Material Specification Mechanical

Insulating joints UHS Zuidwending

Zuidwending H2

S.003843-LF-A435-019

By
N. Kalsbeek

NAME	INITIALS	DEPT.	DATE
(Made by) K. Dambrink J. Hoogeveen		 Bilfinger Tebodin Bilfinger Tebodin	 04-03-2025 04-03-2025
(Checked by) A. Bonhage J.K. Partoleksono	Controle: GU40053 18-03-2025 Controle: J.K. Partoleksono 17-03-2025		
(Approved by) N. Kalsbeek	Door: N. Kalsbeek 19-03-2025		

Department
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Insulating joints UHS Zuidwending

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FOREWORD

This specification relates to project S.003843, UHS Zuidwending.

Within UHS Zuidwending, the primary medium is hydrogen, which is operated at pressures and temperatures, which deviate from the standard values in the OSW-01. Furthermore, within UHS Zuidwending, a different material has been selected as prime pipe material. The result is that the standard material specifications mechanical are not fully applicable and therefore, this specification is written. Within UHS Zuidwending, material specifications relate to norms and standards which are harmonised with Directive 2014/68/EU (PED), where possible.

CONTENTS

1 SCOPE AND APPLICATION

This specification contains the requirements for butt welded Insulation joints fittings for use in the hydrogen gas systems with the following design criteria:

- nominal diameter : DN 50, DN80 and DN 350;
- (system) design pressure : pd ≤ 220,0 barg;
- design temperature : -20 °C < Td ≤ +80 °C;
- medium: hydrogen gas

This specification is applicable for fittings specified in the following pipe classes:

- 220CS01

As defined in the Piping material specification S.003843-LF-A435-001, related to UHS Zuidwending.

High cyclic loading is expected for the insulation joints, further explained in section 4.6

2 REFERENCES

This specification is subject to the requirements of the documents mentioned in this clause. If the documents in this specification are mentioned with a date, this specific edition is applicable.

2.1 Gasunie specifications

Reference is made in this specification to the following Gasunie documents:

MSA-25-E	Transport, packing and marking.
MSW-11-E	Shop coating of steel structures and pipeline elements.
MSA-32-E	Requirements for inspection certificates of pressure parts.

Additionally, reference is made to the following project specific documentation:

S.003843-LF-A435-001	Piping material specification
S.003843-LZ-A435-008	Welding and NDE of Shop and Field fabricated metallic piping
S.003843-LF-A435-011	Pipe material UHS Zuidwending
S.003843-LF-A435-016	Fittings UHS Zuidwending

2.2 Standards

In this specification, reference is made to the standards1 mentioned in this subclause. Any supplements and errata notices that are valid when the project specification was approved are also applicable.

ASME B 16.5	Pipe flanges and flanged fittings NPS ½ through NPS 24 metric/inch standard.
ASME BPVC Sec. VIII, Div. 1	ASME Boiler & Pressure Vessel Code - Section 8: Rules for construction of pressure vessels; Division 1.
NEN 3650-2	Eisen voor buisleidingsystemen - Deel 2: Aanvullende eisen voor leidingen van staal (Requirements for pipeline systems - Part 2: Additional specifications for steel pipelines)
NEN-EN 1594	Gas infrastructure - Pipelines for maximum operating pressure over 16 bar - Functional requirements.
NEN-EN 10160	Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method).
NEN-EN 10228-1	Non-destructive testing of steel forgings - Part 1: Magnetic particle inspection.
NEN-EN 10228-3	Non-destructive testing of steel forgings; Part 3: Ultrasonic testing of ferritic or martensitic steel forgings.
NEN-EN 14870-2	Petroleum and natural gas industries - Induction bends, fittings and flanges for pipeline transportation systems - Part 2: Fittings.
NEN-EN-ISO 3834-2	Quality requirements for fusion welding of metallic materials; Part 2: Comprehensive quality requirements.
NEN-EN-ISO 9606-1	Qualification testing of welders - Fusion welding - Part 1: Steels.
NEN-EN-ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel.
NEN-EN-ISO 11114-2	Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 2: Nonmetallic materials.

NEN-EN-ISO 14731 Welding coordination - Tasks and responsibilities.

NEN-EN-ISO 14732 Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials.

NEN-EN-ISO 15609-1 Specification and qualification of welding procedures for metallic materials - Welding procedure specification; Part 1: Arc welding.

NEN-EN-ISO 15614-1 Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys.

NEN-EN-ISO-23936-2 Petroleum, petrochemical and natural gas industries – Non-metallic materials in contact with media related to oil and gas production - Part 2: Elastomers.

NEN-EN-ISO 3183 Petroleum and natural gas industries - Steel pipe for pipeline transportation systems.

NEN-EN-ISO 5817 Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections.

NEN-EN-ISO 8501-3 Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 3: Preparation grades of welds, cut edges and other areas with surface imperfections.

NEN-EN-ISO 10893-5 Non-destructive testing of steel tubes - Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections.

NEN-EN-ISO 10893-6 Non-destructive testing of steel tubes - Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections

NEN-EN-ISO 10893-8 Non-destructive testing of steel tubes - Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections.

NEN-EN 10253-2 Butt-welding pipe fittings – Part 2: Non alloy and ferritic alloy steels with specific inspection requirements

2.3 European Directive

Reference is made in this specification to the directive mentioned in this subclause.

2014/68/EU Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment (PED).

2014/34/EU Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast) (ATEX 114).

3 DEFINITIONS, ABBREVIATIONS AND SYMBOLS

3.1 Definitions

In this specification, the following definitions are applicable:

Client	The person or persons who is/are responsible, on behalf of Gasunie, for supervising the fulfilment of the contract in general and the execution of the work in particular.
Insulating joint	Consists of two concentric electrically insulated pipe elements which form a rigid and tight construction.
Out-of-roundness (U in %)	The difference between the maximum and the minimum inner diameter. $$U = \frac{(2 \cdot D_{max} - 2 \cdot D_{min})}{(D_{max} + D_{min})} \times 100$$
Pressure-bearing part	Part which is exposed to and contains pressure e.g.: pipe, flange, fitting, nozzle reinforcement plate, valve housing or shell.
VENDOR	The party with whom the contract is or will be concluded.
VENDOR	The party who delivers goods and/or services.

3.2 Abbreviations

In this specification, the following abbreviations are applicable:

ASME	American Society of Mechanical Engineers
EWF	European Welding Federation
FE	Flanged end
HFW	High-Frequency Welded
IIW	International Institute of Welding
ITP	Inspection and Test Plan
MCN	Material Code Number (Gasunie article number)
MPI	Magnetic particle inspection
MT	Magnetic Testing
NDT	Non-destructive testing
RED	Required engineering documents
QT	Quenched and Tempered
RT	Radiographic testing
SAWH	Helical Submerged Arc Welding
SCN	VENDOR Code Number (to be appointed by Gasunie)
UI	User Inspectorate
UT	Ultrasonic Testing
VT	Visual Testing
WE	Welding End
WPQ	Welding Procedure Qualification
WPAR	Welding Procedure Approval Records
WPQR	Welder's Performance Qualification Records
WPS	Welding Procedure Specifications

3.3 Symbols

In this specification, the following symbols are applicable:

Symbol	Description	Unit
a	Round off radius	mm
A_f	Elongation	%
D_{max}	Maximum external diameter of matching pipe	mm
D_{min}	Minimum external diameter of matching pipe	mm
$H_{coupling}$	Wall thickness of coupling	mm
H_{max}	Maximum wall thickness of coupling	mm
H_{min}	Minimum wall thickness of coupling	mm
ID	Internal diameter of matching pipe ebonite coated flange	mm
$ID_{coupling}$	Internal diameter of matching pipe insulating coupling	mm
ID_{min}	Minimum internal diameter of matching pipe ebonite coated flange	mm
L	Length of coated flange	mm
$L_{coupling}$	Length of insulating coupling	mm
P_{calc}	Calculation pressure	MPa
$P_{d,IC}$	Design pressure of insulating coupling	MPa
P_d	Design pressure of system	MPa
P_{test}	Test pressure	MPa
r	Radius	mm
$R_{e(c)}$	Specified minimum yield strength of coupling welding-end material	N/mm^2
$R_{e(p)}$	Specified minimum yield strength of material of matching pipe	N/mm^2
R_m	Tensile strength	MPa
$R_{t0,5}$	Yield strength for 0,5 % total strain	MPa
t	Wall thickness of steel ring	mm
t_{nom}	Nominal wall thickness of matching pipe (t1)	mm
T_d	Design temperature	°C
U	Out of roundness	%

4 GENERAL REQUIREMENTS

4.1 Directive

Insulating joints shall comply with the Pressure Equipment Directive (2014/68/EU).

4.2 Medium composition (Hydrogen)

The hydrogen gas quality applicable for this specification is given in the table below.

Components	Unit	Value
Hydrogen (H_2)	mol/mol	≥ 0,98
Total sum of hydrocarbons including CH_4 (C_XH_Y)	mol/mol	≤ 0,015
Oxygen (O_2)	µmol/mol (ppm)	≤ 10
Total sum of inert gasses (N_2, He, Ar)	mol/mol	≤ 0,02
Carbon dioxide (CO_2)	µmol/mol (ppm)	≤ 20
Carbon monoxide (CO)	µmol/mol (ppm)	≤ 20
Total Sulphur including H_2S (S)	µmol/mol (ppm)	≤ 5
Formic acid (CH_3OOH)	µmol/mol (ppm)	≤ 10
Formaldehyde (CH_2O)	µmol/mol (ppm)	≤ 10
Ammonia (NH_3)	µmol/mol (ppm)	≤ 10
Halogenated components	µmol/mol (ppm)	≤ 0,05
Water dew point (H_2O)	ºC @ 70 bara	≤ -8
Carbon dewpoint	°C @ 1-70 bara	≤ -2
Wobbe-index	$MJ/m^3(n)$	44,85 – 48,35
Other impurities	Shall not contain solid, liquid or gaseous material that might interfere with the integrity or operation of pipes or any gas appliance	

4.3 Design codes and standards

Design, manufacturing, inspection and testing of Insulating joints shall comply with NEN 3650-2, NEN-EN 14870-2 (fitting class B) and NEN-EN-ISO 3183.

ASME BPVC Section VIII, Division 1 appendix 2 shall be used as the calculation method.

The allowable design stress shall be Re/2.

The design pressure of the insulating joints shall be two times the design pressure of the system.

$P_{calc} = P_{d,IC} = 2 \times P_d$

4.4 Certifying authority

The certifying authority shall be a Notified Body as defined in Directive 2014/68/EU. Gasunie reserves the right to impose additional requirements. Obtaining the (EU) declaration of conformity shall be the responsibility of and at the expense of the manufacturer.

4.5 Requirements for documents

Drawings and other documents shall be submitted to Client for approval according the requirements of GTS_RED-W05.

Required information on documents:
All drawings and documents as mentioned in the GTS_RED-W05 form shall contain at least the following information:
– Gasunie purchase order number, and
– item number.

And where relevant:
– design code;
– design data;
– applicable Gasunie specifications.

Additionally:
– outline details;
– construction details;
– weld details;
– material specifications;
– destructive and non-destructive test requirements;
– impact test requirements;
– heat treatment requirements;
– coating and conservation requirements;
– weight;
– test pressures (hydrostatic and/or pneumatic).

Manufacturing report:
A manufacturing report shall be compiled for each item of the purchase order. The required documents will be specified on the RED form as per Annex A Requirements for Documents (RED).

4.6 Fatigue assessment

A fatigue assessment shall be performed as per EN 13445-3 section 18 in which the VENDOR shall prove through a fatigue test or calculations that the fitting is suitable for 21.900 cycles according to Table 1.

The allowed cycles per year per pressure fluctuation shall be calculated following the equations 18.10-17 till 18.10-20, and taking into account all correction factors of section 18. From the allowed pressure cycles, a “damage per pressure cycle” shall be stated by VENDOR. This “damage per cycle” is required to measure the accumulated damage over the operational life during operation (using the “reservoir cycle counting method” described in section 18.9.3).

Table 1: Cyclic Fatigue

Piping class/section	Operating pressure	Pressure fluctuation	Number of pressure cycles	Number of pressure cycles
	(barg)	(barg)	(per day)	
220CS01 (High pressure manifold)	+200	10	1	21.900
	Operating temperature	Temperature fluctuation	Number of temperature cycles	Number of temperature cycles
	(°C)	(°C)	(per day)	
	+40/+70	30	12	219.000

- In order to calculate the allowable number of years, full continuous operation shall be assumed (daily cycles at design temperature in the table below, shall hold for 365 days per year).
- For equipment, the “allowable years” shall be at least 30 years, assuming inspection (at 50% of the accumulated damage) is possible by design.

4.7 Failure mode analysis

A failure mode analysis according API579-1 or BS7910 is required on all pressure vessels and their components that are subjected to repeated fluctuations of stress.
VENDOR shall perform both a limit state analysis and a crack growth analysis to determine the minimum required wall thickness.

4.7.1 Limit state

This analysis shall be carried out in accordance with API579-1 or BS7910. According to these standards, a fracture mechanical analysis can be carried out where the minimum required wall thickness should be determined based on the parameters below:

Kmat	Fracture toughness	50	$[\boldsymbol{MPa}\cdot\sqrt{\boldsymbol{m}}]$
a	Depth of crack	$^1/_4\,t$	$[mm]$
2c	Lenght of crack	$6\cdot a$	$[mm]$
t	Wall thickness	Variable	$[mm]$

The following parameters shall be included in this calculation:
- Design pressure of the component
- Residual stresses if applicable
- Dimensional tolerances affecting the component under assessment.

4.7.2 Fatigue crack growth

Fatigue is a relevant failure mechanism and therefore hydrogen-induced crack growth should be assessed.
To ensure timely detection of defects, a crack growth life of at least 12 years is used whereby the vessel can be inspected every 4 years. 0-measurement in new constructions will serve as a reference for any small embedded weld defects.
The crack growth analysis should be performed using the curve from B31.12:

$$\frac{da}{dN} = C_1 \cdot \Delta K_I^{m_1} + C_2 \cdot \Delta K_I^{m_2} + C_3 \cdot \Delta K_I^{m_3}$$

The calculation should be performed with an assumed defect of a=3 mm and 2c=50 mm.

5 MATERIALS

5.1 Material

The materials used shall be suitable for hydrogen service.
Pressure bearing steel parts shall be made of unalloyed carbon steel with a maximal yield strength of 360 MPa. The tensile properties of the forgings shall be equal to the matching pipe material P355NH (table 5, EN 10253-2). The minimum elongation of the base and weld materials shall be at least 20%.

Cast iron, nodular iron or otherwise shall not be used.

Other materials used shall be submitted to Gasunie for approval.

Steels with a hardness above 225HV10 are susceptible to fatigue crack growth in hydrogen gas applications. Therefore, post welding heat treatment shall be performed on all steels in contact with hydrogen to lower the hardness to 225HV10. PWHT shall be performed in accordance with S.003843-LZ-A435-008 Welding and NDE of Shop and Field fabricated metallic piping

Non-metallic parts shall be resistant to explosive decompression.

The insulating joint manufacturer shall demonstrate to Client that all materials are compatible with the mixture of natural gas with hydrogen up to 100 % hydrogen gas and the composition as defined in section 4.2 to which it is exposed according to the design conditions.

5.2 Certification

Materials for pressure-bearing parts shall be certified in accordance with MSA-32-E.

Route 6, 9 and 10 shall be taken (Table 2 of MSA-32-E).

5.3 Insulating joint design

During construction of the plant, Post Weld Heat Treatment (PWHT) shall be applied to welds of fittings, appendages and piping equal to or above DN100. This will introduce a lot of heat to the non-metallic materials of the coupling. To prevent damage to the non-metallic materials, insulating joints with a diameter equal to or larger than DN100 shall be provided with sufficient length to prevent damage due to PWHT.
The insulating coupling must be of such a length (on both ends) that no cooling is required due to preheating and/or post weld heat treatment according to specification S.003843-LZ-A435-008 for welding the insulating coupling to the matching pipes assuming a holding time of 60 minutes and a PWHT temperature of 600 °C.

The welds within the insulating joint shall be subject to PWHT according to section 6.[note 1]

The strength calculation shall be made according ASME BPVC.VIII.1, appendix 2 Drawings and calculations require the approval of Gasunie.

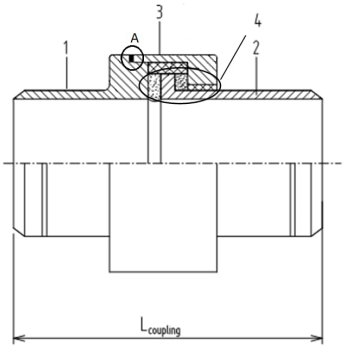
The design shall be such that it is impossible that the sealing O-ring will get stuck by glue, paint or other materials.

That part of the insulating ring of the coupling that is in contact with the medium (hydrogen) shall be rounded off.

The Insulating Joints shall be suitable for bi-directional flow.

A principle basic drawing of a DN350 insulating coupling is given below:

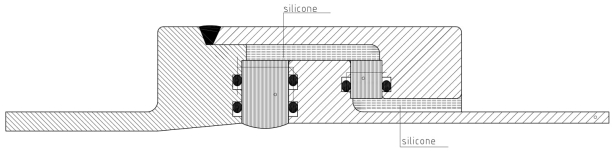
Pos. nr.	Description
1	Forging
2	Forging
3	Forging
4	Insulating materials
A	Weld



The tensile properties of the final product for part [1, 2, 3] is equal to that of the matching pipe, which is P355NH (table 5, EN 10253-2) on both ends.

The coupling part [4] consists of materials which shall be proposed by the VENDOR, including the material of the O-rings. Materials shall be suitable for the associated medium (taking leakage into consideration).

The design shall limit the number of welds in the design.



Additional requirements:
1. Sub-VENDORs do not require approval by Client;
2. High-frequency welded (HFW) and helical-seam submerged-arc welding (SAWH) pipes shall not be used;
3. Weld of incoming longitudinal pipe shall be 100% radiographic or 100% UT tested by manufacturer of the Insulating Joint;
4. Mechanical properties of the welded pipe to be determined;
5. All welds ≥DN100 and a wall thickness ≥6 mm and in contact with the medium shall be inspected with two volumetric inspection techniques. Manual UT inspection is not permitted unless agreed upon and approved by Gasunie;
6. PWHT shall be performed on all welds which are in contact with the medium.

5.4 Sealing elements

The O-ring shall be an endless O-ring, shall be selected from Table 1 of NEN-EN-ISO 11114-2 and shall be usable in the conditions stated in de scope (chapter 1). Furthermore, the O-ring shall be resistant against RGD and shall be inspected according to NEN-EN-ISO-23936-2 (chapter 7.10).

5.5 Welding ends

Welding ends shall be bevelled to fit the matching pipe. The wall thickness of the matching pipe within the 220CS01 pipe class DN350 is 28mm. The bevel shall be as per annex B Welding end detail.

The manufacturer shall verify that the welding ends are in accordance with the internal pressure.

The following applies for wall thickness of the welding ends (*H*w) (see also annex B Welding end detail)

$$H_w \geq \frac{R_{ep}}{R_{ev}} \times t_{nom}, \quad \text{where: } H_{w,min} = t_{nom};\ H_{w,max} = 1{,}5\ t_{nom}$$

R_{ep}: specified minimum yield strength of Gasunie matching pipe (P355NH);
R_{ev}: specified minimum yield strength of welding-end material at design temperature of 80 °C;
t_{nom}: nominal: wall thickness of Gasunie matching pipe.

If equal materials are selected as specified in section 5.1. The minimum wall thickness shall be equal to the adjoining pipe wall thickness as per

For DN 50 ≤ DN 400: $H_{w,max} = 1{,}2\ t_{nom}$, see annex B Welding end detail.

Tolerance on dimension *H*w:

± 0,5 mm where *t*nom > 10 mm;
t_{nom} is nominal wall thickness of Gasunie matching pipe;
Inside diameter at welding end: tolerance ± 1 mm;
Out-of-roundness at welding end: true round.

6 MANUFACTURING

6.1 Organisation

The company that performs welding shall be certified in accordance with NEN-EN-ISO 3834-2 by an authorised Notified Body.

The company shall have a qualified welding engineer available. This welding engineer shall be certified by the EWF or the IIW in accordance with NEN-EN-ISO 14731 as an International Welding Engineer.

Within the company, a welding technician shall be employed who is responsible for the actual welding activities of the company. This welding technician shall be certified by the EWF or the IIW in accordance with NEN-EN-ISO 14731

6.2 Welding personnel

Welders of welds to and in pressure parts shall be qualified in accordance with NEN-EN-ISO 9606-1 or NEN-EN-ISO-14732.

The Welding Procedure Qualification (WPQ) shall be issued as required in 2014/68/EU by a Notified Body or a recognised third party organisation for permanent joining.

6.3 Welding documentation

The following documents shall be prepared for welds to or joining pressure-containing parts and welds on parts which are subject to mechanical loading (for example supports and lifting lugs) and submitted to Client for approval:
– Welding Procedure Specification (WPS), in accordance with NEN-EN-ISO 15609-1, within the limits of NEN-EN-ISO 15614-1 and the applicable construction code if this is more restrictive than NEN-EN-ISO 15614-1.

The WPS shall be prepared and signed by the welding engineer of the company. Alternatively, the WPS can be prepared and signed by the welding technician.
– Welding Procedure Approval Record (WPAR), in accordance with NEN-EN-ISO 15614-1. The WPAR shall be issued as required in 2014/68/EU by a Notified Body or a recognised third party organisation for permanent joining.

6.4 Production welding

During welding, the applicable WPS as per sub clause 4.6.3 of this specification shall be available to the welder at the location where welding is performed.

Welds to and in pressure-containing parts or subject to mechanical loading shall be made by welders qualified as per subclause 6.2.

6.5 Post Weld Heat Treatment

Post Weld Heat Treatment (PWHT) shall be required on welds which are in contact with hydrogen. PWHT shall not be performed when insulating materials are in place, except when it can be guaranteed that the elevated temperature applied during the PWHT process will not affect the insulating material in any way. The top weld indicated by “A” in section 5.3 does not required PWHT.
All welding shall be completed prior to post-weld heat treatment. No welding, hammering or deformation is permitted after post-weld heat treatment.

7 INSPECTION AND TESTING

Insulating joints shall be subjected to inspection and testing during manufacture.
Inspection and testing shall be carried out by the VENDOR in accordance with the inspection and test plan submitted by the VENDOR and approved by all involved parties.

The VENDOR shall afford the Gasunie inspector every opportunity and facility to convince the inspector that the design, materials and construction of the equipment are in accordance with the specified requirements.

A pre-manufacturing meeting shall be arranged if considered necessary by the VENDOR or Client.

The VENDOR shall submit a manufacturing report in accordance with subclause 4.5, for each fitting at the time of delivery.
A responsible person representing the manufacturer shall be present during the inspection to ensure that the inspection can proceed without delay. The charts from the recording instruments shall be available at the time of inspection.

7.1 Inspection and Test Plan

The VENDOR shall draw up an ITP covering all verification activities and indicating all tests/inspections to be witnessed by Client and/or an authorised inspection agency. The ITP shall be approved by Client prior to start of manufacturing. In principle, Service providers may use their own procedure and format for the ITP, provided the minimum requirements are included. All verification activities shall be grouped in a logical sequence in line with the production plan.

The following information shall be provided on each activity:
– activity number;
– description;
– controlling document;
– acceptance criteria;
– type of record or document to be provided;
– verification action (witness, hold-point or review of documents);
– party (manufacturer, Gasunie, UI).

The relevant work instruction/procedures shall be indicated in the controlling document column. The acceptance criteria column shall identify the specific clause/subclause of the applicable documents (codes, standards, requisitions, specifications and the like).

Reference to the following documents shall be included:
– manufacturer's written material specifications for pressure-containing parts
– Welding Procedure Specifications (WPS);
– Welding Procedure Approval Records (WPAR);
– Welder's Performance Qualification Records (WPQR);
– Non-destructive testing (NDT) procedures;
– functional testing procedures;
– mechanical testing procedures;
– final testing procedures;
– painting procedures;
– marking procedures;
– shipping procedures.
The welding procedure shall be submitted to Gasunie for approval.

For NDT procedure see subclause 7.3
For hydrostatic pressure test see subclause 7.5
For pneumatic pressure test see subclause 7.6

Gasunie inspectors are authorised to carry out two types of inspection, either in the context of a Gasunie Quality Inspection and/or – if stated in the purchase order – as a User Inspectorate.

An update of the ITP and approval by Gasunie is required either every
3 years or following any change in the manufacturer's production procedures
or a new revision of this specification.

7.2 Visual inspection

Each insulating joint shall be visually inspected to ensure conformity with the approved design drawings and the requirements of this specification.
The inspection shall be in accordance with the approved inspection and test plan and shall include the following items:
– dimensional check;
– surface quality;
– paint quality;
– execution of appurtenances;
– die-stamped identification numbers;
– marking and shipping requirements/procedure.

All surfaces shall be free from nicks, dents, gouges, laminations, arc burns and other detrimental surface defects.

The tolerances of the internal diameter at the welding ends of the pipe ends shall be ± 1.0 mm for all dimensions.

Fittings with wall thicknesses more than 20 mm shall be machined true round.

7.3 Non-destructive testing

Non-destructive testing shall meet the following requirements:

Organisation:
The manufacturer shall have NDT experts as a minimum available for the NDT methods employed. These NDT experts shall be certified according to NEN-EN-ISO 9712 level 3 in the method employed by the manufacturer. The personnel performing the examinations shall have at least NEN-EN-ISO 9712 level 2 for the technique they use.

Documentation:
For each test method used, a procedure shall be written and approved by the level 3 expert for the relevant method. This NDT procedure shall fulfil the requirements of the relevant standards. All relevant information for performing the test, interpretation, evaluation of results and reporting shall be included in the procedure as a minimum.

The written procedures for each method employed in production shall be submitted to Gasunie for approval before start of manufacturing. A sketch or document showing the location of the NDT and the repairs shall be made for the manufacturing report.

NDT on base materials:

- Pipe:
  100 % UT longitudinal/transverse imperfections in accordance with NEN-EN-ISO 10893-10 acceptance level U2 sub-category C.
  100 % UT laminar imperfections in accordance with NEN-EN-ISO 10893-8, acceptance level U2;
- Forging:
  100 % UT in accordance with NEN-EN 10228-3 quality class 4;
  100 % MT in accordance with NEN-EN-10228-1 quality class 4.

All welds joining pressure containing parts shall be non-destructively tested according to the standards set in document S.003843-LZ-A435-008 sections 15 to 17.

7.4 Inspection certificated and NDT procedures

Inspection certificates of materials and approved NDT procedures shall be available to the NDT personnel and inspector(s) at the location where the testing is performed and at the time of inspection.
All NDT results (including X-ray films) shall be fully documented and available for Gasunie inspection at the production location.

In case of repairs, NDT shall be performed on the entire weld after the repair.

7.5 Hydrostatic pressure test

All slag, loose scale, dirt, grit, weld spatter, paint, oil and other foreign materials shall be removed thoroughly prior to the hydrostatic pressure test and the final inspection.

Hydrostatic testing shall be carried out before coating and painting.

The maximum allowable chloride content of the testing water shall be 50 ppm.

No repairs, welding or heat treatment shall be carried out after the hydrostatic test without Gasunie's permission.
The hydrostatic test procedure shall be submitted to Gasunie for approval.
Insulating couplings shall be hydrostatically tested with a test pressure (Ptest) of 1.3x the design pressure for the insulating coupling (Pd,IC).
For instance: The test pressure for a system design pressure (Pd) of 220 barg shall be 1,3 x 2 x 220 = 572 barg.

The test sequence shall be as follows:

a. at test pressure for 5 minutes;
b. reduce to zero;
c. at test pressure for5 minutes;
d. at 10 bar for 5 minutes;
e. at test pressure for 5 minutes;
f. at 10 bar for 5 minutes.

No leakage is permitted.

Pressure versus time shall be recorded with automatic recording devices. The chart with test results shall be part of the quality/testing documents.

7.6 Air test

After the hydrostatic tests, before air test, the insulating couplings shall be dried. The couplings shall be tested with air at 5 bar for10 minutes, followed by a soap-test. No leakage is permitted.

Pressure versus time shall be recorded with automatic recording devices. The chart with test results shall be part of the quality/testing documents.

7.7 Electrical testing

Electrical checks, to be done after the hydrostatic pressure test, shall be carried out in the following sequence:

- A voltage of 1500 V (AC) at 50 Hz shall be applied across the joint for 5 minutes. There shall be no breakdown, flash-over or reduction in electrical resistance during this period.
- A voltage of 1000 V (DC) shall be applied across the joint in a dried condition. The resistance shall be at least 1 MΩ.

7.8 Destructive testing

Materials requiring destructive testing shall be tested in accordance with NEN-EN 10253-2 (fitting type B).

7.9 Ultrasonic testing

Forgings shall be 100% US tested in accordance with NEN-EN 10228-3.

7.10 O-ring testing

The manufacturer shall provide a proof that the selected O-rings are usable under the conditions as stated in the scope. If this is not possible the O-ring shall be tested conform the requirement below.

The used laboratory shall be NEN-EN-ISO/IEC 17025 approved.

AMENDMENTS/SUPPLEMENTS TO NEN-EN-ISO 23936-2

The following section is an amendment / supplement to NEN-EN-ISO 23936-2. The seals shall be tested in accordance with NEN-EN-ISO 23936-2 amended as specified in this section of this specification. A test report shall be submitted to client as required according to attached RED.

Only seals with a tested rating "0000" are acceptable.

SECTION 3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

3.1.15 User

Substitution — Substitute entire section with: "For the context of this specification, the user is the joint manufacturer."

3.1.16 Purchaser

Substitution — Substitute entire section with: "For the context of this specification, the purchaser is the joint manufacturer."

3.1.16 Manufacturer

Substitution — Substitute entire section with: "For the context of this specification, the manufacturer is the party that manufactures the seals."

Annex B

B.1 Test requirements

B.1.1 RGD test conditions

B.1.1.2 Test fluid

Substitution — Should be representative for de mediums stated in de scope (chapter 1).

B.1.1.3 Test temperature

Substitution — Substitute a) and b) with: "The RGD test shall be conducted at 100 °C."

B.1.1.4 Test pressure

Substitution — Substitute a) and b) with: "The RGD test shall be conducted at 220barg."

B.1.1.6 Rate of depressurization

Substitution — Substitute a) and b) with: "The rate of test cell depressurization shall be 20 bar/min."

B.1.2 RGD test specimen

Addition — The test specimen shall be from the same production batch as the O-rings that are used in the insulating joint.

7.11 Final inspection

Each item shall be inspected to assure conformity with the validated documents and the requirements of this specification. The inspection shall include the following items:

- Dimensions: end-to-end dimension; alignment, dimensions of welding ends; inside diameter at welding end (tolerance ± 1 mm); out-of-roundness at welding end (true round)
- Surfaces quality;
- Die-stamped heat numbers: correlation with relevant material certificates;
- Execution of appurtenances such as drain and lubrication provisions, dowel pins, identification plates and the like;
- Applicable approved drawing;
- Paint and coating quality (if applicable);
- Markings: in accordance with this specification;
- Shipping requirements: in accordance with this specification;
- Non-destructive testing reports if applicable;
- Destructive testing reports if applicable;
- Final testing report.

7.12 Documentation

VENDOR shall provide the documents as indicated in the RED in annex A Requirements for Documents (RED). In addition, the VENDOR shall provide 3D models of the purchased items in accordance with Annex C 3D model requirement.

8 COATING, MARKING AND PACKING

8.1 Painting

The insulating joint shall be coated in accordance with MSW-11-E.

Additional anti-static requirements according to ISO 80079-36 for equipment group IIC and ATEX zone 2 apply.

8.2 Coating

For coating applications all prescriptions and terms from MSW-11-E shall be fulfilled.
Coating shall be cutback at the welding ends of the insulating joint over the following length:

Pipes external

Size up to DN100:	200mm ±10mm
DN100 to DN250:	300mm ±10mm
DN300 and above:	500mm ±10mm

Cutbacks shall be coated with a temporary coating of two layers of SK 40 (or equivalent of code A shop primer only)

8.3 Marking

The following information shall be shown on the material:
- name or symbol of manufacturer;
- number of purchase order;
- nominal size;
- P_d and $P_{d,IC}$;
- VENDOR's type number;
- MCN;
- SCN.

In case of insulating couplings and coated flanges, this information shall be die-stamped into the coupling or flange.

8.4 Packing

For packing reference is made to MSA-25-E

Annex

A REQUIREMENTS FOR DOCUMENTS (RED)

Requirements for Documents (RED)	
Insulating pipe connections	

Legend:
P = Number of prints
DF = Digital file in 3D model, native and PDF format
W/O = Required number of weeks after purchase order issue[1)]
W/A = Required number of weeks after release by Gasunie Inspection[2)]

TYPE OF DOCUMENTS	REQUIRED							FOR NOTES, SEE PAGE 2
	Inquiry	For approval[3)]			Final			
	P	P	DF	W/O	P	DF	W/A	
A GENERAL DOCUMENTS								
A1 General arrangement drawings								
A2 Manufacturing Data Book						X	0	
B ENGINEERING DOCUMENTS (Mechanical)								
B1 Construction drawings			X	3		X	2	
B2 Material parts list			X	3		X	2	
B3 Dimensional drawings and weight data for handling								
B4 Design calculations			X	3		X	2	
B5 Thermal design calculations								
B6 Completed data sheets								
B7 Data/curves								
B8 Test data/curves								
B9 Noise limitation data sheet								
B10 Vibration analysis								
B11 Hazard analyses								
B12 3D model acc. Annex C						X	2	
C ENGINEERING DOCUMENTS (E&I)								
C1 Logic diagram/functional diagram								
C2 Wiring diagrams								
C3 Loop diagrams								
C4 Connection diagrams								
C5 EMC test proposal								
C6 EMC test report								
C7 ATEX explosion-proof certificates								
D OPERATING DOCUMENTS								
D1 Installation instructions								
D2 Operating manual								

D3	Maintenance manual							
D4	Spare parts list							
E	INSPECTION AND TEST DOCUMENTS							
E1	Inspection and Test Plan (ITP)[4)]			X	3		X	0

	Specification no.:			
GENERAL NOTES TO REQUIREMENTS FOR DOCUMENTS (RED)				
	Page	of		Rev.:

General:

a. All documents required for inquiry shall be submitted with the quotation to Gasunie's Procurement Department.
b. All documents shall be submitted to Gasunie with a properly addressed transmittal form (GTS_REQ-003 and GTS_REQ-004) for the attention of the department as specified.
c. Any deviations from the timing for submission of documents shall be notified to Gasunie's Procurement Department by letter or e-mail.
d. Each document shall bear the item or tag number and the Gasunie purchase order number and shall be dispatched in time to meet the required dates as specified in the purchase order.
e. All documents should preferably be in Dutch. English may be used as an alternative.
f. Dimensions used on engineering documents shall be in SI units.
Nominal pipe sizes may also be indicated in imperial units between brackets.
g. The following standard sizes shall be used: A4, A3, A2 and A1.
h. Drawings consisting of five or more pages shall be treated as a package. A package shall include a front page, an index page and a revision page. The lay-out of these pages shall be submitted to the supplier by Gasunie's engineer.
i. Data sheets are to be completed if applicable.

Notes:

1) Lead time for Gasunie approval is 10 working days. Shop fabrication shall not be started before the required engineering documents have been released for construction (A- or B-approved) by Gasunie.
2) Release note will be submitted after Manufacturing Data Book has been uploaded on Qdocs.
3) Documents such as drawings, calculations and the like that already have been approved by Gasunie are not required for resubmission for approval in the case of the following Purchase Order(s).
4) Approval on major aspects. Final approval during Pre Inspection Meeting after engineering documents have been "released for construction".

Manufacturing Data Book:

Contents:

A. General documents
B. Engineering documents (Mechanical)
C. Engineering documents (E&I)
D. Operating documents
E. Inspection and test documents*

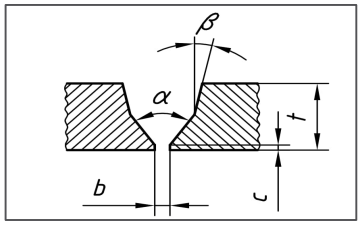
* E1 Approved ITP followed by documents as mentioned in the ITP.

B WELDING END DETAIL

Notes:
1 Inside diameter at welding end: tolerance ± 1 mm.
2 Out-of-roundness at welding end: true round.
3 Dimension for matching Gasunie pipe found in Table 2

4 Welding end details stated in the figures below.
5 Bevel angle +5°/-0° , root face ±0,8mm.

Joint preparations according to EN ISO 9692-1 Table 1

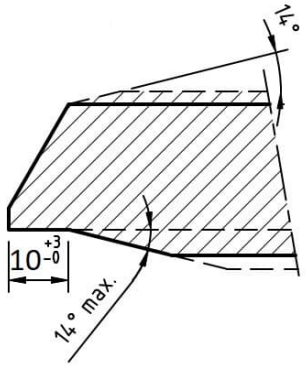


F or WT >12mm, ref no 1.7, α= 60°, β=10°, C=2mm

Table 2: Dimensions of matching Gasunie pipe

SIZE DN	External Diameter D (mm)	Wall Thickness T_{nom} (mm)
	Operating Pressure (barg)	
	220	220
	220CS01	220CS01
50	60,3	7,1
80	88,9	8,8
350	355,6	28,0

Taper end details



C 3D MODEL REQUIREMENT

The scope of this annexure is to specify the 3D model and data requirements for VENDORs of components or “small equipment”. This can be described as components, which may be used on multiple points in the project / design such as (but not limited to): valves, actuators, instrumentation, inline assets, supports, etc.

P.1 FILE TYPE, SIZE AND ORIGIN

The intention of the 3D model requirements is to allow the Client and EC to integrate data from the design into the overall plant data management system. All model files from VENDOR should meet the following requirements:

Whitelisted (3D) file types:	Native Files: RVT, DWG
Export Files:	STP (AP203), IFC, DWG
Blacklisted (3D) file types:	NWD, DWF and DWFx

VENDORs are encouraged to keep file sizes to a minimal.
- details like bolts, nuts and labels can be excluded;
- external details like cooling ribs can be excluded;
- models can be segregated into multiple models.

P.2 UNITS

The project units of measure for the 3D models is millimeters.

P.3 ORIGIN AND ORIENTATION

The origin of a component shall be place in the center of the component, unless the component is included with footings, stands, a baseplate or mounting brackets for placement on a surface. In that case, the Z-origin shall flush with the mounting surface.

The orientation of the axes shall be such that the positive Z-axis points upwards. (It is kindly noted that not all 3D CAD software use this convention)

P.4 TAGS

TAG number shall be applied if so indicated in the specification.

P.5 NAMING CONVENTION

VENDOR shall include the (equipment) tag number in the file name, as agreed with CLIENT. When no tag is provided (yet) or when the model relates to a component which is to be used multiple times (such as valves), VENDOR shall use a company standard definition of the component instead of <TagNr> in the 3D model file name (such as the component ordering number).

All single-equipment STP-models (or other file formats defined above) shall be named:
<TagNr>_<yyyy><mm><dd>_Rev<RevNr>

P.6 INCORPORATED DATA

A 3D model of a component shall incorporate following data in the attributes as an absolute minimum, for which the attributes are named exactly as in the table below.

Attribute name	Description
Tag	The tag number of equipment and inline assets (as per above).
Medium	-empty- (to be filled by the EC during engineering)
MaterialCode	-empty- (to be filled by the EC during engineering)
ItemCode	-empty- (to be filled by the EC during engineering)
DesignPressure	Design pressure of the line group or equipment.
DesignTemperature	Design temperature of the line group or equipment.
OperatingPressure	-empty- (to be filled by the EC during engineering)
OperatingTemperature	-empty- (to be filled by the EC during engineering)
BB_nr	“BestelBrief” nr, or PO number

P.7 GA-DRAWING

If discrepancies between 3D and 2D details are identified by CLIENT or EC at any point the VENDOR will be solely responsible for addressing at their own cost.

CHECK LIST FOR VENDORS

☐ File type ⇨Is any of STP, RVT, DWG and/or IFC

☐ X- and Y-axis ⇨ positive Z-axis upwards

☐ Scaling ⇨ 1 unit in model = 1 mm

☐ Colour ⇨ *To be defined*

☐ Equipment tag ⇨ No unapproved tags are applied

☐ Scope ⇨ Only objects from own scope:
- no dummy objects as reference allowed.

☐ Clash free ⇨ No internal clashes

☐ Conform GA ⇨ Model is conform component GA, no discernable deviations

☐ Revision ⇨ Revision number is same or tractable towards GA

☐ Correct file naming ⇨ <TagNr>_<yyyy><mm><dd>_rev<RevNr> or as above