \geq 4$ mm (finished state) $f \geq 3$ mm	Design supporting welds at the flange connection based on welded connections in compliance with EN 1708-1:2010; Table 2: No. 2.1.8, attached junctions.
4.6		Flange of unalloyed or low-alloyed steel. clad or lined vessel wall	$c \geq 1$ mm $a \geq t_l / t_p$ t_{l1} see welded connection No. 3.1 $t_{l2} =$ 4 mm (finished state) $f \geq 3$ mm $h = 0{,}5\ t_1$	Fillet weld of thickness *a* is to be considered only as a corrosion-resistant seal weld. Design supporting welds at the flange connection based on welded connections in compliance with EN 1708-1:2010; Table 2: No. 2.1.8; attached junctions. Optional design as in welded connection No. 4.5 possible
4.7		Flange of non alloy steel. Clad or lined vessel wall	$L \geq 20$ mm $t_{l1} \approx 2$ mm $t_{l2} \geq 4$ mm (finished state) $a \approx t_{l1}$ $t_p / t_l \geq 3$ mm	Design supporting welds at the flange connection based on welded connections in compliance with EN 1708-1:2010; Table 2: No. 2.1.8; attached junctions. Similar lining also possible on inserted loose flange

Table 4 *(continued)*

No	Figure	Application	Condition	Comment
4.8	 With welded Cladding as an option 	For small, flange made of austenitic steel. Clad vessel wall	$c \geq 3$ mm or designed with butter position $a \approx t_p$ V = at least 2 layers like cladding material	Vessel wall with lining; see also welded No. 2.9
4.9	 	Pipe bottom and frame made of austenitic steel and flange made of non alloy steel	$c \geq 1$ mm	Connections according to welded connections in compliance with EN 1708-1:2010; Table 8: No. 8.1.2; Connection between flat bottom or pipe bottom and vessel, as well as welded connections in compliance with EN 1708-1:2010; Table 5: Flanges (I butt weld).

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[2] EN 12953, *Shell boilers*

[3] EN 13445, *Unfired pressure vessels*

[4] EN 13480, *Metallic industrial piping*

[5] CEN ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system (ISO/TR 15608)*

[6] CEN ISO/TR 20172, *Welding — Grouping systems for materials — European materials (ISO/TR 20172)*

[7] EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063)*

[8] EN ISO 22553, *Welded, brazed and soldered joints — Symbolic representation on drawings (ISO 2553)*

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