

Gasunie Technical Standard

Material Specification Mechanical

MSW-05-E/2

Factory cold bends DN 100 and larger

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Intern/Internal

FOREWORD

This is the first version of this specification MSW-05-E/2.

MSW-05-E/2 shall be read in conjunction with NEN-EN 14870-4:2023.

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1. SCOPE AND APPLICATION

This specification contains requirements for bends with a bending radius of $5 \cdot DN$ or $10 \cdot DN$ made from pipe by the cold bending process. These bends are for use in onshore natural gas, hydrogen gas, carbon dioxide (both phases) or nitrogen gas pipeline systems with the following design conditions:

- nominal diameter : $DN \geq 100$;
- design pressure : $0 \text{ bar (e)} < P_d \leq 80,0 \text{ bar (e)}$;
- design temperature : $-20 \text{ }^\circ\text{C} < T_d \leq + 50 \text{ }^\circ\text{C}$.

1.1 Transport media

Table 1 indicates the transport media for which this specification is applicable.

Table 1: Transport media

Transport medium ¹	Natural gas	Hydrogen	Carbon dioxide	Nitrogen	(Hot) water	Ammonia
	Applicable	Applicable	Applicable	Applicable	Not judged ²	Not judged ²

- 1 The table is based on suitability of the transport medium concerned.
The scope and media for which this specification is suitable are not automatically the same as the scope and media of underlying specifications. The scope and suitability for a medium are described for each specification.
- 2 Suitability shall be determined on the basis of an impact analysis. The requirements that do appear to be applicable shall be observed.

2. REFERENCES

This specification makes prescriptive reference to 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 documents

This specification refers to the following Gasunie specifications:

MSA-25-E	Transport, packing and marking.
MSA-32-E	Requirements for inspection certificates of pressure parts.
MSW-01-E	Pipe for natural gas lines; Seamless and welded line pipe.
MSW-11-E	Shop coating of steel structures and pipeline elements.

2.2 Standards

This specification refers to the following standards. Any supplements and errata notices are also applicable.

The following applies to all NEN-EN standards: Depending on the country where the standard will be applied, DIN-EN or BS-EN, for example, shall be chosen.

NEN EN ISO 148-1	Metallic materials - Charpy pendulum impact test - Part 1: Test method.
NEN-EN-ISO 3183:2019	Petroleum and natural gas industries - Steel pipe for pipeline transportation systems.
NEN-EN 14870-4:2023	Petroleum and natural gas industries - Induction bends, fittings and flanges for pipeline transportation systems. Part 4: Factory cold bends.
NEN-EN-ISO/IEC 17020	Conformity assessment - Requirements for the operation of various types of bodies performing inspection.
NEN-EN-ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories.
NEN-EN-ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel.
NEN-EN-ISO 10893-4	Non-destructive testing of steel tubes - Part 4: Liquid penetrant inspection of seamless and welded steel tubes for the detection of 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 10893-10 Non-destructive testing of steel tubes - Part 10:
Automated full peripheral ultrasonic testing of
seamless and welded (except submerged arc-
welded) steel tubes for the detection of
longitudinal and/or transverse imperfections.
- NEN-EN-ISO 10893-11 Non-destructive testing of steel tubes - Part 11:
Automated ultrasonic testing of the weld seam of
welded steel tubes for the detection of longitudinal
and/or transverse imperfections.

3. DEFINITION, ABBREVIATIONS AND SYMBOLS

In this specification the following definitions, abbreviations and symbols are applicable.

3.1 Definition

Pressure-containing part	Part which is exposed to and contains pressure.
Transport medium	A gaseous or liquefied substance that is transported by and/or stored in a Gasunie transport network; limited to: – natural gas; – hydrogen; – carbon dioxide; – nitrogen; – (hot) water; – ammonia. Additives and other substances used in the medium or in the processes are therefore expressly outside the scope.

3.2 Abbreviations

DN	Nominal Diameter
HFI	High frequency electric induction welding (a type of high-frequency electric welding (HFW))
ITP	Inspection and Test Plan
MPS	Manufacturing Procedure Specification
MT	Magnetic (Particle) Testing
NDT	Non-Destructive Testing
PSL	Product Specification Level
PT	Penetrant Testing
RED	Required Engineering Documents
RT	Radiographic testing
SAWH	Submerged-Arc Helical Welded
SAWL	Submerged-Arc Longitudinal Welded
UT	Ultrasonic Testing

3.3 Symbols

<u>Symbol</u>	<u>Description</u>	<u>Unit</u>
α	bending angle	°
D	specified diameter, outside or inside	mm
P_d	design pressure	bar (e)
r_b	bend centreline radius	mm
S_0	initial cross-sectional area of the tensile specimen	mm
T_d	design temperature	°C
t	nominal wall thickness	mm

4. AMENDMENTS/SUPPLEMENTS TO NEN-EN 14870-4:2023

Factory cold bends shall conform to NEN-EN 14870-4:2023 and the modifications and supplements as stated in this specification:

- Sections not mentioned remain unaltered.
- Topics referred to as "by agreement" or "if specified" in NEN-EN 14870-4 do not apply when these topics are not specifically addressed in this document (MSW-05-E/2).
- Additional requirements, which are not stated in NEN-EN 14870-4, are indicated with "addition".
- Sections of NEN-EN 14870-4, which are not valid, are indicated with "deletion".
- Requirements which are stated in NEN-EN 14870-4 that shall be replaced, are indicated with "substitution".

The numberings, clauses and subclauses in italics in this specification correspond to those in NEN-EN 14870-4 where the subject is covered by that specification and any additional sections or subsections are numbered sequentially.

SECTION 1 SCOPE

Substitution *Substitute the third paragraph of this section with the following:*
This International Standard specifies the requirements for the manufacture of PSL 2 of factory cold bend corresponding to product specification levels given for pipe in NEN-EN-ISO 3183:2019 Annex A.

Deletion *Delete the last paragraph of this section.*

SECTION 5 GENERAL REQUIREMENTS

5.3 Conformance to this document

Addition Any conflicts between requirements of this specification, related specifications, standards, purchase order, or drawing shall be coordinated with the Purchaser for clarification before commencement of the work."

SECTION 7 DESIGN

Substitution *Substitute the entire section with the following:*
Bends shall be manufactured in accordance with the purchase order.

SECTION 8 INFORMATION THAT SHALL BE SUPPLIED BY THE PURCHASER

8.1 General information

Substitution *Substitute paragraph e) in this subsection with the following:*
Factory cold bend dimensions shall be in accordance with the purchase order.

8.2 Additional information

Substitution Substitute paragraph n) in this subsection with the following:
Coating shall be in accordance with MSW-11-E.

Substitution Substitute paragraph q) in this subsection with the following:
Factory cold bends shall be packed and shipped in accordance with MSA-25-E.

SECTION 9 MANUFACTURING**9.1 Mother pipe**

Substitution Substitute "Mother pipe shall be manufactured in accordance with ... additional requirements specified in Annex B of this document" with the following:
Mother pipe for the manufacture of PSL 2 bends shall be made in accordance with NEN-EN-ISO 3183:2019 Annex A.

Addition Manufacturer shall verify the inspection certificate of all related pipes in accordance with MSA-32-E and the suitability for cold bending and cold bends in accordance with this specification (MSW-05-E/2).

Addition SAWH pipe shall not be used for manufacturing of factory cold bends.

9.2 Qualification test bend

Substitution Substitute the first paragraph in this subsection with the following:
The manufacture of all bends within the scope of this specification shall be carried out in accordance with an MPS that shall be qualified in accordance with section 9 at the beginning of production, based on the test results of the production test bend.

9.7 Joints and girth welds

Substitution Substitute the entire subsection with the following:
Factory cold bends shall not contain girth welds.

9.8 End preparation

Substitution Substitute the entire subsection with the following:
End preparation shall be in accordance with the purchase order.

9.9 Weld seam tolerances

Addition For a distance of at least the coating cutback length (according to MSW-11-E) from each end, the outside weld bead shall be removed by grinding such that it does not extend above the adjacent pipe surface by more than 0,5 mm.

SECTION 10 TESTING AND INSPECTION

Substitution Replace in this section all references to:
– "table 2" by "table 2" of this specification (MSW-05-E/2), and
– "table 3" by "table 3" of this specification (MSW-05-E/2).

Substitution Replace in this section all references to "ISO 3183" by "NEN-EN-ISO 3183:2019 Annex A".

10.1 General requirements

Substitution Replace table 2 by the following table:

Table 2: Summary of testing and inspection requirements for PSL 2 test and production bends

	Test		Acceptance
10.3 Chemical test	Product analysis (chemical composition)	T and P ^a	In accordance with NEN-EN-ISO 3183 and MSA-32-E
10.4 Physical Tests	Tensile	T ^b	In accordance with NEN-EN-ISO 3183
	Impact	T	In accordance with MSW-01-E and 10.4.3*
	Through-thickness hardness	T	In accordance with 10.4.2.2*
	Surface hardness	T and P	In accordance with 10.4.5.2*
	Metallography	T	In accordance with 10.4.6.2*
	Guided bend (weld seam)	T	In accordance with MSW-01-E
	Flattening	T	In accordance with MSW-01-E
NDT	Visual inspection	T and P	In accordance with MSW-01-E and 10.5.1*
	Weld seam (UT or RT)	T and P	In accordance with MSW-01-E and 10.5.2*
	Bend ends (MT or PT)	P	In accordance with 10.5.3*
	Bend ends (UT) laminations	P	In accordance with 10.5.3*
	Bend body (MT or PT)	T and P	In accordance with 10.5.4*
	Bend body (UT) transverse defects	T and P	In accordance with 10.5.5*
	Residual magnetism ends	P	In accordance with 10.5.6*
	Repairs by grinding	P	In accordance with MSW-01-E and 10.5.7*
Dimensions	Wall thickness	T and P	In accordance with 10.6*
	D bend body	P	In accordance with 10.6*
	D at ends	P	In accordance with 10.6*
	Out-of-roundness ends	P	In accordance with 10.6*
	Out-of-roundness body	P	In accordance with 10.6*
	Linear dimensions	P	In accordance with 10.6*
	Angle	P	In accordance with 10.6*
	Radius	P	In accordance with 10.6*
	End squareness	P	In accordance with 10.6*
	Out of plane	P	In accordance with 10.6*
	End preparation	P	In accordance with 9.8*

P: Required for each production bend

T: Required for each test bend

a: The product analysis may be performed on the mother pipe.

b: The tensile test orientation for the tangent, extrados and intrados shall be as per the orientation for tensile testing for mother pipe in NEN-EN ISO 3183.

* These subsection numbers refer to NEN-EN 14870-4:2023.

10.2 Extent of testing and inspection**10.2.1 Qualification test bend**

Substitution Replace table 3 by the following table:

Table 3: Location of test pieces and type of test for destructive testing of test bends

Location	Required tests for each test bend
Tangent base metal	Tensile Impact Through-thickness hardness
Tangent weld	Tensile transverse Impact Flattening (only for HFI pipe) Through-thickness hardness Metallography Guided bend (only for SAWL pipe)
Bend extrados base metal	Tensile Impact Through-thickness hardness
Bend intrados base metal	Tensile Impact Through-thickness hardness
Bend weld	Tensile transverse Impact Flattening (only for HFI pipe) Through-thickness hardness Metallography Guided bend (only for SAWL pipe)

10.2.3 Production test bends

Substitution Substitute the entire subsection with the following:

The extent of testing and inspection that shall be performed on each test bend is as specified in Table 2 of this specification (MSW-05-E/2).

The location and type of tests shall be as specified in Table 3 of this specification (MSW-05-E/2), with the locations for the extraction of samples as shown in Figure 1.

During production one test bend shall be made:

- per heat;
- per pipe manufacturer;
- per diameter;
- per wall thickness
- per bending radius.

Where the bend quantity for a given size and heat exceeds 50, a production test shall be performed for each batch of 50 bends produced. Production testing shall consist of those tests performed during the MPS.

10.4 Physical testing

10.4.2 Tensile testing

10.4.2.2 Test method

Substitution

Substitute sixth paragraph in this subsection with the following:

The percentage elongation after fracture shall be reported with reference to a proportional gauge length of $5,65\sqrt{S_0}$, where S_0 is the initial cross-sectional area of the tensile specimen.

10.4.3 Charpy V-notch impact testing

10.4.3.2 Test method

Substitution

Substitute second paragraph in this subsection with the following:

Charpy V-notch impact testing shall be in accordance with NEN-EN-ISO 148-1 with an additional requirement to report the shear area of the fracture surface for all test pieces except those for the weld centreline. The required striker radius is 2 mm.

Substitution

Substitute third paragraph in this subsection with the following:

Impact test specimens shall be tested at temperatures in accordance with the table 4 of this specification (MSW-05-E/2):

Table 4: Charpy V-notch impact test temperature

Nominal wall thickness t (mm)	Test temperature (°C)
< 14	0
≥ 14 to 19	-10
≥ 19 to 23	-20
≥ 23 to 25	-30
≥ 25 to 27,5	-40
≥ 27,5 to 30	-50

10.4.3.3 Requirements

Substitution

Substitute the entire subsection with the following:

The results of the Charpy V-notch impact tests shall meet the requirements of MSW-01-E.

10.4.7 Guided bend testing

10.4.7.2 Test method

Substitution

Replace reference to "ISO 3183" by "MSW-01-E".

10.4.8 Flattening tests

Substitution

Substitute the entire subsection with the following:

Flattening tests shall be carried out in accordance with MSW-01-E for pipe of the same grade and type.

10.5 Non-destructive testing

Addition

The company that performs the NDT shall be NEN-EN-ISO/IEC 17020 or NEN-EN-ISO/IEC 17025 accredited with the relevant scope.

Addition

The manufacturer shall have at least one NDT expert available for the NDT methods employed. This NDT expert shall be certified according to NEN-EN-ISO 9712 level 3 in the methods employed by the manufacturer.

- Addition* 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 EN or ISO standards. All relevant information for performing the test, interpretation, evaluation of results and reporting shall be included in the procedure as a minimum.
- Addition* The written procedures for each method employed in production shall be submitted to Purchaser for validation prior to the commencement of manufacturing.
- 10.5.1 Visual inspection*
- Substitution* Replace reference to ISO 3183 by MSW-01-E.
- 10.5.2 Weld seam testing*
- Substitution* *Substitute the entire subsection with the following:*
The full length of the weld seam(s) shall be ultrasonic tested in accordance with NEN-EN-ISO 10893-11 acceptance level U2 and U2H.
- 10.5.3 Inspection of bend ends*
- Substitution* *Substitute the entire subsection with the following:*
MT of bend ends shall be performed in accordance with NEN-EN-ISO 10893-5. PT shall be performed in accordance with NEN-EN-ISO 10893-4.
- 10.5.4 Magnetic particle testing or liquid-penetrant testing on the bend body*
- Substitution* *Substitute the entire subsection with the following:*
For all cold bends, the bend body shall be inspected over an arc of 180°, 90° each side of the extrados by:
- MT in accordance with NEN-EN-ISO 10893-5, or
 - PT in accordance with NEN-EN-ISO 10893-4.
- 10.5.5 Ultrasonic testing on the bend body*
- Substitution* *Substitute the entire subsection with the following:*
Ultrasonic testing in accordance with NEN-EN-ISO 10893-10 and shall be performed over an arc of 180°, 90° each side of the extrados to verify that the bend is free from transverse defects.
- 10.5.8 NDT personnel*
- Substitution* *Substitute this subsection with the following:*
The NDT inspection personnel shall be certified according to NEN-EN-ISO 9712 level 2 for the relevant testing method.

10.6 Dimensions

Substitution Replace table 4 by the following table:

Table 5: Permissible dimensional tolerances

Dimension	Permissible tolerance
Linear dimensions ^a	+10 / -50 mm
Minimum wall thickness	Zero
Inside diameter of bend ends	See purchase order
Inside diameter of bend arc and tangents	See subsection 10.7
Bend angle α	$\pm 1^\circ$
Bend radius for bends with $r_b \geq 1\,000$ mm	$\pm 1\%$
Bend radius for bends with $r_b < 1\,000$ mm	± 10 mm
End out-of-squareness	3 mm max.
Out-of-planeness	1 % of outside diameter
Out-of-roundness at ends	According MSW-01-E
Out-of-roundness in bend body	Out-of-roundness in bend body $r_b \geq 5D$; 2,5 % max. $3D \leq r_b < 5D$; 3 % max.

^a Such as centre-to-end, offsets, chord lengths.

10.7 Gauging

Substitution Substitute the entire subsection with the following:

The inside diameter of each finished factory cold bend shall permit the passage of a drift mandrel consisting of two parallel circular metal disks, each at least 6 mm thick, rigidly connected and separated by a distance of one nominal pipe diameter. The disk diameter shall be at least 95 % of the specified nominal pipe inside diameter of the connecting pipe.

SECTION 11 INSPECTION DOCUMENT

Substitution Substitute the entire section with the following:

Bends shall be certified in accordance with MSA-32-E. The required inspection certificate shall be in accordance with MSA-32-E route 9 or 10, depending on the nominal diameter of the bend.

Materials shall be clearly identifiable by the steel quality (grade), heat number and steel manufacturer's stamp or inspection authority stamp. Other required documents are specified in the purchase order.

SECTION 12 MARKING

Addition Add this section with the following:

The required markings shall be applied by low-stress die-stamping and placed on the outside pipe surface between 20 mm and 150 mm from one pipe end and at least 25 mm from any weld. The height of the markings shall be at least 4 mm and the minimum impression shall be 0,2 mm. The die-stamped marks shall be placed within a frame of white paint (weld primer).

5. INSPECTION AND TEST PLAN

The manufacturer shall draw up an ITP covering all verification activities and indicating all tests/inspections to be witnessed by Gasunie or an authorised inspection agency. The ITP shall be validated by Gasunie, prior to commencement of manufacturing. In principle, manufacturers 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 or Notified Body).

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).

The following documents shall be included:

- manufacturer's written material specifications for pressure-containing parts, if different from NEN-EN 14870-4;
- non-destructive testing procedures;
- functional testing procedures;
- mechanical testing procedures;
- final testing procedures;
- painting procedures;
- marking procedures;
- shipping procedures.

Note:

The inspectors of Gasunie 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 quality inspection plan and validation by Gasunie is required either every 3 years or by a change in the manufacturer's production procedures or by a new revision of this specification (MSW-05-E/2).

6. DOCUMENTATION

This specification refers informatively to the following documentation:

- 1 N.V. Nederlandse Gasunie, GTS-MSW-05-E/2, factory cold bends, een nieuwe Gasunie technische standaard voor koudbochten, [VA 24.0202](#), 31-10-2024