

Gasunie Technical Standard

Material Specification Mechanical

MSW-05-E/1

**Induction bends DN 100 and
larger**

Version 1 *01-03-2024*

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N.V. Nederlandse Gasunie
Postbus 19, 9700 MA Groningen (Netherlands)
Telephone +31 50 5219111

Intern/Internal

FOREWORD

This specification supersedes the eighth version of MSW-05-E and shall be read in conjunction with the standard NEN-EN 14870-1 (June 2023).

With respect to the previous version the following has been changed:

- Construction drawings format has been updated.
- Mother pipe requirements have been updated.
- General update of section 10 due to the new revision of 14870-1 (2023).
- Clause 6: documentation 1 has been changed (memorandum OTWS).

Alterations are marked with a left margin line.

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1. SCOPE AND APPLICATION

This specification contains requirements for bends with a bending radius of $3 \cdot DN$, $5 \cdot DN$ or $10 \cdot DN$ made from pipe by the induction bending process.

These bends are for use in onshore pipeline systems with the following design conditions:

- transportmedia : natural gas and hydrogen;
- nominal diameter : $100 \leq DN \leq 1200$;
- design pressure : $0 \text{ bar} < P_d \leq 80,0 \text{ bar}$;
- design temperature : $-20 \text{ }^\circ\text{C} < T_d \leq +50 \text{ }^\circ\text{C}$.

This specification is based on NEN-EN 14870-1 and serves as a supplement to that document. Topics referred to as "by agreement" or "if specified" in NEN-EN 14870-1 do not apply when these topics are not specifically addressed in this document.

All bends specified shall be in accordance with this specification and typical manufacturing drawings E-11.54.000 SH.001-010 shall comply with the requirements of NEN-EN 14870-1, as amended and supplemented herein.

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

¹ The table is based on 100 % 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 chapter.

If the documents in this specification are mentioned with a date, this specific edition is applicable.

2.1 Gasunie documents

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

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

2.2 Drawings

Reference is made in this specification to the following drawings:

E-11.54.000 SH.001-010	Induction bend $R \geq 3 \cdot D$ typical manufacturing drawing.
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2.3 Standards

Reference is made in this specification to the standards mentioned in this subclause¹. Any supplements and errata notices are also applicable.

NEN-EN-ISO 3183	Petroleum and natural gas industries - Steel pipe for pipeline transportation systems.
NEN-EN 14870-1 (June 2023)	Petroleum and natural gas industries - Induction bends, fittings and flanges for pipeline transportation systems. Part 1: Induction 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.

¹ Applicable for 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 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-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. DEFINITIONS, ABBREVIATIONS AND SYMBOLS

3.1 Definitions

In this specification the following definitions are applicable:

Pressure-containing part	Part which is exposed to and contains pressure.
Transport medium ²	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.

3.2 Abbreviations

In this specification the following abbreviations are applicable:

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
QA	Quality Assurance
QC	Quality Control
RED	Required Engineering Documents
SAWH	Submerged-Arc Helical Welded
SAWL	Submerged-Arc Longitudinal Welded
UT	Ultrasonic Testing

3.3 Symbols

In this specification the following symbols are applicable:

<u>Symbol</u>	<u>Description</u>	<u>Unit</u>
D	specified diameter, outside or inside	mm
r_b	bend centreline radius	mm
T_d	design temperature	°C
$T_{d,min}$	minimum design temperature	°C
t	nominal wall thickness	mm
α	bending angle	°
P_d	design pressure	bar

² Additives and other substances used in the medium or in the processes are therefore expressly outside the scope.

4. AMENDMENTS/SUPPLEMENTS TO NEN-EN 14870-1:2023

If requirements of the mentioned codes and specifications conflict with this specification, this specification shall prevail.

This clause is presented in the form of amendments and supplements to NEN-EN 14870-1 and uses the same section numbering.

SECTION 1 SCOPE

Substitution *Substitute the fourth paragraph of this section with the following:*
Induction bends according to this specification (MSW-05-E) shall be manufactured according to PSL 2 as given for pipe in NEN-EN-ISO 3183.

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 this section with the following:*
Bends shall be manufactured in accordance with drawings E-11.54.000 SH.001-010.

SECTION 8 INFORMATION THAT SHALL BE SUPPLIED BY THE PURCHASER

8.1 General information

Substitution *Substitute paragraph e) and f) in this subsection with the following:*
Bend dimensions shall be in accordance with drawings E-11.54.000 SH.001-010.

8.2 Additional information

Substitution *Substitute paragraph o) in this subsection with the following:*
Type of coating is specified on drawings E-11.54.000 SH.001-010 and shall be in accordance with MSW-11-E.

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

SECTION 9 MANUFACTURING**9.1 Mother pipe**

Substitution Substitute the first two sentences in this subsection with the following:
"Mother pipe for the manufacture of PSL2 bends shall be made in accordance with NEN-EN-ISO 3183, Annex A."

Addition Mother pipe delivered by Gasunie meets the requirements of MSW-01-E, therefore the mother pipe is also in accordance with NEN-EN-ISO 3183, Annex A.

Substitution Substitute paragraph seventh with the following:
The bend manufacturer is responsible for the quality of the mother pipe and shall make sure that the mother pipe can be used to produce induction bends according to the MSW-05-E specification. Therefore, the bend manufacturer shall verify that the inspection certificate is correct and in accordance with MSA-32-E.

Addition SAWH pipe shall not be used for manufacturing of induction 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.

Substitution Modify item "Surface condition" mentioned in table 1 as follows:

Surface condition	According to 8501-1:2007, SA 2 (as stated in chapter 10.5.1 NEN-EN 14870-1:2023)
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9.8 End preparation

Substitution Substitute this subsection with the following:
End preparation shall be in accordance with drawings E-11.54.000 SH.001-010.

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 1" of this specification (MSW-05-E), and
- "table 3" by "table 2" of this specification (MSW-05-E).

10.1 General requirements

Substitution Replace reference to "ISO 3183" by NEN-EN-ISO 3183, Annex A.

Substitution Replace table 2 by the following table:

Table 1: Summary of testing and inspection requirements

	Test		Acceptance
Chemical analysis	Chemical Composition	T and P***	In accordance with NEN-EN-ISO 3183 and MSA-32-E par. 4.4
Physical Tests	Tensile	T	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 10.4.4.2*
	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 10.5.2
	Weldseam (UT)	T and P	In accordance with MSW-01-E
	Bend ends (laminations) (MT or PT)	P	In accordance with 10.5.4*
	Bend body (MT or PT)	T and P	In accordance with 10.5.5*
	Bend body (UT) transverse defects	T and P	In accordance with 10.5.6*
	Welding ends (MT or PT)	P	In accordance with 10.5.4*
	Residual magnetism ends	P	In accordance with 10.5.7*
	Repairs by grinding	P	In accordance with MSW-01-E and 10.5.8*
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*
Gauging		P	In accordance with 10.7*

N – Not required

P – Required for each production bend

T – Required for each test bend

* These subsections refer to NEN-EN 14870-1 (2023) and this specification where applicable.

** Not required for DN 100 and DN 150 on the HFI weld seam.

*** Chemical analysis can be done on the mother pipes.

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

Substitution *Substitute this subsection with the following:*
 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 pieces, a production test shall be performed for each batch of 50 bends produced. Production testing shall consist of those tests performed during the MPS.

Substitution *Replace table 3 by the following table:*

Table 2: Location of test pieces and type of test for destructive testing of test bends

Location	Test	
Tangent base metal ^a	Tensile Impact Through-thickness hardness	T
Tangent weld ^a	Tensile transverse Impact Flattening (only for HFI pipe) Through-thickness hardness Metallography Guided bend (only for SAWL pipe)	T
Transition zones base metal extrados, start or stop	Tensile ^b Impact ^b Through-thickness hardness ^b Metallography ^b	
Transition zones welds, start or stop	Tensile transverse ^b Impact ^b	T
Bend extrados base metal	Tensile Impact Through-thickness hardness Metallography	T
Bend intrados base metal	Tensile Impact Through-thickness hardness	T
Bend weld	Tensile transverse Impact Flattening (only for HFI pipe) Through-thickness hardness Metallography Guided bend (only for SAWL pipe)	T

a - Testing after bending is not necessary if test results are available for mother pipe and the tangent is not heat-treated during induction bending or subsequent heat treatment.

b - Where the entire length of the mother pipe, including tangents, is subject to the same continuous induction heating, cooling and speed parameters as the bent portion during the induction bending process then, unless specified otherwise by the purchaser, these induction bends are not considered to have transitions for testing purposes.

T - Required for each test bend

10.4 Physical testing**10.4.2 Tensile testing****10.4.2.2 Test Method**

Substitution *Substitute* "Tensile testing at ambient temperature shall be carried out in accordance with ISO 6892-1 or ASTM A370" with "Tensile testing at ambient temperature shall be carried out in accordance with ISO 6892-1."

In third paragraph:

Replace reference to "ISO 3183:2012, 10.2.4.2" by "MSW-01-E".

10.4.3 Charpy V-notch impact testing**10.4.3.1 Test pieces**

Substitution *Substitute* "Charpy V-notch test pieces shall be prepared in accordance with ISO 148-1 or ASTM A370" with "Charpy V-notch test pieces shall be prepared in accordance with ISO 148-1 and the required strike radius is 2 mm".

10.4.3.2 Test Method

Substitution *Substitute third paragraph in this subsection with the following:*
Impact test specimens shall be tested at temperatures in accordance with the table below:

Table 3: 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 this subsection with the following:*
The results of the Charpy V-notch impact tests shall meet the requirements of MSW-01-E.

10.4.5 Surface hardness testing**10.4.5.2 Requirements**

Substitution *Substitute this subsection with the following:*
The average value of the three hardness readings at each location of a production bend shall not vary by more than 30 HV 10, hardness points from the average value measured in the same location of the test bend. Single harness values shall meet the requirements of 10.4.4.2.

10.4.8 Guided bend testing**10.4.8.2 Test method**

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

10.4.9 Flattening tests

Substitution *Substitute this 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

10.5.1 General

- 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* The personnel performing the examinations shall have at least NEN-EN-ISO 9712 level 2 for the used technique.
- 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 Gasunie for validation prior to the commencement of manufacturing.

10.5.2 Visual inspection

- Substitution* Replace reference to ISO 3183 by MSW-01-E.

10.5.3 Weld seam testing

- Substitution* *Substitute this subsection with the following:*
The weld seam(s) shall be UT tested in accordance with NEN-EN-ISO 10893-11 or RT in accordance with NEN-EN-ISO 10893-6.

10.5.4 Inspection of bend ends

- Addition* MT: NEN-EN-ISO 10893-5, or
PT: NEN-EN-ISO 10893-4
UT (PSL 2 bends): NEN-EN-ISO 10893-8.

10.5.5 Magnetic particle testing or liquid-penetrant testing on the bend body

- Substitution* In first paragraph:
Replace "ISO 10893-5" by "NEN-EN-ISO 10893-5" for MT.
Replace "ISO 12095" by "NEN-EN-ISO 10893-4" for PT.
ASTM E709 not allowed.

- Addition* MT: NEN-EN-ISO 10893-5, or
PT: NEN-EN-ISO 10893-4

10.5.6 Ultrasonic testing on the bend body

- Substitution* Testing shall be performed according to NEN-EN-ISO 10893-10.
Replace "ISO 3183" with "NEN-EN-ISO 3183".

10.5.9 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:*

Wall thickness measurements (UT) in accordance with ASTM E797.

Table 4: Permissible dimensional tolerances

Dimension	Permissible tolerance
Linear dimensions ^a	+10 / -50 mm
Minimum wall thickness	Zero
Maximum wall thickness	According MSW-01-E, only applicable for mother pipe and not the bend.
Inside diameter of bend ends	According drawing
Inside diameter of bend arc and tangents	See 10.7 of this specification (MSW-05-E)
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 O.D.
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 this subsection with the following:*

The inside diameter of each finished 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 this 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 applicable RED-form mentioned in the purchase order.

SECTION 12 MARKING*Substitution**Substitute this section with the following:*

Bends shall be marked in accordance with the applicable drawings mentioned in the purchase order.

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 14870-1;
- 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).

6. DOCUMENTATION

In this specification the following documentation is applicable:

- 1 N.V. Nederlandse Gasunie, memorandum [OTWS 23.2459](#), Revisie MSW-05-E (version 8 → 9), doorgevoerde wijzigingen d.d. 28-07-2023 (*not available for external parties*).