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Schutzvermerk ISO 16016 beachten/Please note protection notice ISO 16016

1 Scope of application and purpose

This standard describes requirements for the planning and manufacturing of welding and soldering products for Von Ardenne.

All content of this Ardenne standard is considered part of the order specification, must be adhered to by the supplier on a binding basis and must be evaluated already within the scope of the feasibility study. Notify VA immediately if you become aware of any discrepancies or if any deviations are unavoidable before or during commissioning using a deviation approval application.

Legal or regulatory provisions that go beyond this standard are unaffected by this standard and remain fully valid.

2 Terms and abbreviations

| Term/abbreviation | Definition/description |
|-------------------|------------------------|
| VA | VON ARDENNE GmbH |
| AN | Ardenne Standard |

3 Scope and general provisions

Irrespective of the contents of this standard, all tests, versions and characteristics specified on the drawing must be implemented in a contractually binding manner.

3.1 Welding and soldering stamp

(1) Welding and soldering products are marked on VA drawings with the following stamp:

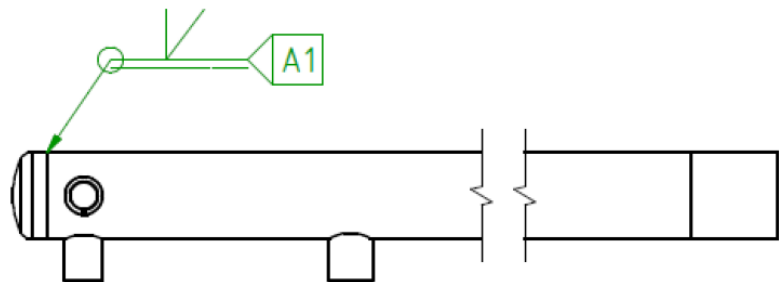
| | | | | |
|--|-----------------------------|------------------------------------|--|-----------------------------------|
| Schweißnaht welding seam | Prozess ISO 4063 process | Zusatzwerkstoff filler material | Prüfung AN 3005 inspection | Bewertungsgruppe quality class |
| Allgemeintoleranz ISO 13920 tolerance class | - BF | | mitgeltende Norm AN 3006 following standard | |

Illustration 1 - Welding stamp

(2) The welding stamp is supplemented by superimposed lines that create the reference to the respective weld seam.

3.2 Examples for welding stamp

An example of a conceivable configuration is presented and explained below:



| | | | | | |
|--|--------------------------|---------------------------------|---|--------------------------------|--------------|
| A1 | 1 | AW | Vorgabe AN 3006 specification | Klasse class 2 | ISO 5817 - C |
| Schweißnaht welding seam | Prozess ISO 4063 process | Zusatzwerkstoff filler material | Prüfung AN 3005 inspection | Bewertungsgruppe quality class | |
| Allgemeintoleranz ISO 13920 tolerance class | | - BF | mitgeltende Norm AN 3006 following standard | | |
| Bauteilprüfung nach Ardenne Norm AN3005 Part inspection according to Ardenne standard AN3005 | | | Klasse 2 Class 2 | | |
| maximaler zulässiger Druck maximum allowable pressure | | | 0,6 MPa (= 6 bar) | | |
| Prüfmedium test medium | | | Wasser / water | | |

Illustration 2 - Water manifold to atmosphere with 6bar maximum allowable pressure

| | | | | | |
|--|--------------------------|---------------------------------|--|--------------------------------|--------------|
| A4 | 1 | AW | Vorgabe AN 3006 specification | Klasse class 4 | ISO 5817 - C |
| A3 | 1 | AW | Vorgabe AN 3006 specification | Klasse class 3 | ISO 5817 - C |
| A2 | 1 | AW | Vorgabe AN 3006 specification | Klasse class 2 | ISO 5817 - C |
| A1 | 1 | AW | Vorgabe AN 3006 specification | Klasse class - | ISO 5817 - C |
| Schweißnaht welding seam | Prozess ISO 4063 process | Zusatzwerkstoff filler material | Prüfung AN 3005 inspection | Bewertungsgruppe quality class | |
| Allgemeintoleranz ISO 13920 tolerance class | | - BF | mitgeltende Norm AN 3006 following standard | | |
| Bauteilprüfung nach Ardenne Norm AN3005 Part inspection according to Ardenne standard AN3005 | | | Klasse 4 Class 4 | | |
| zul. Ha-Einzelackrate perm. single leakage rate of helium | | | $\leq 1 \times 10^{-4} \text{ Pa-l-s}^{-1} (= 1 \times 10^{-6} \text{ mbar-l-s}^{-1})$ | | |
| Bauteilprüfung nach Ardenne Norm AN3005 Part inspection according to Ardenne standard AN3005 | | | Klasse 3 Class 3 | | |
| maximaler zulässiger Druck maximum allowable pressure | | | 0,6 MPa (= 6 bar) | | |
| zul. Ha-Einzelackrate perm. single leakage rate of helium | | | $\leq 1 \times 10^{-4} \text{ Pa-l-s}^{-1} (= 1 \times 10^{-6} \text{ mbar-l-s}^{-1})$ | | |
| Bauteilprüfung nach Ardenne Norm AN3005 Part inspection according to Ardenne standard AN3005 | | | Klasse 2 Class 2 | | |
| maximaler zulässiger Druck maximum allowable pressure | | | 0,6 MPa (= 6 bar) | | |
| Prüfmedium test medium | | | Wasser / water | | |

Illustration 3 - Example stamp for several seams of different testing categories (seam A1 only with visual inspection)

Note – In addition, the following requirement applies, which is not explicitly defined by test category:

If an attached cooling channel crosses the joint of two butt-welded plates, the joint must be welded leak-tight in the cooling channel area. Since the joint is usually welded without leak tightness requirements and is then not subject to a test category, there is the explicit indication here that leak tightness must be ensured in the case of a crossing cooling channel.

4 Requirements before submitting an offer

4.1 Feasibility and risk estimation

Before submitting an offer, the supplier has to evaluate feasibility, covering at least the following points:

- a) Technical implementation regarding the required production steps, taking into account the specific material properties (e.g. high-alloy steels)
- b) Handling of parts, including crane loads and transport routes
- c) Procurement options for all necessary materials and semi-finished products
- d) Compliance with tolerances in welding production and mechanical processing
- e) Qualification of welding personnel in accordance with this standard
- f) Qualification of the welding procedure in accordance with this standard
- g) Suitability of the welding and additional equipment in accordance with this standard
- h) Implementation of the required tests, including test equipment, inspector qualification, compliance with the necessary safety measures and auxiliary material
- i) Deadline implementation in relation to the desired delivery date (proof of capacity); also explicitly for subcontractors!

4.2 Subcontracting

- (1) VA shall be notified of any subcontracting of welding production steps upon submission of the offer.
- (2) The suitability of the subcontractor for welding production shall be taken into account for the subcontracting.
- (3) All requirements of this specification and the drawings remain fully valid in the case of subcontracting – the supplier takes full responsibility for all subcontracted work steps.

5 Personnel requirements

- (1) Welding personnel must meet the requirements of **ISO 9606** (ex DIN EN 287) for the relevant scope of application and hold a valid certificate of competence
- (2) The testing personnel must meet the requirements of **ISO 9712** (ex DIN EN 473) level 1.
- (3) Suitable work instructions must be available for the flame straightening personnel. The personnel deployed for flame straightening must be recorded and named within the company.

6 Qualification of welding procedures

- (1) All welding procedures must be qualified by the supplier according to the regulations of the **ISO 15607 - 15614** series of standards.
- (2) VA reserves the right to specify the corresponding procedure for qualification or to coordinate it with the supplier. In this case, coordination takes place within the scope of the contract awarding, before the supplier is assigned the contract.

7 Selection of procedure and additional materials

7.1 Selection of the welding procedure

The selection of the welding process according to **ISO 4063** is made by the manufacturer of the welding product and is subject to the following logic:

| Weld seam stamp on VA drawing | Permissible reference number according to ISO 4063 | Permissible welding processes according to ISO 4063 |
|-------------------------------|--|---|
| A | 12, 13, 14, 15 | All arc welding processes <u>except 11</u> (metal arc welding without gas protection or E-Hand) |
| D | 12, 13, 14, 15 | All arc welding processes <u>except 11</u> (metal arc welding without gas protection or E-Hand) |
| F | 51 | Electron beam welding |
| D | 78 | Stud welding |
| H1 | 21 | Resistance spot welding |
| H2 | 23 | Projection welding |

7.2 Selection of the welding filler material

The following is a list of welding filler materials depending on the base material and the selected process, which the manufacturer of the welding product may choose from.

| Specification for welding procedure according to stamp | Base materials combination | Permitted welding filler materials depending on the selected welding process according to ISO 4063 |
|--|---|--|
| A | Non-alloy structural steels: EN 10025-2 S235JR+N to EN 10025-2 S355J2+N | 135: ISO 14341-A-G 3Si1 141: ISO 636-A-W 3Si1 |
| | CrNi steels: 1.4301, 1.4307, 1.4541 | 135: ISO 14343-A-G 19 9 L Si 141: ISO 14343-A-W 19 9 L Si |
| | CrNiMo steels 1.4401, 1.4404, 1.4408, 1.4571 and mixed joints with 1.4301, 1.4307 | 135: ISO 14343-A-G 19 12 3 L Si 141: ISO 14343-A-W 19 12 3 L Si |
| | Joint welds between S235JR+N and 1.4301, 1.4307 (Black/White) | 135: ISO 14343-A-G 23 12 2 L 141: not suitable - degree of mixing! |
| D | Aluminium alloys: EN AW-5083, -5754, -6060, -6082, -7020 | 131: ISO 18273-S Al 5183 141: ISO 18273-S Al 5183 |

If other filler materials are to be used depending on the base materials to be joined and the procedures, this must be reported to VA accordingly and requires written approval (once or for a specific purpose, if necessary)

7.3 Filler materials for soldered joints

- (1) In contrast to welding stamps, soldering stamps have specific binding specifications for the filler materials to be used. On the one hand, the solder to be used is defined and on the other hand the flux to be applied.
- (2) For the selection, the requirements and contents apply according to the following key. The respective specific filler material is specified in the stamp.

| Intended soldering process | Specification for solder | Specification for flux |
|----------------------------|--------------------------|------------------------|
| Soft soldering | ISO 9453 | ISO 9454 |
| Brazing | ISO 17672 | EN 1045 |

8 Requirements for the implementation of welding work

8.1 Planning the welding sequence

A verifiable plan for the welding sequence based on the supplier's internal rules and regulations shall be created.

The welding sequence plan must at least provide information about:

- a) Preheating/interlayer temperature
- b) Order in which the individual parts are to be joined
- c) Shape of the beads (layers of the weld metal)
- d) Cleaning or surface treatment before and after the welding procedure
- e) Intermediate inspections such as warping checks and dimensional checks

8.2 Execution of the welding work

- (1) The processing status of the welded assemblies must be traceable and determinable at any time in a form specified by the supplier (including cleaning)
- (2) The weld seam preparation is to be implemented in accordance with **ISO 9692**. The cut surfaces must be ground free of scale.
- (3) All surface impurities caused by welding (e.g. slag, weld spatter, scale, oxide layers (for stainless steel) etc.) must be removed – the required surface qualities must be maintained by mechanical processing
- (4) The dye penetrant test (PT) is not permitted in areas exposed to vacuum.
- (5) The welding conditions defined in the scope of the process test shall be maintained for the part welds.
- (6) The welding parameter ranges and handling guidelines recommended by the manufacturer of the welding filler metals and defined by the scope of the welding procedure inspection shall be observed.
- (7) Non-permanent welded-on pieces or temporary welds must consist of the same type of material.
- (8) Tacking points must be removed for through-welded seams in the course of root preparation. In the case of one-sided through-welded seams, over-welding of tacking points is permitted if safety precautions are taken, to ensure a perfect transition of the root weld to the tacking point.
- (9) To avoid tungsten inclusions, contact of the electrode with the part to ignite the arc is not permitted during TIG welding. It is therefore necessary to use igniters that allow the arc to be ignited without contact. Any ignition points that may occur must be handled correctly.

Special features for stainless steels (according to **EN 10088**)

- (1) The formation of annealing colours should be avoided.
- (2) Weld seam roots are to be formed in a suitable manner.
- (3) Any annealing colours that arise must always be removed (blasting, pickling, brushing).
- (4) Heat-affected zones are to be formed in inaccessible areas, unless analysis has been provided to prove that annealing colours do not occur.

- (5) Brushes, slag hammers, grinders or other cleaning equipment used for the mechanical cleaning of stainless components must be made of stainless material and must not be contaminated with base metals - this also applies to blasting abrasive.
- (6) The welding equipment and auxiliary devices (e.g. supporting, clamping or covering devices) shall be designed so that production-related ferritic contamination of parts is avoided.
- (7) During flame straightening, special attention must be paid to having a neutral burner flame.

8.3 Heat treatment

- (1) The heat treatment equipment must allow sufficient accuracy and uniformity of temperature control in the part for the type of heat treatment selected.
- (2) Recording temperature-time measuring devices with an accuracy of at least ± 10 K and a valid calibration must be available for this purpose.

8.4 Cleaning and surface finishes

- (1) For cleaning and after-treatment after welding and mechanical processing, cleaning plans shall be prepared which include the mechanical and/or chemical process, as well as the application of cleaning and pickling agents including the exposure and processing times and neutralisation conditions (e.g. in the form of work instructions).
- (2) Cleaned surfaces must be dried immediately and thoroughly after rinsing with water.
- (3) Only fully deionised water or water with chloride contents below 50 ppm may be used.
- (4) Flux residues must be removed without leaving any remains after soldering.
- (5) Sealing faces must be protected during cleaning.

9 Evaluation of welding products

9.1 Quality of the welding and separation cuts

- (1) All welds seams shall be 100% visually inspected by a trained (or certified) person (see chapter 5). The respective evaluation classes apply to each individual weld according to the drawing stamp (e.g. in accordance with **ISO 5817**)
- (2) Unless otherwise specified, the **ISO 9013-542 specification** according to **ISO 9013** applies to the cut quality and tolerance class of cut edges in relation to thermal cutting

9.2 Geometric product specification

- (1) For the geometrical evaluation of welded products, permissible deviations in accordance with **ISO 13920** apply according to the tolerance class specified in the stamp

10 Other provisions

11 Other applicable documents

- AN3005 – Requirements for testing pipes and chambers
- Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2012, including Cor 1:2012 and Cor 2:2013); German version EN ISO 9606-1:2017
- Welding - Fusion welded joints in steel, nickel, titanium and their alloys (excluding beam welding) - Quality levels for imperfections (ISO 5817:2014); German version EN ISO 5817:2014
- Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012); German version EN ISO 9712:2012
- Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607:2019)
- Welding - Guidelines for a metallic materials grouping system: ISO 15608...15614

- Welding and allied processes - List of processes and reference numbers (ISO 4063:2009, corrected version 2010-03-01); Trilingual version EN ISO 4063:2010
- Soft solders - Chemical composition and forms of delivery (ISO 9453:2014); German version EN ISO 9453:2014
- Fluxes for soft soldering - Classification and requirements - Part 1: Classification, labelling and packaging (ISO 9454-1:2016); German version EN ISO 9454-1:2016
- Brazing - Solders (ISO 17672:2016); German version EN ISO 17672:2016
- Brazing - Fluxes for brazing - Classification and technical delivery conditions; German version EN 1045:1997
- Welding and allied processes - Types of weld seam preparation - Part 1: Manual arc welding, gas-shielded welding, gas welding, TIG welding and beam welding of steels (ISO 9692-1:2013); German version EN ISO 9692-1:2013
- Welding and allied processes - Weld seam preparation - Part 2: Submerged arc welding of steel (ISO 9692-2:1998, includes corrigendum AC:1999); German version EN ISO 9692-2:1998 + AC:1999
- Welding and allied processes - Types of weld seam preparation - Part 3: Metal inert gas welding and tungsten inert gas welding of aluminium and aluminium alloys (ISO 9692-3:2016); German version EN ISO 9692-3:2016
- Welding and allied processes - Recommendations for weld seam preparation - Part 4: Clad steels (ISO 9692-4:2003); German version EN ISO 9692-4:2003
- Stainless steels - Part 1: List of stainless steels; German version EN 10088-1:2014
- Welding - General tolerances for welded assemblies - Linear and angular dimensions; shape and position (ISO 13920:1996); German version EN ISO 13920:1996
- Thermal cutting - Classification of thermal cuts - Geometric product specification and quality (ISO 9013:2017); German version EN ISO 9013:2017

12 Change index

| Brief description of the change | Version |
|---------------------------------|---------|
| Initial approval | 1.0 |