

Group Standard

VW 01106-1

Issue 2009-08

Class. No.: 04817

Descriptors: welding, gas-shielded arc welding, steel, MIG welding, MAG welding, TIG welding, sheet steel, steel sheet joint, sheet

Gas-Shielded Arc Welding, Sheet Steel Joints

Design, Type, Quality Assurance

Previous issues

VW 01106-1: 1997-01, 2003-05, 2004-07

Changes

The following changes have been made as compared to VW 01106-1: 2004-07:

- References to standards updated
- Standard updated and extended
- Application of quality levels specified in detail
- Requirements for lap welds defined
- Section 5.3: penetration width changed

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Check standard for current issue prior to usage.

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The English translation is believed to be accurate. In case of discrepancies the German version shall govern.

Numerical notation acc. to ISO practice.

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Technical responsibility			Standards Department	
GQL-LM	Dr. Knud Nörenberg	Tel.: +49-5361-9-73623	EKDV/4 Uwe Fischer	EKDV
GQL-L	Dr. Stephan Eisenberg		Tel.: +49-5361-9-27995	Manfred Terlinden

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VWNORM-2008-12g

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1 Scope

This standard applies to the design, layout and quality assurance of arc-welded joints on steel materials. As regards aluminum alloys, please refer to VW 01106-3. The evaluation of joints of other nonferrous materials such as nickel, titanium or copper alloys, should be based on this standard as a first approximation.

It includes the processes in Table 1 acc. to DIN EN ISO 4063:

Table 1 – Processes covered in this standard

Code number	Process	Code
131	Metal inert gas welding	MIG
135	Metal active gas welding	MAG
141	Tungsten inert gas welding	TIG

Weld types:	Butt welds, fillet and lap welds, plug and auxiliary welds and special weld types
Material:	Bright, uncoated and coated steel sheets as well as high-alloyed steels and stainless steels, workpiece thickness 0,5 mm to 6 mm
Quality:	Test characteristics of quality levels B, C and D (depending on requirement) acc. to DIN EN ISO 5817 . If the quality level is not explicitly specified, quality level B applies.

All fusion-welded joints to which this scope is not applicable require clarification with the responsible engineering departments. Special measures made necessary because of the component, e.g. change to the quality level for specific imperfections, are permissible and must be entered in the drawing (in the data record).

2 Abbreviations and definitions

2.1 Abbreviations

a	Calculational weld thickness, mm
z	Calculational side length, mm
b	Penetration width, mm
B	Oblong hole width, mm
$f_{1,2}$	Penetration on sheet 1 or 2, mm
f_L	Penetration length, mm
f_{St}	Penetration on face surface, mm or % (of the face surface)
F_i	Joining plane
h	Size of an imperfection, e.g. gap size, mm
k	Edge projection, mm
l	Weld length, mm
L	Length, mm
s	Weld thickness, mm
$s_{1,2}$	Throat thickness with respect to sheets 1 and 2, mm
s_N	Smallest common throat thickness, mm
t_1	Thickness of sheet 1, mm
t_2	Thickness of sheet 2, mm
WAZ	Heat-affected zone
Σt	Total sum of sheet thicknesses, mm
$\varnothing$	Diameter, mm

2.2 Definitions

The following definitions apply to the application of this standard.

2.2.1 Welded joint

Joint created by fusion welding (Figure 1). It comprises the weld, fusion line, heat-affected zone and the unaffected base material.

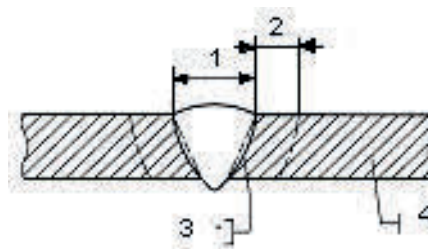


Figure 1 – Fusion-welded joint

Legend

1	Weld
2	Heat-affected zone
3	Fusion line, fusion zone
4	Unaffected base material

2.2.1.1 Weld

The molten area of the welded joint where the workpiece(s) is/are joined at the weld joint. The weld comprises the mixed base material and/or the filler material.

2.2.1.2 Fusion line

Borderline or zone between the base material and/or filler material melted during welding and the unmelted base material.

2.2.1.3 Weld material

Material that solidified after welding, comprising either the base material or filler material and base material. Some elements in the weld material may also come from coatings and/or accessory materials (for further terms refer to DIN 1910-100).

2.2.1.4 Heat-affected zone HAZ

Area of the base material that remained solid, but, due to the energy applied during welding, experienced microstructural changes related to temperature.

2.2.1.5 Unaffected base material

Area of the base material that experienced no evident microstructural changes as a result of the energy applied during welding.

2.2.2 Materials of the same type

Materials which do not differ significantly in terms of their chemical composition and their welding suitability.

2.2.3 Different types of material

Materials which differ significantly in terms of their chemical composition and their welding suitability.

3 Process description for gas-shielded arc welding

Gas-shielded arc welding is a form of fusion welding. An electrical arc is used as the heat source. It burns between the electrode and the workpiece. In this process, the arc and the weld pool are protected from the atmosphere by a shield of protective gas. The classification into the following procedures depends on the electrode type used:

3.1 Tungsten inert gas welding (TIG)

In this procedure, an arc is ignited between a non-consumable tungsten electrode and the workpiece. Argon, helium and mixtures of both, sometimes mixed additionally with active gases, are used to form the protective atmosphere. The filler material is (as in the case of gas welding) fed from the side.

3.2 Gas metal arc welding (MIG/MAG)

In this procedure, an arc is ignited between the melting end of the wire electrode (filler material) and the workpiece. The welding current flows via the current contact nozzle in the welding gun to the wire electrode.

When inert gases (low-activity gases, e.g. noble gases such as argon, helium or mixtures of both) are used as protective gases, this is called metal inert gas welding (MIG).

When active gases are used (e.g. CO₂, or mixed gases containing CO₂ or oxygen), this is called metal active gas welding (MAG).

4 General requirements

Deviations with respect to the specified weld geometries and weld layouts must be specified in the drawing, verified by testing, and described in Test Specifications (PV).

Further requirements with respect to gas-shielded arc welding are contained in the following documents:

VW 01106-2	Gas-Shielded Arc Welding; Rework of Sheet Steel Joints
VW 01106-3	Gas-Shielded Arc-Welding; Part 3: Al Welded Joints
VW 01142	Welded Seam Repairs on Aluminum Structures; Product Evaluation and Notes on Procedure

When creating arc-welded joints, the greatest possible design strength in accordance with the design goal must be achieved while, at the same time, ensuring sufficient reliability and a favorable cost/quality ratio. For this purpose, every welded joint must be "suitable for welding", i.e., the dimensions of the welding equipment as well as the accessibility of the weld according to [DVS 0929](#) must be taken into consideration in the design.

The "welding suitability" of a joint is given, if the component, on the basis of its design (Section [Section 4.3](#)) and with the material used (Section [Section 4.1](#)), remains functional ([Figure 2](#)) under the intended operating stresses ([Section 4.4](#)).

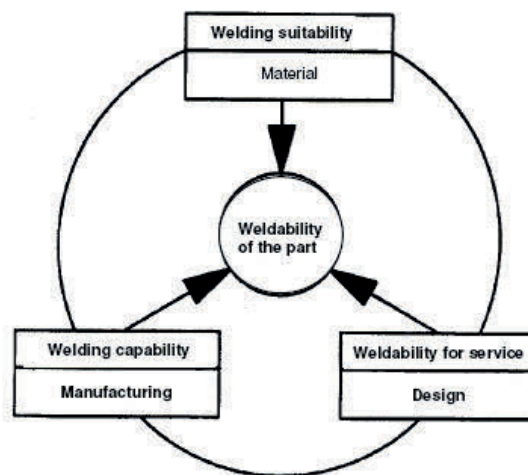


Figure 2 – Representation of welding suitability

4.1 Materials

Unalloyed or low-alloyed steel materials with a carbon content of up to 0,20 weight percent or with a carbon equivalent of up to 0,45 are generally well-suited for welding. The carbon equivalent for unalloyed steel materials is determined using the following formula:

$$CE = C + Mn/6 \quad (1)$$

in %

Legend

CE	Carbon equivalent
C	Carbon content in weight percent
Mn	Manganese content in weight percent

This is a shortened version of the general formula used to determine the carbon equivalent, DIN EN 1011-2:

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15 \quad (2)$$

in %

Hardened spots in the HAZ are evaluated based on DIN EN 1043-1 und DIN EN 1043-2. The following maximum hardness values serve as reference values for hardened spots in the HAZ:

Up to 380 HV	non-critical
380 HV to 450 HV	critical, a limit value should be specified in the drawing and verified by means of testing
Exceeding 450 HV	welding is to be avoided

Moreover, a ratio of HAZ maximum hardness to base material hardness of $\geq 3,5$ is considered critical. In such cases, a verified limit value should also be specified in the drawing.

The welding suitability of unalloyed and low-alloyed steel materials is always impaired by zinc coatings. The following applies as a general reference value: zinc layers with a thickness of max. 10 µm can be welded in a sufficiently process-reliable manner, i.e. up to "Z100" or "ZE75".

DIN EN 10088-2 and DIN EN 1011-3 contain notes and recommendations regarding the welding suitability of different high-alloyed, corrosion-resistant steels

4.2 Filler material

If no particular filler material is specified in the drawing, filler materials acc. to DIN EN ISO 14341 (MAG) or DIN EN ISO 636 (WIG), such as e.g. ISO 14341-A-G3Si1, are permissible.

If low-alloyed or high-alloyed filler materials are required in order to ensure component function, these must be indicated in the drawing. The same applies to filler materials specifically adapted to the base materials used.

Examples: Filler materials for stainless steels acc. to DIN EN ISO 14343; filler materials for nickel alloys acc. to DIN EN ISO 18274.

4.3 Design

The following specifications and the notes on design as set forth in the DVS 0929 specification are used as the basis for the production-friendly design of arc-welded sheet steel joints.

4.3.1 Joint types

The weld joint is the area in which the parts are joined by welding. The respective type of joint is determined by the arrangement of the parts with respect to each other (extension, reinforcement, branching). For definitions of the different joint types, please refer to DIN EN ISO 17659.

4.3.2 Weld types

The weld type is determined by the following:

- Type of weld joint
- Type and scope of preparation, e.g. gap optimization (see DIN EN ISO 5817 and DIN EN ISO 9692-1)
- Material
- Welding method

4.3.2.1 Fillet weld

The parts lie in two planes with respect to one another, form a fillet joint and are joined by welding. The seam edges are generally arranged at right angles with respect to each other. In the case of bevel joints (Figure 6), they are arranged at an angle between $> 30^\circ$ and $< 150^\circ$. It is possible to differentiate between a

- fillet weld (Figure 3 and Figure 4) - double fillet weld (Figure 5)
- with and without gap preparation
- fillet weld on lap joint; in contrast to the lap weld, the front side of the top sheet is not completely molten in this weld type. This causes the weld edges to be located at right angles with respect to each other. This type of weld is predominantly used in cases where the top sheet is significantly thicker than the bottom one.

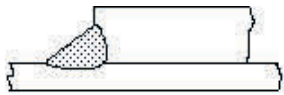


Figure 3 – Fillet weld on lap joint

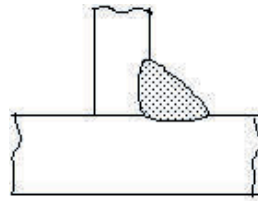


Figure 4 – Fillet weld on T-joint

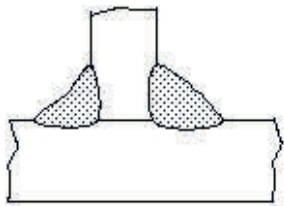


Figure 5 – Double fillet weld on T-joint

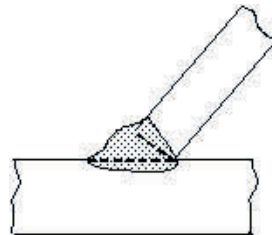


Figure 6 – Fillet weld on bevel joint without gap preparation

4.3.2.2 Square butt weld on butt joint

The parts lie in one plane, form a gap and are joined by welding, Figure 7 to Figure 10.

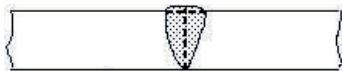


Figure 7 – Square butt weld completely welded through

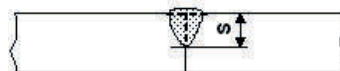


Figure 8 – Square butt weld not completely welded through

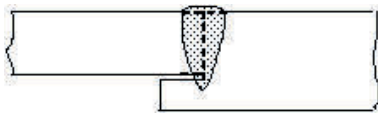


Figure 9 – Square butt weld on offset butt joint (weld pool backing) completely welded through

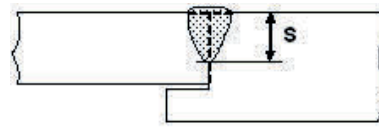


Figure 10 – Square butt weld on offset butt joint not completely welded through

For square butt welds that are not completely welded through, the required minimum weld thickness $s_{\min}$ must be specified in the drawing.

4.3.2.3 Lap weld

The term lap weld refers to welds, in which the individual parts to be joined overlap in a parallel manner, with the front sides of both being welded together (Figure 11). In case of deviating wall thicknesses, the design objective should be to arrange the individual parts in such a way that the thinner one is located at the top and that it is thus welded to the thicker one.



Figure 11 – Lap weld

4.3.2.4 Front weld

See Figure 12

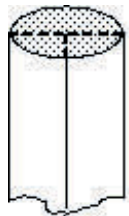


Figure 12 – Front weld

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