1 Scope

This requirement for suppliers is only applicable for welding-related orders for the manufacturing of converters, mixing tubes as well as for welded components.

This requirement for suppliers is applicable for orders worldwide, with the exception for manufacturers in the USA.

2 Purpose

This requirement for suppliers is to ensure the required quality of welding seams, as well as for the correct execution of all welding work and procedures.

3 Scope of application

- Converters and welded components
- For construction of rail-bound vehicles and ships, there are complementary regulations.

4 Terms

IWE	International Welding Engineer
rWS	responsible Welding Supervisor
ISTR	Initial Sample Test Report
FAT	Factory Acceptance Test
WPS	Welding Procedure Specification (Schweißverfahrensbeschreibung)
WPQR	Welding Procedure Qualification Record, (Bericht über die Qualifizierung des Schweißverfahrens)

5 General guidelines

- Grease, slag, rust and scale must be removed before welding.
- After welding, welding spatter must generally be removed (applies to internal and external weld seams - as far as accessible)
- After welding, the reactors must generally be cleaned of welding and grinding dust
- In the case of Cr-Ni steels, annealing colours must be removed as far as possible and accessible (applies to internal and external weld seams - if not defined, a mechanical process is permitted – see surface code on the drawing according to → ANWE0456 Corrosion protection)
- Transport and corrosion protection must be applied inside and outside as per the order
- Dust, dirt, blasting material and pickling residues must be removed before packaging and transport.

5.1 Order text in the HUG project order

The project order defines the general information and requirements that must be accepted upon acceptance of the order. These include, among other things, the requirements for documentation, NDT, execution, leak testing, FAT, and packaging.

6 Normative guidelines

6.1 Basic normative guidelines

- **EN ISO 3834-2** Quality requirements for fusion welding of metallic materials - part 2: Comprehensive quality requirements.

  The rWS in the area of EN ISO 3834-2 must hold at least the certificate "International welding specialist engineer" (IWE) or "European welding specialist engineer" (EWE).
  The provider must specify the rWS (external or internal), as responsible person for welding quality, when providing the quotation to HUG Representation must be quoted complementary (one of the two must be internal).
  The qualification of the rWS must be proved by the rWS certificate.

- Complementary, the use of the standards EN ISO 3824-1 and EN ISO 3834-5 is mandatory.

- The company must be holding a related rWS EN ISO 14731. The responsibilities of the rWS must be regulated and organised according to standard EN ISO 14731.

- Considering the related basic materials, the related welding procedure test must be proved according to standard:
  EN ISO 15614-1 Requirement and qualification of welding methods for metallic materials – welding procedure test part 1: Arc- and gas-welding of steels and arc-welding of nickel and nickel-alloys.

- Considering the related basic materials, the related welding procedure test must be proved according to standard:
  EN ISO 15609-1 Requirement and qualification of welding methods for metallic materials - welding procedure test - Part 1: Arc-welding.

- Under consideration of the basic- and welding auxiliary materials as well as the welding position, related valid certificates must be proved by the executing welder according to the following standard:
  EN ISO 9606-1 Tests for welders - Melt-welding - Part 1: Steels.

  EN ISO 14732 Welding personnel - Qualification of operators and setters for mechanical and automatic welding of metallic materials

- Consider the recommendations for welding of metallic materials according to the following standards:
  EN 1011-1 Welding - Recommendations for welding metallic materials – Part 1: General instructions for arc welding.
  EN 1011-2 Welding - Recommendations for welding metallic materials – Part 2: Arc welding of ferritic steels
  EN 1011-3 Welding - Recommendations for welding metallic materials – Part 3: Arc welding of stainless steels

- For construction of rail-bound vehicles and ships, there are complementary regulations:
  Rail vehicle construction: Conditions out of rail-regulations and standards **EN 15085-1 to -6**.

6.2 Normative guidelines for the execution of welding work

- The welding seam preparation must be made under the consideration of the technical documentation and the drawing related specifications according to the standard:
  EN ISO 9692-1 Welding and related processes - Variations of welding seam preparation - Part 1: Arc welding, protective gas welding, gas welding, WIG welding, and beam welding of steels.

- Minimal requirements for irregularities in welding seams, **evaluation group C**, according to standard, unless otherwise defined on the drawing or documents:
  EN ISO 5817 Welding-melt welding connections in steel, nickel, titan and its alloys (without beam welding) - Valuation groups of irregularities.

- For the extended NDT methods, the minimum requirements of acceptance criteria C are defined according to EN ISO 17635 or as follows:

Magnetic particle testing MT	Test techniques and classes according to ISO 17638	Acceptance limits according to ISO 23278 – 2 X
Penetrant testing PT	Test techniques and classes according to ISO 3452-1	Acceptance limits according to ISO 23277 – 2 X

  In particular cases there may be drawing related conditions or higher requirements in the technical documentation.

- Minimal requirements for general tolerances for the execution of welded constructions, **tolerance class BF** according to the standard:
  EN ISO 13920 Welding - general tolerances for welded constructions - dimensions and angles; form and position.

- Minimum requirements for general tolerances for the execution of machined structures, **tolerance class mk** according to the standard:
  ISO 2768-1 General Tolerances; Tolerances for linear and angular dimensions without individual tolerance indications

If necessary, higher requirements for permissible irregularities in weld seams or tolerances may be specified in the technical documentation or drawing specifications. These take precedence over the general tolerances.

6.3 Normative guidelines for the materials and welding consumable to be processed

- The processed base materials must be evidenced by an **inspection certificate 3.1**.
- For the welding consumables used, an **inspection certificate 3.1** according to EN 10204 must be provided for the chemical composition and at least type 2.2 for the mechanical properties.
- For the rail vehicle construction sector according to DIN EN 15085, the welding consumables must also have a valid **approval certificate from DB AG**.

6.4 Normative conditions for the execution of welding work

- For the visual test, qualified staff is necessary according to:
  EN ISO 9712 Qualification and certification of personnel of non-destructive examination

- The general rules for NDT must be taken into account:
  EN ISO 17635 Non-destructive testing of welds - General rules for metallic materials

- During visual testing, the following standard must be considered:
  EN ISO 17637 Visual testing of melt welding connections

- When carrying out the dye penetrant test (PT), the following must be taken into account:
  EN ISO 3452-1 to 6 Non-destructive testing - Penetrant testing

- When carrying out the magnetic particle test (MT), the following must be taken into account:
  EN ISO 17638 Non-destructive testing of welds - Magnetic particle testing

7 Documents to be submitted

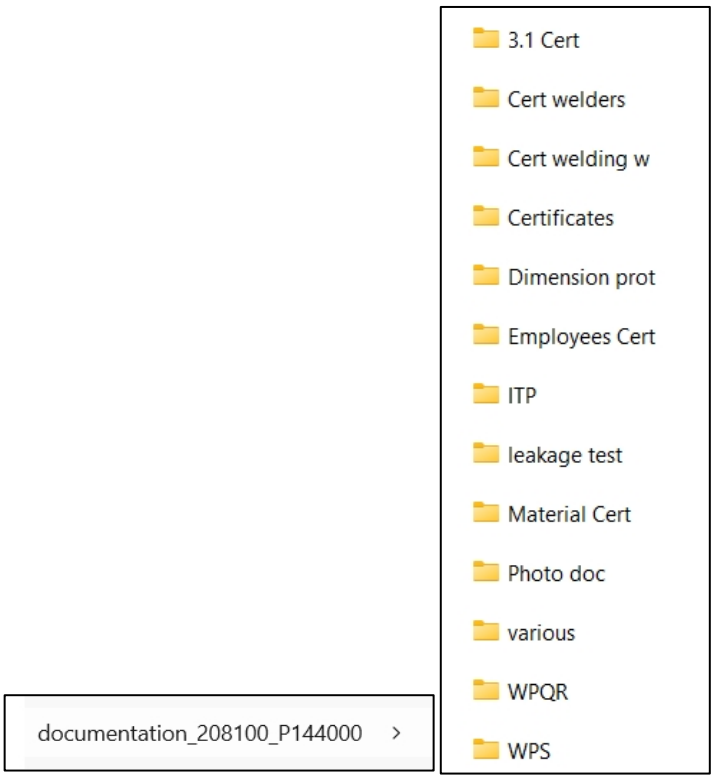
The required documents according to separate order text and the specifications from chapter 7 following, must be archived for at least 10 years (project based with the Hug order number) and need to be submitted to Hug on request.

7.1 Structure of the documentation

The documentation should be stored in individual folders according to the following structure:

doc_(project number)-(order number)		
	Certificates-company	required
	ITP-Insp and test plan	required
	Acceptance test Certficate 3.1	required
	Certificates-material	required
	Material tracking	only if required – see chapter 7.2
	Certificates-Employees	Required
	Certificates-Welding consumable	required
	Protocol-dimension	required
	Protocol-NDT	Required -– see chapter 7.2
	WPS	required
	WPQR	required
	Welder certificates	required
	Welding map	only if required – see chapter 7.2
	Welding Work samples	only if required – see chapter 7.2
	Leakage test	Required – if ordered
	Painting documentation	only if required – see chapter 7.2
	Factory acceptance test (FAT)	only if requested – see chapter 7.2
	Photo documentation	required
	Various	if necessary

The documentation must be sent as a zip file with the file name "doc_(order number)-(order number)" to the email address: postfach.quality.documentation@hug-engineering.com within 10 business days of the respective delivery date. (Example: Documentation_208100_P144000.zip)



7.2 Content of the documentation

7.2.1 Certificates – company

For an initial order, the EN ISO 3834 certificate, if required DIN EN 15085 and technical documentation in accordance with EN ISO 15614 and EN ISO 15609 must be submitted with the offer in accordance with Chapter 6 Normative specifications.

7.2.2 ITP - Inspection and test plan

An inspection and test plan must be created and submitted for each order. If no project-specific test plan has been defined by Hug Engineering AG, the general template → FORM0081 Inspection and Test Plan (ITP) for steelwork can be used. Alternatively, the supplier can use his test plan.

7.2.3 Acceptance test Certficate 3.1

An Acceptance test Certificate 3.1 must be issued for each reactor or mixing tube, or for each delivery batch. Template → ZERT0056 Acceptance test Certificate 3.1 can be used for this purpose.

7.2.4 Material certificates

The base materials used must be verified by a test certificate 3.1 according to DIN EN 10204 (see chapter 6.3).

7.2.5 Material tracking

Labelling and traceability of the base materials is not required during the manufacturing process. Unless this is explicitly required before production begins.

7.2.6 Certificates - Employees

Valid personal certificates from the NDT inspectors (VT, PT, MT, RT,...) for the test procedures used and the rWS certificate. (See chapter 6.1 and 6.4)

7.2.7 Certificates - Welding consumable

For each welding filler used, a 3.1 test certificate according to DIN EN 10204 must be provided, as well as a valid approval certificate from DB AG for components manufactured according to DIN EN 15085. (See Chapter 6.3)

7.2.8 Dimension Protocol

A dimension protocol must be created and filed for each order item. The template → PP0063 Dimension protocol - steel work can be used for this. Alternatively, the production drawing can be used for documentation. For this purpose, the measured dimension with the tolerance according to the drawing must be noted for each control dimension. The name of the inspector and the test date must be indicated on the drawing.

The following dimensions must be tested and documented at a minimum:

- All test dimensions defined on the drawing - tolerances according to the drawing
- Flatness of the inlet and outlet flanges - tolerances according to the drawing
- Flatness of the service opening - tolerances according to the drawing

For simple components that are manufactured in series, a sample test can be defined and applied with the agreement of Hug Engineering AG.

7.2.9 NDT Protocol

The VT test must be documented and the protocol filed. (See Chapter 6.4) Alternatively, the VT test carried out in accordance with the standard can be documented in the ITP.

For orders according to DIN EN 15085 or if explicitly required, a VT test report according to EN ISO 17637 is mandatory.

If additional NDT (MT, PT, RT, UT,...) has been ordered, defined on the drawing or required in the ITP, the test must be recorded.

7.2.10 WPS

Every weld seam must be covered by a WPS (welding procedure specification) according to EN ISO 15609-xx. The used WPS must be submitted. (See Chapter 6.1)

7.2.11 WPQR

Every WPS (welding procedure specification) must be qualified by a WPQR (welding procedure test) according to EN ISO 15614-xx. The WPQR used, at least the cover sheet with the scope, must be submitted. (See Chapter 6.1) Alternatively, qualification based on an pre-production welding test according to EN ISO 15613 is permissible.

7.2.12 Welder Certificates

The valid welder certificates and operator certificates must be present. (See Chapter 6.1). The 6-month confirmation by the welding supervisor on the certificate must be observed.

7.2.13 Welding map

If a FAT has been ordered by Hug Engineering AG, a list of the welders used and the WPS used must be created for the FAT.

If explicitly ordered or for components manufactured according to EN 15085, all welds must be marked and traceable so that the execution drawing of the weld and the documents can be linked to the design drawing. The documentation can be based on the weld list Appendix A of EN 15085-3.

More comprehensive welding documentation (welding map) with traceability of the welder to position in the drawing, welding date, NDT test... can also be ordered before production begins.

7.2.14 Welding work samples

If applied or agreed, the work samples must be documented and filed (see chapter 9). If explicitly ordered or for components manufactured according to EN 15085, the requirements of EN 15085 must be observed.

7.2.15 Leakage test

If a leak test has been ordered, unless otherwise agreed, it must be carried out, recorded and filed according to Hug Engineering AG instruction → PA0032 Leak tightness test for converters. (See chapter 6.4)

7.2.16 Painting documentation

If nothing else agreed, no records are to be filed. The verification can be done in the ITP.

7.2.17 Factory acceptance test (FAT)

If no order has been placed, no FAT needs to be submitted. The FAT is usually carried out with Hug Engineering AG and, if necessary, with the end customer. The resulting protocol needs to be submitted.

For orders according to DIN EN 15085, a FAT needs to be carried out and submitted by Hug Engineering AG or by the manufacturer.

7.2.18 Photo documentation

The following photos should be stored and transmitted at least:

- Overview photo of the finished components for each delivery item
- Nameplate or designation
- Leak test - – Photo before and after the test according to instruction PA0032
- Inlet and outlet bottle (with Nox ports overview)
- Coating - internal oiling or moisture-absorbing VCI capsules - if required
- Internal parts or fittings or filters or cassettes
- Components packed
- Components loaded

7.2.19 Various

If required or if needed, e.g. documentation of filter / cassette installation and assembly. See protocol → PP0035 Equipping converter

8 Contract review

Prior to a confirmation of order by the supplier, it must be guaranteed in form of a contract review, that all requirements to the welding performance/requirement can be properly met. This also includes:

- The examination under a construction/design perspective related to arrangement, design and execution of the welding connections according to the presented building documentations (drawings). Related deficiencies that are detected must be reported to Hug Engineering prior to the confirmation of order.
- Examination related to the completeness of the documentation.

9 Specification from rWS of Hug Engineering AG

The rWS of Hug Engineering AG decides on a project-specific basis on the necessity of verifiable work samples, welding map, material tracking, special tests, FAT and the extent of photo documentation.

10 Materials

Materials must be used according to their specifications. Basic materials must be marked (short determination e.g. Standard materials eventually colour marked). The marking must be made in a manner that it remains legible at all times during transport and storage. The supplier must guarantee the separated handling and machining of INOX-steels and black-steels.

For the marking and storage of welding auxiliary materials it is to be observed:

- Welding sticks must be marked individually by flags or stamping.
- Welding wire must be marked at the roll/coil.
- Stick electrodes must be marked by stamping at the coating. Appropriate storage conditions (special storage room for special materials, drying, oven) must be kept.

11 11 Handling Demand Joints

Demand joints (additional welds not defined on the drawing) are generally permitted in the manufacture of reactors, mixing tubes, and similar components, provided they are necessary for manufacturing reasons (e.g., material optimization, waste minimization, machine availability).

These requirements also apply, as far as applicable, to flanges unless otherwise defined in the drawing or standard.

The following must be observed:

- Cross joints and weld clusters are not permitted or should be avoided as far as possible.
- Demand joints must be located in areas subject to low mechanical stress.
- Minimum distance between welds: Recommended: ≥ 100 mm Permissible (minimum): ≥ 25 mm
- The weld seam must be designed as an I-joint, V-joint with counter-layer, or double V-joint (X-joint) as a full penetrant weld according to EN ISO 9692-1, depending on the thickness.
- The weld must be performed by a certified welder or operator according to a WPS qualified by a WQPR or work sample. See Chapter 6.
- The exact position and length of the required joint must be documented in the manufacturing documents (e.g., drawing, manufacturing plan, welding documentation).
- Scope of testing – 100% VT inspection of the weld and at least 20% of the weld must be tested using a surface crack test (MT or PT). See Chapter 6.2 for requirements.
- Grinding the weld flat is only required if it is functionally relevant, e.g., in the area of filter cassettes, flanges, doors, sealing surfaces, etc.

12 Deviations from Technical Order Documents

Any deviations from the technical documentation, the drawing specifications, or the applicable standards must be submitted to HUG for approval immediately upon discovery, but no later than before delivery.

13 Subcontracting

The subcontracting of the manufacturing of welded parts/components to third parties is only allowed after prior written permission of rWS and the procurement department. Subcontractors must comply with all quality standards and requirements of the present norm.

14 Initial Sample Test Report inspection for series projects

The sampling (ISTR) and quality assurance of series production is agreed on with the contractor prior to the award.

15 Tests / Documentation

Performed tests must be assigned to an individual tester i.e. by a signature. The test characteristics to be documented are detailed in the test-drawing. In case this is not available, they are to be mutually agreed with Hug Engineering AG.

On the test document, a signature of the Welding Supervisor is mandatory.

An eventual FAT is going to be announced by a separate order text.

16 Documents to be handed over to Hug Engineering AG after the finishing of a product

See Chapter 7 - Documents to be submitted.

17 Monitoring

The monitoring of the required approvals and verifications according to point 6 and 9 are in the supplier's responsibility.

It is expected that the supplier proactively clarifies any questions and ambiguity with the rWS of Hug Engineering AG.