

Gasunie Technical Standard

Material Specification Mechanical

MSW-11-E

**Shop coating of steel structures
and pipeline elements**

External

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N.V. Nederlandse Gasunie

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Material Specification Mechanical
MSW-11-E

Shop coating of steel structures and pipeline elements

This specification has been drawn up by the Gasunie department
"Operations & Projects; Techniek - Werktuigbouw Installaties"
(Operations & Projects; Technology - Mechanical Engineering Installations).

The specification may be distributed to suppliers and contractors.

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FOREWORD

This specification supersedes the eleventh version of MSW-11-E.

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

- General update
- For coating code A, generically formulated conditions have to be fulfilled unless it is indicated that a shop primer shall be used.
- The requirements and methods for obtaining qualification for coating application are prescribed and described.
- The coating selection table (annex B) has been updated.
- The required tests are separated into PPT & production tests (annex C) and PQT (qualification) tests (annex D).
- The addendum to version 11, containing coating code Q (Nickel plated coating), is integrated in this version (version 12).

Alterations are marked with a left margin line.

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1. SCOPE AND APPLICATION

This specification applies to and defines all coatings of steel structures, pressure equipment, pipes and pipeline elements for underground and above ground application, not applied in the field and comprises the requirements for:

- coating materials;
- surface preparation;
- coating methods;
- inspection methods.

The application of additional concrete (weight) coating is not covered in this specification. For additional concrete coating [MSW-10-E](#) (see documentation 1) is to be used.

2. REFERENCES

This specification is subject to the requirements of the documents stated in this clause.

2.1 Gasunie documents

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

GTS W-024	Audit question list coating.
GTS W-111	Coatingcoderingen (Coating codes).
GTS W-129	Qualified paint systems for shop application (MSW-11-E).
MSA-23-N	Handling, opslag en kwaliteitsbewaking materialen (Handling, storage and quality inspection of materials).
MSA-25-E	Transport packing and marking.
MSW-06-E	Insulated pipe connections.

2.2 National standards

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

KIWA directive BRL-K768	Uitwendige epoxybekledingen van ondergronds te leggen stalen tanks, buizen en hulpstukken (External epoxy coatings of underground steel tanks, pipes and fittings).
KIWA directive BRL-K779	Beoordelingsrichtlijn: Inwendige bekleding op stalen tanks voor brandbare vloeistoffen (Assessment directive: internal coating on steel tanks for flammable liquids).
KIWA directive BRL-K790	Beoordelingsrichtlijn: Het appliceren van bekledingen op stalen opslagtanks of stalen leidingen en hulpstukken (Assessment directive: the application of coating systems on steel storage tanks or steel pipes and fittings).
NEN 3050	Kleuren voor het merken van pijpleidingen voor het vervoer van vloeibare of gasvormige stoffen in landinstallaties (Identification colours for pipes conveying fluids in liquid or gaseous condition in land installations).
NEN 3650-1	Eisen voor buisleidingsystemen - Deel 1: Algemene eisen (Requirements for pipeline systems – Part 1: General requirements)
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 5254	Het industrieel aanbrengen van organische deklagen op thermisch verzinkte of gesherardiseerde producten (duplex-systeem) (Industrial application of organic coatings on hot-dip zinc coated or sherardised products (duplex- system)).
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2.3 International standards

Reference is made in this specification to the international standards¹ mentioned in this subclause. Any supplements and errata notices are also applicable.

DIN 30670	Polyethylene coatings of steel pipes and fittings; requirements and testings.
DIN 30678	Polypropylene coatings for steel pipes.
NEN-EN 1090-2	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures.
NEN-EN 10289	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied epoxy and epoxy-modified coatings.
NEN-EN 10290	Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings.
NEN-EN-ISO 527-1	Plastics - Determination of tensile properties - Part 1: General principles
NEN-EN-ISO-527-2	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics.
NEN-EN-ISO-527-3	Plastics - Determination of tensile properties - Part 3: Test conditions for films and sheets.
NEN-EN-ISO 527-4	Plastics - Determination of tensile properties - Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites.
NEN-EN-ISO 527-5	Plastics - Determination of tensile properties - Part 5: Test conditions for unidirectional fibre-reinforced plastic composites.
NEN-EN-ISO 868	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness).
NEN-EN-ISO 1461	Hot-dip galvanised coatings on fabricated iron and steel articles-Specifications and test methods.
NEN-EN-ISO 2081	Metallic and other inorganic coatings - Electroplated coatings of zinc with supplementary treatments on iron or steel.
NEN-EN-ISO 2409	Paints and varnishes – Cross-cut test.
NEN-EN-ISO 2815	Paints and varnishes - Buchholz indentation test.
NEN-EN-ISO 3231	Paints and varnishes – Determination of resistance to humid atmospheres containing sulphur dioxide.

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 4527	Metallic coatings - Autocatalytic (electroless) nickel-phosphorus alloy coatings - Specification and test methods.
NEN-EN-ISO 4624	Paints and varnishes - Pull-off test for adhesion
NEN-EN-ISO 4628-2	Paints and varnishes - Evaluation of degradation of coatings; Designation of quantity and size of defects, and of intensity of uniform changes in appearance; Part 2: Assessment of degree of blistering.
NEN-EN-ISO 4628-3	Paints and varnishes - Evaluation of degradation of coatings; Designation of quantity and size of defects, and of intensity of uniform changes in appearance; Part 3: Assessment of degree of rusting.
NEN-EN-ISO 4628-4	Paints and varnishes - Evaluation of degradation of coatings; Designation of quantity and size of defects, and of intensity of uniform changes in appearance; Part 4: Assessment of degree of cracking.
NEN-EN-ISO 4628-5	Paints and varnishes - Evaluation of degradation of coatings; Designation of quantity and size of defects, and of intensity of uniform changes in appearance; Part 5: Assessment of degree of flaking.
NEN-EN-ISO 4628-6	Paints and varnishes - Evaluation of degradation of coatings; Designation of quantity and size of defects, and of intensity of uniform changes in appearance; Part 6: Assessment of degree of chalking by tape method.
NEN-EN-ISO 6270-1	Paints and varnishes - Determination of resistance to humidity; Part 1: Continuous (single-sided exposure).
NEN-EN-ISO 6270-2	Paints and varnishes - Determination of resistance to humidity; Part 2: Condensation (in-cabinet exposure with heated water reservoir).
NEN-EN-ISO 7010	Graphical symbols - Safety colours and safety signs - Registered safety signs.
NEN-EN-ISO 8501-1	Preparation of steel substrates before application of paints and related products; Visual assessment of surface cleanliness; Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
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 8502-3	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness; Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method).

NEN-EN-ISO 8502-6	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness; Part 6: Extraction of soluble contaminants for analysis - The Bresle method.
NEN-EN-ISO 8503-4	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates - Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Stylus instrument procedure.
NEN-EN-ISO 9227	Corrosion tests in artificial atmospheres - Salt spray tests.
NEN-EN-ISO 12944-1	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction.
NEN-EN-ISO 12944-2	Paints and varnishes; Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.
NEN-EN-ISO 12944-3	Paints and varnishes; Corrosion protection of steel structures by protective paint systems; Part 3: Design considerations.
NEN-EN-ISO 12944-4	Paints and varnishes; Corrosion protection of steel structures by protective paint systems; Part 4: Types of surface and surface preparation.
NEN-EN-ISO 12944-5	Paints and varnishes; Corrosion protection of steel structures by protective paint systems; Part 5: Protected paint systems
NEN-EN-ISO 12944-6	Paints and varnishes; Corrosion protection of steel structures by protective paint systems; Part 6: Laboratory performance test methods.
NEN-EN-ISO 12944-7	Paints and varnishes; Corrosion protection of steel structures by protective paint systems; Part 7: Execution and supervision of paint work.
NEN-EN-ISO 17652-1	Welding - Test for shop primers in relation to welding and allied processes - Part 1: General requirements
NEN-EN-ISO 17652-2	Welding - Test for shop primers in relation to welding and allied processes - Part 2: Welding properties of shop primers.
NEN-EN-ISO 17652-3	Welding - Test for shop primers in relation to welding and allied processes - Part 3: Thermal cutting
NEN-EN-ISO 17652-4	Welding - Test for shop primers in relation to welding and allied processes - Part 4: Emission of fumes and gases.
NEN-EN-ISO 19840	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces.
NEN-EN-ISO 21809-1	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems; Part 1: Polyolefin coatings (3-layer PE and 3-layer PP).

NEN-EN-ISO 21809-3	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems; Part 3: Field joint coatings.
NEN-EN-ISO 29601	Paints and varnishes – Corrosion protection by protective paint systems – Assessment of porosity in a dry film
NEN-ISO 15741	Paints and varnishes - Friction-reduction coatings for the interior of on- and offshore steel pipelines for non-corrosive gases
RAL 841 GL	Primary standards of 196 RAL CLASSIC colours

2.4 Other references

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

SSPC SP1	Solvent Cleaning
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3. DEFINITIONS, ABBREVIATIONS AND SYMBOLS

3.1 Definitions

In this specification the following definitions are applicable:

Coating application	Pre-treatment plus the application of one or more coatings to a surface. In this specification the meaning of the expression "coating" includes the meaning of the expression "paint" as used in (the titles of) various standards.
Dew point temperature	The dew point temperature is the temperature at which air is saturated with water vapour. When the air cools down further condensation will occur.
Dry film thickness	The thickness (in microns) of the dried or cured coating film.
High Build	Coating types with a considerable coating thickness, which can be achieved in a single operation.
Sweep blasting	Blast-cleaning at reduced velocity.
Surface roughness	The roughness profile of a blast-cleaned surface.

3.2 Abbreviations

In this specification the following abbreviations are applicable:

DFT	Dry Film Thickness
FBE	Fusion Bonded Epoxy
HDPE	High density polyethylene
MFR	Melt Flow Rate
NPD	Nominal Pipe Diameter
OIT	Oxidation Induction Time
PE	Polyethylene
PP	Polypropylene
PPT	Pre-Production Trial
ITP	Inspection and Test Plan
APS	Application Procedure Specification
PQT	Procedure Qualification Trial
REACH	Registration, Evaluation, Authorization and restriction of Chemicals

3.3 Symbols

In this specification the following symbols are applicable:

<u>Symbol</u>	<u>Description</u>	<u>Unit</u>
T	Temperature	°C
T_g	The glass transition temperature	°C
R	Radius	mm
R_s	Resistivity	Ωm^2
R_z	Surface roughness	μm

4. GENERAL REQUIREMENTS

To be entitled to supply coated (pressurised) equipment, pipes and/or pipeline elements to Gasunie or for usage in Gasunie projects or to apply coating commissioned by Gasunie, both coating system and coating application shall be qualified by Gasunie as described in annex D.

The occurrence of galvanic corrosion shall be prevented. As is indicated in [NEN-EN-ISO 12944-3](#) for aboveground constructions, corrosion can occur at an electrically conducting joint of two metals of different electrochemical potential. To prevent this kind of corrosion both metals shall be coated. When one of the metals is e.g. stainless steel (SS), then the SS shall be coated over a length of at least 1,5 cm from the joint.

Where underground application applies, objects shall be fully coated.

For proper coating application, the design considerations which are given in [NEN-EN-ISO 12944-3](#) shall be met. In [NEN-EN-ISO 12944-3](#) it is stated that the requirements of [NEN-EN-ISO 8501-3](#) grade P3 shall be fulfilled. When these are not fulfilled, this may impair the ability to meet coating guarantee obligations. Therefore the coating applicator shall notify the client and Gasunie in such a situation. The written notification of such a situation shall be part of the applicator's coating documentation.

5. PRE-TREATMENT (SURFACE PREPARATION)

5.1 Degreasing and cleaning

When grease or oil is present than the surface shall be cleaned according to SSPC SP1 prior to blast cleaning.

5.2 Blast cleaning

The blasting material shall be sharp edged (grit).
Shot (round blasting material) is prohibited.

For stainless steel and aluminium an inert blasting material shall be used.

The grit material shall be free of grease, oil and other contaminants, such as salts. The maximum conductivity of the abrasive is 150 µS/cm.

During blasting, the interior of valves shall be protected in such a way that no grit or dirt can penetrate the inside of the valve. The same applies to other parts of the pipeline or its appurtenances where penetration by or the presence of blasting material may cause the component to malfunction or to be damaged.

Gasket surfaces shall be protected during blast cleaning.

Item identifications, such as permanent hard stamps, shall be protected during blasting or other cleaning operations.

5.2.1 Pre-treatment of galvanised surfaces

The following applies to galvanised surfaces:
The surface shall be free from zinc corrosion, burrs, zinc sheets, zinc oxides and flux remains. If these defects occur, they shall be removed by steam cleaning and **manual** sanding and/or filing. The surface shall be blasted lightly and evenly with a moderate pressure and a fine-grained, non-metallic blasting agent.

The blasting activities and also the removal of the aforementioned defects shall be executed in such a way that the surface will be roughened evenly and no damage is done to the zinc layer. Blasting agents containing iron or copper are not allowed.

Repair of damaged hot-dip galvanised steel shall be in accordance with [NEN-EN-ISO 1461](#). Efforts shall be made to match the colours of the original hot-dip galvanised work.

6. APPLICATION OF COATINGS

6.1 General requirements

Application of coating systems other than mentioned in this specification, or application of mentioned coating systems on application areas other than mentioned in annex A, are not allowed.

Coating application shall be done in conformance with the applicable system. Systems are described in annex A. The identification of the object to be treated (as indicated on the type plates) shall be registered before coating activities are carried out on this object.

6.2 Stripe coat

As required by [NEN-EN-ISO 12944-7](#) all critical parts such as edges, gaps, angles, weld seams, bolts and nuts shall be pre-applied with a **brush** before the specified coating layer is applied (not valid for factory-applied line pipe). This shall be done for each specified layer. The DFT on these areas shall fulfil the required DFT.

6.3 Sealing

Capillary seams, blind holes and other potential points for corrosion attack arising from retention of moisture and dirt, including any abrasive used for surface preparation and which are without a safety function, shall be sealed with a durable polyurethane sealant (e.g. Sikaflex 212), ensuring that the requirements of [NEN-EN-ISO 12944-3](#) are met.

The sealant shall be placed before the last coating layer. The transitions between the sealant and steel surface shall be smooth and shall not have raised edges.

6.4 Application

6.4.1 Material

All coating material shall be supplied in the original packaging. All packaging shall be manufacturer sealed and fitted with a clearly readable inscription mentioning:

- manufacturer's name and brand name;
- name and complete identification of material, including plant of fabrication;
- date of manufacturing and/or expiry date;
- batch number;
- RAL colour number or colour identification;
- contents in litres/kilos;
- mixing instructions;
- filling date;
- in case of several components in separate packaging: the components relating to each other and the mixing weight and volume ratio.

All packages shall be kept closed until their contents are necessary for use. Materials whose storage life has expired shall not be applied.

Materials shall be stored in accordance with the specification of the coating material manufacturer.

6.4.2 Coating thickness

When determining the coating thickness, account shall be taken of the surface roughness, i.e. the roughness value of the blast-cleaned surface. This in accordance with [NEN-EN-ISO 19840](#).

In case a minimum and/or maximum DFT is specified (e.g. PE, PP extrusions, code U) all the individually measured DFTs shall be equal to or greater than the specified minimum and equal to or less than the maximum value.

6.4.3 Applying subsequent coating layers

A clear colour difference shall be visible between the successive layers (as far as possible with the specified products). The underlying layers may not be visible through the final layer. The colour of the top coating shall be in compliance with the requirements of clause 8.

6.4.4 Application of galvanised surfaces

Hot-dip galvanised layers shall be applied in accordance with [NEN-EN-ISO 1461](#). The coating thickness shall be in accordance with [NEN-EN-ISO 1461](#).

The maximum zinc layer shall not exceed 150 micron. The coated surface shall be free of nodules, blisters, roughness and sharp points.

6.4.5 Transition underground - aboveground coating

The transition of code U or Z to code B shall be applied approximately 100 mm below the name plate bracket or vertical drain valve. Code U or Z shall be applied first and for a length of 10 cm, code B on top of code U or Z. The ending of code U or Z shall be smooth and sloping.



6.4.6 Method of application

6.4.6.1 Spray application

Paint systems shall be applied by spray application. Brush application is not allowed except for applying stripe coat. Runs and sags, if any, shall be smoothed with a brush immediately.

Overspray is not permitted.

6.4.7 Repairs

Each layer and the finished coating shall be free from dust and other contaminants, holidays, pores, runs and sags, scorching or any other defect.

Should a defect occur, the affected area shall be smaller than 10 cm² per defect. The total amount of defects in the finished coating shall not exceed three. If these requirements are not met, the coating will be rejected. Repairs of coating to be buried in soil shall be marked with a green circle.

7. UNCOATED SURFACES

The surfaces of the following parts shall not be blast cleaned and shall remain uncoated; these shall be protected with a temporary rust protection.

- gasket surfaces¹⁾;
- male and female threads¹⁾;
- greasing points¹⁾;
- all planes of moving parts¹⁾;
- vent plugs¹⁾;
- spindle squares¹⁾;
- stainless steel parts (only for aboveground application)²⁾;
- identification plates²⁾.

Notes:

1) Gasunie is standardised on Tectyl 506.

2) Underground parts shall be coated but aboveground parts remain uncoated.

7.1 Length and coating of cutback (weld ends)

The length of the cutback shall be as follows:

Internally:

- | | |
|----------------------|----------------|
| – pipes: | 20 mm ± 5 mm; |
| – valves: | 0 mm; |
| – bends: | 20 mm ± 10 mm; |
| – insulating joints: | 20 mm ± 10 mm; |
| – fittings: | 20 mm ± 10 mm; |

Externally:

- | | |
|-------------------------|-----------------|
| – pipes: | 200 mm ± 10 mm; |
| – valves: | 20 mm ± 5 mm; |
| – bends: | 180 mm ± 30mm; |
| – insulating joints: | 200 mm ± 10 mm; |
| – fitting side ≤ DN 600 | 90 mm ± 20 mm; |
| – fitting side > DN 600 | 180 mm ± 30 mm. |

Temporary coating on cutback

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

7.2 Identification of materials

Codes marked in the steel, such as batch and pipe numbers, shall remain visible at all times after treatment. These codes shall be marked with a white frame. These marked surfaces shall be provided with temporary, removable protection (e.g. SK 40).

The following details shall also be marked on the coating with the use of a template:

- N.V. Nederlandse Gasunie;
- Gasunie purchase order (BB) number;
- supplier's name;
- nominal diameter (DN) x wall thickness (mm);
- length (in metres) (only for pipe);
- pipe and/or bend numbers.

The template shall be placed externally and internally (internally only above DN 600) at the ends. The template requires Gasunie's approval.

A colour coding shall be applied to pipes by means of one coloured band, 50 mm - 70 mm wide at each end of the pipe or bend, at least 500 mm from the steel bevel (depending on the template size). The coating used shall be weather- and UV-resistant and shall adhere to the coating.

The following colours and marks shall be used:

steel L485ME:	blue band;
steel L415ME:	red band;
steel L245ME/NE:	no band;

QT steel	On each cutback in the 12, 4 and 8 o'clock position the marking: "QT steel"
Skelp welds:	green coloured band on the ends of the pipe;
Centre of the pipe:	black band for PP coated pipes; white band for PE coated pipes;
Repairs on coating systems buried in soil:	green circle.

If identification plates are required, these shall be fitted with epoxy glue **after** the complete coating has been applied.

8. COLOUR SYSTEMS

The requirements of this clause are applicable to aboveground application only. No colour requirements are applicable to underground application.

The colour of steel structures, vessels and pipeline systems for natural gas (maximum operating temperature 90 °C) shall be grey, RAL 7038¹⁾.

Exceptions:

- Structural steel on LNG: Blue RAL 5010;
- Safety icons: as per [NEN-EN-ISO 7010](#);
- Identification colours: as per [NEN 3050](#).

The colour of pipelines carrying other media than (sweet) natural gas, shall be carried out in conformance with [NEN 3050](#).

1) All RAL numbers are according to [RAL 841 GL](#).

9. SHIPPING, STORAGE AND TRANSPORT

Materials shall be handled, transported and stored according to [NEN 3650](#)-1 and -2, [NEN-EN-ISO 12944-3](#), [MSA-23-N](#) (stacking height) and [MSA-25-E](#).

The firm, to whom the Gasunie order is assigned, is responsible for safe and adequate storage of products and stacked products shall be properly supported to prevent damage or deformation.

10. WARRANTY FOR COATING SYSTEMS

10.1 Warranty obligations

10.1.1 Warranty period

The warranty period for coating systems, as mentioned in annex A, is five years after the delivery date except for code A, which is one year.

10.1.2 Corrosion

The protective effect of the coating system shall be such that the conserved parts of the relevant object shall show no corrosion during the period mentioned in subclause 10.1.1 (Ri 0 according to [NEN-EN-ISO 4628-3](#)).

10.1.3 Detachment or flaking

During the period mentioned in subclause 10.1.1, the coating system applied shall show no detachment from the underground layer or between the individual layers (flaking) of the coating system ([NEN-EN-ISO 4628-5](#) class 0).

10.1.4 Blistering

During the period mentioned in subclause 10.1.1, the coating system applied shall show no blisters ([NEN-EN-ISO 4628-2](#) density class 0).

10.1.5 Cracks

During the period mentioned in subclause 10.1.1, the coating system applied shall show no cracks or crackle; not in the entire coating system, nor in any one of the individual layers that are part of this ([NEN-EN-ISO 4628-4](#) class 0).

10.1.6 Chalking

The coating system applied (code B only) shall show no chalking larger than value 1 according to [NEN-EN-ISO 4628-6](#) during the period mentioned in subclause 10.1.1.

11. DOCUMENTATION

In this specification, the following documentation is applicable:

- 1 [MSW-10-E](#), Concrete coating; External concrete coatings for buried or submerged pipelines

ANNEXES

A COATING SYSTEMS

The coating systems mentioned in this annex apply to entire surfaces. For coating of welding stubs, reference is made to subclause 7.1. For each coating system, the required product qualification tests (PQTs) are mentioned in annex D. Qualified paint systems are given in [GTS W-129](#).

A.1 Code A

This coating is a temporary coating for storage purposes only. The type of coating is not prescribed; only the generic conditions that have to be fulfilled.

Storage conditions:

- objects will be stored at Gasunie premises outdoors, on paved ground and in open air.

Allowable corrosion:

- after a storage period of 1 year (maximum), the corrosion on objects shall be limited to flash rust and no pitting rust shall occur.

General conditions of the coating used; the coating:

- can be removed without creating limitations to blasting to Sa 2½;
- does not have negative implications on the performance of mill and field applied coatings. In particular, the adhesion of such mill or field coatings to the steel shall not be negatively affected.
- shall be in compliance with REACH;
- shall not have negative effects on the weldability of weld ends;
- shall not have negative HSE implications, not during storage, nor during removal e.g. by grit blasting, nor during welding.

When removal is not possible by grit blasting, manufacturer shall indicate the proper manner of removal of the coating. The method of removal shall be acceptable for Gasunie.

Internal coating: Before application of code A, the metal surface shall be grit blasted to Sa 2½ according [NEN-EN-ISO 8501-1](#). Grit blasting enables the detection of slivers, scabs, laps and the like. This requirement does not apply to external coating.

When in subclause 7.1 "temporary coating on cutback" code A is chosen or when in annex B it is indicated that a shop primer shall be used, then the following applies:

1	One full layer (sprayed) of zinc silicate shop primer.	25 µm DFT
	Total coating thickness:	25 µm DFT

Shop primer shall comply with [NEN-EN 1090-2](#) and [NEN-EN-ISO 17652](#).

A.2 Code B (maximum operating temperature 120 °C)

1	One layer of epoxy mastic high build epoxy, aluminium pigmented	120 µm DFT
2	One layer of epoxy mastic high build epoxy.	120 µm DFT
3	One layer of high-gloss acrylic/polyurethane finishing coating, colour RAL 7038.	60 µm DFT
Total coating thickness:		300 µm DFT

Note:

- Brush application is not allowed except for applying stripe coat.

A.3 Code C paint system on galvanised steel or aluminium

1	Sweep blasting.	
2	One layer of epoxy mastic high build epoxy	140 µm DFT
3	One layer of high-gloss polyurethane finishing coating, colour RAL 7038.	60 µm DFT
Total coating thickness:		200 µm DFT

Notes:

- Hot-dip galvanised plate shall be prepared in accordance with [NEN 5254](#) and [NEN-EN-ISO 12944-4](#).
- Surface with thermal sprayed metal (zinc and aluminium) shall be prepared according [NEN-EN-ISO 12944-4](#).
- On surfaces with thermal sprayed metal an additional sealer (40 µm) shall be applied which fills the metal pores, as according to [NEN-EN-ISO 12944-5](#). The total thickness is then 240 µm.
- Brush application is not allowed except for applying stripe coat.

A.4 Code E3 (maximum operating temperature 500 °C)

Contact Gasunie representative.

A.5 Code F (thermal hot-dip galvanising)

1	Galvanising.	NEN-EN-ISO 1461
	Coating thickness steel ≥ 6 mm	85 µm - 150 µm
	Coating thickness steel ≥ 3 mm < 6 mm	70 µm - 130 µm
	Steel < 3 mm	55 µm - 110 µm

Note:

The galvanised items shall comply with [NEN-EN-ISO 1461](#).

A.6 Code J (HDPE extrusion coating¹⁾)

- 1 Applying FBE min 150 µm DFT
- 2 Applying adhesive coating.¹⁾ min 150 µm DFT
- 3 Applying extrusion coating, both wrapping and tube extrusion being permitted.¹⁾ See table 1
- 4 Bevelling PE coating ends (max 30° bevel).
- 5 Transition PE bevel - steel one layer of modified bitumen solution (e.g. Bausion Elastic plus)

Notes:

- The coating application shall fulfil [NEN-EN-ISO 21809-1](#).
- Total coating thickness shall be at least in accordance with table 1.

Table 1: Coating thicknesses code J

Nominal pipe diameter	Coating thickness in mm	
	on pipe	on weld seam
DN 25 ≤ NPD ≤ DN 100	1,8	1,8
DN 100 < NPD < DN 250	2,0	1,8
DN 250 ≤ NPD < 500	2,2	2,0
DN 500 ≤ NPD < 750	2,5	2,2
NPD ≥ 750	3,0	2,5

- 1) Other application methods, with or without adhesive coating, can be allowed provided qualified by Gasunie.

A.7 Code J1 (HDPE extrusion coating¹⁾, heavy duty purpose)

- 1 Applying FBE min 150 µm DFT
- 2 Applying adhesive coating.¹⁾ min 150 µm DFT
- 3 Applying extrusion coating, both wrapping and tube extrusion being permitted.¹⁾ See table 2
- 4 Bevelling PE coating ends (max 30° bevel).
- 5 Transition PE bevel - steel one layer of modified bitumen solution (e.g. Bausion Elastic plus)

Notes:

- The coating application shall fulfil [NEN-EN-ISO 21809-1](#)
- Total coating thickness shall be at least according to table 2.

Table 2: Coating thicknesses code J1

Nominal pipe diameter	(Total) Coating thickness in mm	
	on pipe	on weld seam
DN 25 ≤ DN 500	4,5	3,0
> DN 500	6,0	4,0

- 1) Other application methods, with or without adhesive coating, can be allowed provided qualified by Gasunie.

A.8 Code L1 (flow coating)

1	One layer of epoxy flow coating	80 µm DFT
	Total coating thickness:	<u>80 µm DFT</u>

Notes:

The coating shall be applied in accordance with [NEN-ISO 15741](#).

Between the application of internal coating in a spool piece and the evacuation (vacuum condition), which for instance is a common procedure in the factory acceptance test of an ultrasonic meter or any other pressurisation/depressurisation sequence of that spool piece, a minimum period of one week (seven days) shall be observed for curing of the coating. Brush application is not allowed except for applying stripe coat.

A.9 Code L2 (Tectyl)

1	One layer of Tectyl	min 15 µm DFT
	Total coating thickness (indicative):	<u>min 15 µm DFT</u>

Note:

- Valves shall not be blast cleaned internally.

A.10 Code Q (Nickel-plated coating)

1	Electroless nickel coating NEN-EN-ISO 4527	
	Layer thickness nominal:	75 µm DFT

Notes:

- nickel-plated coating for final inside and outside coating of ultrasonic and turbine gas meters;
- corrosion resistance 4; very severe according to annex C of [NEN-EN-ISO 4527](#);
- uniform colour and a layer without damage;
- brown decolourisation due to dewatering is accepted;
- layer thickness determined according to B.3.3 of [NEN-EN-ISO 4527](#);
- test plates shall be made to measure:
 - adhesion;
 - thickness;
 - porosity;
 - corrosion resistance.
- type 4 of nickel coating according to annex C, table C.2 of [NEN-EN-ISO 4527](#).

A.11 Code R (vulcanising)

1	Bonding primer	25 µm DFT
2	Ebonite coating	3 000 µm DFT
3	Vulcanising < 145 °C.	
	Total coating thickness:	<u>3 025 µm DFT</u>

Notes:

- Flanges shall be coated internally and externally. The finish of the weld ends depends on the nominal pipe size (see [MSW-06-E](#)).
- Spark testing shall be done at 6 V/µm.

A.12 Code U (Solvent-free two-component polyurethane coating)

1	One layer of polyurethane	min 1500 µm DFT max 4000 µm DFT*
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The coating shall be applied in accordance with [NEN-EN 10290](#).

- * On valves locally 6 mm DFT is allowed (e.g. bolts, nuts, connections of seal and drain tubes)
Brush application is not allowed except for applying stripe coat.

A.13 Code V3 (Solvent-free epoxy with KIWA certificate)

1	One layer of high solid epoxy	500 µm DFT
	Total coating thickness:	<u>500 µm DFT</u>

Chemical resistance of the coating shall be checked for application.
Brush application is not allowed except for applying stripe coat.

A.14 Code W1 (PP extrusion coating¹⁾)

1	Applying FBE	min 150 µm DFT
2	Applying adhesive coating. ¹⁾	min 150 µm DFT
3	Applying extrusion coating, both wrapping and tube extrusion being permitted. ¹⁾	See table 3
4	Bevelling PP coating ends (max 30° bevel).	
5	Transition PP bevel - steel one layer of modified bitumen solution (e.g. Bausion Elastic plus)	

Notes:

- The coating application shall fulfil [NEN-EN-ISO 21809-1](#).
- Total coating thickness shall be at least in accordance with table 3.

- 1) Other application methods, with or without adhesive coating, can be allowed provided qualified by Gasunie.

Table 3: Coating thicknesses Code W1

Nominal pipe diameter	(Total) Coating thickness in mm	
	on pipe	on weld seam
DN 25 ≤ DN 500	4,5	3,0
> DN 500	6,0	4,0

A.15 Code Z (High build solvent-free epoxy)

1 One layer of high build solvent-free epoxy

1500 µm DFT

Notes:

- The coating shall be applied in accordance with [NEN-EN 10289](#).
- Brush application is not allowed except for applying stripe coat.

A.16 Overview of coating systems at Gasunie

An overview of all coating systems used within Gasunie is given in [GTS W-111](#).

B SYSTEM SELECTION TABLE

ITEM	External surfaces	Internal surfaces
Accessories	A ¹²⁾	A ¹²⁾ , L1
Actuators	B, C ⁹⁾	-
Bends (3D, 5D, 10D)		
≤ DN 600 (above- and underground)	A	A ¹²⁾ , L1
> DN 600 (aboveground)	B	L1
> DN 600 (underground)	U, Z	L1
Cage ladders	F	-
Caps	A ¹²⁾	A ¹²⁾
Elbows (1,5D, 3D)		
≤ DN 600 (above- and underground)	A	A ¹²⁾ , L1
> DN 600 (aboveground)	B	A ¹²⁾ , L1
> DN 600 (underground)	U, Z	A ¹²⁾ , L1
> DN 600 prefab	A	A ¹²⁾ , L1
Exhaust systems ≤ 500 °C ^{1, 7)}	E3 ⁶⁾	-
Flanges	A	A
Flow straighteners	L2	-
Gas pressure regulators	B, C	-
Gearboxes	B	-
Insulating flanges	R	R
Insulating joints	U	L1
Liquid catchers	U, Z	-
Pipes		
aboveground ≤ 120 °C	B	L1 ^{10,8)}
underground	J ¹⁰⁾ , W1 ¹⁰⁾	L1 ^{10,8)}
> 120 °C	E3 ⁷⁾	E3 ⁷⁾
HDD, drillings, pressings	W1, J1	L1 ⁸⁾
in storage (surplus pipe)	A ¹²⁾	L1 ^{10,8)}
Pipe supports aboveground	F, B	-
Pipe supports underground	F, U, Z	
Platforms	F	-
Pressure relief valve ¹¹⁾	B	-
Pressure vessels ≤ 120 °C ^{2),8)}	B	-
Pressure vessels, insulated	B	-
Quick closing doors	B	A ¹²⁾ , L1
Reducers		
≤ DN 600 (above- and underground)	A	A ¹²⁾ , L1
> DN 600 (aboveground)	B	A ¹²⁾ , L1
> DN 600 (underground)	U	A ¹²⁾ , L1
> DN 600 prefab	A	A ¹²⁾ , L1
Repair sleeves	A ¹²⁾	A ¹²⁾
Right-angled transmissions	U, Z	-
Scraper traps	B	L1
Skids	F+C	-
Spindles	U, Z	-
Spindles hollow	U, Z	L2
Spool pieces	B	L1 ⁸⁾
Stairs	F	-

ITEM	External surfaces	Internal surfaces
Static mixers	U, Z	L2
Steel structures with colour	F+C	-
Steel structures without colour	F	-
Stopples and splittees	A ¹²⁾	A ¹²⁾
Storage tanks aboveground	B	V3 ³⁾
Storage tanks underground	Z ³⁾	V3 ³⁾
Stud bolts, bolts, nuts, washers	⁵⁾	-
Syphons	U, Z	-
Tees		
≤ DN 600 (above- and underground)	A	A ¹²⁾ , L1
> DN 600 (aboveground)	B	A ¹²⁾ , L1
> DN 600 (underground)	U	A ¹²⁾ , L1
> DN 600 prefab	A	A ¹²⁾ , L1
Turbine gas meters	B, Q ¹³⁾	L1, Q ¹³⁾
Ultrasonic gas meters	B, Q ¹³⁾	L1, Q ¹³⁾
Valves aboveground (including spindle extensions)	B	L2
Valves underground (including spindle extensions)	U, Z	L2
Extension casings	A ¹²⁾	A ¹²⁾ , L1

Notes:

1. Exhaust systems made from stainless steel, coating is not required.
2. Dust filters, heat exchangers, filter separators, scrubbers, cyclones or similar objects.
3. The application shall comply with KIWA directives [BRL-K790](#), [BRL-K768](#) and [BRL-K779](#). Testing shall be done in conformance with the requirements for KIWA certification. The coating shall have KIWA approval. The supplier shall have application process certificate [BRL-K790](#).
4. For the length and coating of the cutbacks (weld ends) see subclause 7.1.
5. Yellow passivated according to [NEN-EN-ISO 2081](#) code Fe/Zn 8C.
6. Gasunie shall be consulted before heat-resistant coatings are applied.
7. For design temperatures above 120 °C, Gasunie shall be consulted.
8. Not required for < DN 100 and if application is infeasible.
9. For galvanised or aluminium, use code C.
10. Maximum temperature for code J, J1, L1 is 80 °C and for code W1 110 °C.
11. Valid for PED category III and IV.
12. For code A only, shop coating shall be applied.
13. When Q is chosen, then Q is both internally and externally applied.

Where options are given in the table above, the party who received the Gasunie order for supply of items is responsible for making a proper choice regarding coating systems. This party also bears responsibility for the warranty obligations mentioned in this specification.

C PPT & PRODUCTION TESTS FOR COATING SYSTEMS

The following clauses contain the tests, test methods and Gasunie requirements. The results from the tests shall be reported in writing. Where possible, test results shall be reported with numerical values; pass/fail report results shall be avoided.

Specific per coating code

C.1 PPT & production tests for 3 layer PE coating (code J & J1)

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 µm - 100 µm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Preheating temperature before application	Monitored T	according to data sheet
Temperature after cooling	Monitored T	max 80 °C
Epoxy thickness	NEN-EN-ISO 19840	Min 150 µm
Minimum adhesive thickness	NEN-EN-ISO 19840	Min 150 µm
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Inspection cutback external	n/a	200 mm ± 10 mm
Inspection cutback internal	n/a	20 mm ± 5 mm
Impact resistance	NEN-EN-ISO 21809-1	> 7 J per mm coating thickness.
Peel strength	NEN-EN-ISO 21809-1	≥ 15 N/mm at 23 °C and ≥ 3 N/mm at 80 °C
Indentation	NEN-EN-ISO 21809-1	≤ 0,2 mm at 23 °C and ≤ 0,4 mm at 80 °C

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Elongation at break	NEN-EN-ISO 21809-1	$\geq 400 \%$
Holiday detection	NEN-EN-ISO 21809-1	Test voltage 25 kV, no holidays
Cd test (on special request)	NEN-EN-ISO 21809-1	23 °C/28 d -1,5 V $R \leq 5$ mm 65 °C/24 h -3,5 V $R \leq 4$ mm
Glass transition temperature epoxy	NEN-EN-ISO 21809-1	$-3 \text{ °C} < \Delta T_g < 3 \text{ °C}$
Product stability of PE (Δ MFR between compound and extruded film) ¹⁾	NEN-EN-ISO 21809-1	Δ MFR $\leq 20 \%$

¹⁾ When Δ MFR is not relevant, than an OIT test shall be done according to [NEN-EN-ISO 21809-3](#).

C.2 PPT & production tests for 3 layer PP coating (code W1)

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 µm - 100 µm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Preheating temperature before application	Monitored T	according to data sheet
Temperature after cooling	Monitored T	max 80 °C
Epoxy thickness	NEN-EN-ISO 19840	Min 150 µm
Minimum adhesive thickness	NEN-EN-ISO 19840	Min 150 µm
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Inspection cutback external	n/a	200 mm ± 10 mm
Inspection cutback internal	n/a	20 mm ± 5 mm
Impact resistance	NEN-EN-ISO 21809-1	> 10 J per mm coating thickness
Peel strength	NEN-EN-ISO 21809-1	≥ 25 N/mm at 23 °C and ≥ 4 N/mm at 90 °C
Indentation	NEN-EN-ISO 21809-1	≤ 0,1 mm at 23 °C and ≤ 0,4 mm at 110 °C
Elongation at break	NEN-EN-ISO 21809-1	≥ 400 %
Holiday detection	NEN-EN-ISO 21809-1	Test voltage 25 kV, no holidays
Cd test (on special request)	NEN-EN-ISO 21809-1	23 °C/28 d -1,5 V R ≤ 5 mm 65 °C/24 h -3,5 V R ≤ 4 mm
Glass transition temperature epoxy	NEN-EN-ISO 21809-1	-3 °C < ΔT _g < 3 °C

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Product stability of PP (Δ MFR between compound and extruded film) ¹⁾	<u>NEN-EN-ISO 21809-1</u>	Δ MFR $\leq$ 35 %

- 1) When Δ MFR is not relevant, than an OIT test shall be done according to [NEN-EN-ISO 21809-3](#).

C.3 PPT & production tests for Polyurethane coatings (code U)

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 µm - 120 µm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Impact resistance	NEN-EN 10290	7 J per mm coating thickness at 23 °C and no holidays
Adhesion Pull Off method	NEN-EN-ISO 4624	>10 MPa (after 3 days)
Hardness test shore D	NEN-EN-ISO 868	75 shore D ± 5 after 24 hours
Holiday detection	NEN-EN 10290	Test voltage 20 kV, no holidays

C.4 PPT & production tests for flow coating (code L1)

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides on steel surface after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 25 µm - 60 µm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Bendability	NEN-ISO 15741	No cracking
Cross cut test	NEN-ISO 15741	Class ≤ 1
Hardness test	NEN-ISO 15741	≥ 94 Buchholz
Pinhole test	NEN-ISO 15741	Max one pinhole per day
Low voltage holiday detection (if pinhole test fails)	NEN-ISO 15741	One pinhole per 100 cm ² tested at at least 10 areas, excluding welds
Curing test	NEN-ISO 15741	No blistering, softening or wrinkling
Water test	NEN-ISO 15741	No blistering, softening or wrinkling, no loss of adhesion

C.5 PPT & production tests for High solid epoxy coatings (code Z)

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 µm - 100 µm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Impact resistance	NEN-EN 10289	5 J per mm coating thickness at 23 °C and no holidays
Adhesion Pull Off method	NEN-EN-ISO 4624	>10 MPa (after 3 days)
Holiday detection	NEN-EN 10289	5 kV per mm DFT no holidays
Hardness Buchholz	NEN-EN-ISO 2815	manufacturer's specification

C.6 PPT & production tests for paint systems (codes B, C)

PPT & production tests to be performed and reported	Test method according to:	Gasunie requirements
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 µm - 100 µm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Film thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Stripe coat applied on all critical parts	n/a	According to this specification (MSW-11-E)
Visual assessment	NEN-EN-ISO 12944-7	No sags, runs and the like, fulfilling NEN-EN-ISO standard
Adhesion test, Pull Off test	NEN-EN-ISO 4624	≥ 8 MPa (after 3 days)
Low voltage holiday detection	NEN-EN-ISO 29601	No holidays

D QUALIFICATION PROCESS

Approvals in the qualification process of coating materials and coating applications are given by the Gasunie's coating department.

Qualification is (generally) based on the qualification scheme according to [NEN-EN-ISO 21809-1](#). According to this standard, this scheme consists of:

- a coating material qualification by manufacturer;
- b coating system qualification by applicator;
- c Pre-Production Trial (PPT);
- d Procedure Qualification Trial (PQT).

The Application Procedure Specification (APS) and an Inspection and Test Plan (ITP) are applicable to the trials and during production. The APS describes how the coating is applied (and associated items) and the ITP describes the items to be tested, the test criteria and the frequency of the tests. In general, the ITP represents the quality control plan of the coating application in accordance with the APS.

During the PPT, the tests that are done during production are done at a higher frequency: at least all tests are applied to the first three objects of the production. The tests at the PPT and during production are the same and are given in annex C. The tests are done on objects for delivery to or usage by Gasunie.

The PQT is the basis for qualification and the tests in the PQT are the tests during PPT and production with some additional tests. In the tests, items a and b are combined. Gasunie can approve test results of tests done on objects for other users, they need not necessarily have been done on Gasunie objects.

The qualification scheme applies to permanent coatings, not to temporary coatings. Temporary coatings have to prove their final objective: protection for 1 year.

The approval consists of the following steps:

1. Completion and approval by Gasunie of the "Audit question list coating" ([GTS W-024](#)). Documents for a, b and d and the ITP for PPT and production form part of this question list.
2. Inspection and witnessing of the coating plant, coating application and the quality control system used for a, b, c and d. Tests on test plates form part of this inspection.
3. Formal qualification of the coating materials and coating applications that were used in the qualification process. The qualification has a validity of three (3) years.

The order for coating application can be given by Gasunie, but also by others, such as suppliers or contractors. The ordering company has the final responsibility for the coating and the coating application. The Gasunie-approved ITP shall be used for the coating application and the activities in this ITP shall be endorsed by the coating application ordering party.

PQT tests, specific per coating code**D.1 PQT tests for 3 layer PE coating (code J & J1)**

In general the requirements of [NEN-EN-ISO 21809-1](#) shall be met and in particular:

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Cathodic disbonding	NEN-EN-ISO 21809-1	23 °C/28 d -1,5 V R ≤ 5 mm 65 °C/24 h -3,5 V R ≤ 4 mm
Peel strength	NEN-EN-ISO 21809-1	≥ 15 N/mm at 23 °C and ≥ 3 N/mm at 80 °C
Elongation at break	NEN-EN-ISO 21809-1	≥ 400 %
Impact resistance	NEN-EN-ISO 21809-1	>7 J per mm coating thickness.
Indentation	NEN-EN-ISO 21809-1	≤ 0,2 mm at 23 °C and ≤ 0,4 mm at 80 °C
Flexibility at (0 °C and 2° per pipe diameter length)	NEN-EN-ISO 21809-1	No cracks or holidays
Heat aging	NEN-EN-ISO 21809-1	ΔMFR ≤ 35 %
UV aging	NEN-EN-ISO 21809-1	ΔMFR ≤ 35%
Coating Resistivity	DIN 30670	$R_s > 10^8 \Omega m^2$
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 μm - 100 μm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Preheating temperature before application	Monitored T	according to data sheet
Temperature after cooling	Monitored T	max 80 °C
Epoxy thickness	NEN-EN-ISO 19840	Min 150 μm
Minimum adhesive thickness	NEN-EN-ISO 19840	Min 150 μm
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Inspection cutback external	n/a	200 mm $\pm$ 10 mm
Inspection cutback internal	n/a	20 mm $\pm$ 5 mm
Holiday detection	NEN-EN-ISO 21809-1	Test voltage 25 kV, no holidays
Glass transition temperature epoxy	NEN-EN-ISO 21809-1	-3 °C < ΔT_g < 3 °C
Product stability of PE (Δ MFR between compound and extruded film) ¹⁾	NEN-EN-ISO 21809-1	Δ MFR $\leq$ 20 %

¹⁾ When Δ MFR is not relevant, than an OIT test shall be done according to [NEN-EN-ISO 21809-3](#).

D.2 PQT tests for 3 layer PP coating (code W1)

In general the requirements of [NEN-EN-ISO 21809-1](#) shall be met and in particular:

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Cathodic disbonding	NEN-EN-ISO 21809-1	23 °C/28 d - 1,5 V $R \leq 5$ mm 65 °C/24 h - 3,5 V $R \leq 4$ mm
Peel strength	NEN-EN-ISO 21809-1	≥ 25 N/mm at 23 °C and ≥ 4 N/mm at 90 °C
Elongation at break	NEN-EN-ISO 21809-1	≥ 400 %
Impact resistance	NEN-EN-ISO 21809-1	> 10 J per mm coating thickness.
Indentation	NEN-EN-ISO 21809-1	$\leq 0,1$ mm at 23 °C and $\leq 0,4$ mm at 110 °C
Flexibility at (0 °C and 2° per pipe diameter length)	NEN-EN-ISO 21809-1	No cracks or holidays
Heat aging	NEN-EN-ISO 21809-1	$\Delta MFR \leq 35$ %
UV aging	NEN-EN-ISO 21809-1	$\Delta MFR \leq 35$ %
Coating resistivity	DIN 30678	$R_s > 10^8 \Omega m^2$
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	$5^\circ C < T < 35^\circ C$
ΔT surface to be coated at least 3 °C above dew point	n/a	$> 3^\circ C$
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R_z 50 μm - 100 μm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating $\leq$ rate 2
Preheating temperature before application	Monitored T	according to data sheet
Temperature after cooling	Monitored T	maximal 80 °C
Epoxy thickness	NEN-EN-ISO 19840	minimal 150 μm
Minimum adhesive thickness	NEN-EN-ISO 19840	minimal 150 μm
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Inspection cutback external	n/a	200 mm $\pm$ 10 mm

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Inspection cutback internal	n/a	20 mm $\pm$ 5 mm
Holiday detection	NEN-EN-ISO 21809-1	Test voltage 25 kV no holidays
Glass transition temperature epoxy	NEN-EN-ISO 21809-1	$-3\text{ }^{\circ}\text{C} < \Delta T_g < 3\text{ }^{\circ}\text{C}$
Product stability of PP (Δ MFR between compound and extruded film) ¹⁾	NEN-EN-ISO 21809-1	Δ MFR $\leq$ 35 %

¹⁾ When Δ MFR is not relevant, than an OIT test shall be done according to [NEN-EN-ISO 21809-3](#).

D.3 PQT tests for polyurethane coatings (code U)

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Cathodic disbonding	NEN-EN 10290	23 °C/28 d - 1,5 V $R \leq 6$ mm 60 °C/48 h - 1,5 V $R \leq 6$ mm
Adhesion test Pull Off method	NEN-EN 10290	≥ 10 MPa at 23 °C and ≥ 6 MPa at 80 °C
Indentation	NEN-EN 10290	$\leq 0,2$ mm at 23 °C and $\leq 0,3 \cdot \text{DFT}$ per mm at 80 °C
Flexibility at 0 °C ± 2 °C and 23 °C ± 2 °C	NEN-EN 10290	No cracks or holidays
Water absorption test	NEN-EN 10290	100 h/80 °C no loss of adhesion or ≤ 3 mm (to steel)
Heat aging	NEN-EN 10290	100 d/80 °C 8 MPa (to steel)
Elongation at break	NEN-EN-ISO 527-1 u/i -5	≥ 10 %
Coating resistivity	NEN-EN 10290	$R_s > 10^7 \Omega \text{m}^2$
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	$5 \text{ °C} < T < 35 \text{ °C}$
ΔT surface to be coated at least 3 °C above dew point	n/a	$> 3 \text{ °C}$
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	$< 20 \text{ mg/m}^2$
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	$R_z 50 \mu\text{m} - 120 \mu\text{m}$
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating $\leq$ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Impact resistance	NEN-EN 10290	7 J per mm coating thickness at 23 °C and no holidays
Hardness test shore D	NEN-EN 10290	75 shore D ± 5 after 24 hours
Holiday detection	NEN-EN 10290	Test voltage 20 kV, no holidays

D.4 PQT tests for flow coating (code L1)

In general the requirements of [NEN-ISO 15741](#) shall be met and in particular:

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Adhesion test	NEN-ISO 15741	Class ≤ 1
Hardness Buchholz	NEN-ISO 15741	Minimum 94
Bendability	NEN-ISO 15741	No cracking
Water immersion	NEN-ISO 15741	No blistering, softening or wrinkling, no loss of adhesion
Salt spray test	NEN-ISO 15741	Corrosion max. 3 mm from scratch
Hydraulic blistering	NEN-ISO 15741	No blistering
Gas blistering	NEN-ISO 15741	No blistering
Humidity (air)	n/a	$< 80 \%$
Temperature (air)	n/a	$5^{\circ}\text{C} < T < 35^{\circ}\text{C}$
ΔT surface to be coated at least 3°C above dew point	n/a	$> 3^{\circ}\text{C}$
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides on steel surface after blasting	NEN-EN-ISO 8502-6	$< 20 \text{ mg/m}^2$
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	$R_z 25 \mu\text{m} - 60 \mu\text{m}$
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating $\leq$ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Bendability	NEN-ISO 15741	No cracking
Cross cut test	NEN-ISO 15741	Class ≤ 1
Hardness test	NEN-ISO 15741	≥ 94 Buchholz
Pinhole test	NEN-ISO 15741	Max one pinhole per day
Low voltage holiday detection (if pinhole test fails)	NEN-ISO 15741	One pinhole per 100 cm^2 tested at at least 10 areas, excluding welds
Curing test	NEN-ISO 15741	No blistering, softening or wrinkling

D.5 PQT tests for high solid epoxy coatings (code Z)

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Cathodic disbonding	NEN-EN 10289ASTMG8	23 °C/28 d - 1,5 V R ≤ 6 mm 60 °C/48 h -1,5 V R ≤ 6 mm
Adhesion test (Pull Off)	NEN-EN 10289	≥ 10 MPa at 23 °C and ≥ 6 MPa at 80 °C
Impact resistance	NEN-EN 10289	> 5 J per mm coating thickness at 23 °C and no holidays
Indentation	NEN-EN 10289	≤ 0,2 mm at 23 °C and ≤ 0,3·DFT per mm at 80 °C
Flexibility at 0 °C ± 2 °C and 23 °C ± 2 °C	NEN-EN 10290	No cracks or holidays
Water absorption test	NEN-EN 10289	100 h/80 °C no loss of adhesion or ≤ 3 mm
Heat aging	NEN-EN 10289	100 d/80 °C 8 MPa
Elongation at break	NEN-EN-ISO 527-1 u/i -5	≥ 1,7 %
Coating resistivity	NEN-EN 10289	$R_s > 10^7 \Omega m^2$
Humidity (air)	n/a	< 80 %
Temperature (air)	n/a	5 °C < T < 35 °C
ΔT surface to be coated at least 3 °C above dew point	n/a	> 3 °C
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides contamination after blasting	NEN-EN-ISO 8502-6	< 20 mg/m ²
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	R _z 50 μm - 100 μm
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Total coating thickness (DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Holiday detection	NEN-EN 10289	5 kV per mm DFT no holidays
Hardness (Buchholz)	NEN-EN 10289	manufacturer's specification

D.6 PQT tests for paint systems (codes B, C)

Paint systems shall comply with C5H according [NEN-EN-ISO 12944-1](#) and [NEN-EN-ISO 12944-2](#).

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Determination of resistance to neutral salt spray (fog)	NEN-EN-ISO 9227 (1440 h)	Corrosion from scribe ≤ 1 mm NEN-EN-ISO 4628-2 Blistering 0 (S0) NEN-EN-ISO 4628-3 Rusting Ri (0) NEN-EN-ISO 4628-4 Cracking 0 (S0) NEN-EN-ISO 4628-5 Flaking 0 (S0) NEN-EN-ISO 2409 Class 0 or 1; NEN-EN-ISO 4624 Pull Off test ≥ 5 MPa (No adhesive break)
Determination of resistance to humidity	NEN-EN-ISO 6270-1 & -2 (720 h)	Corrosion from scribe ≤ 1 mm NEN-EN-ISO 4628-2 Blistering 0 (S0) NEN-EN-ISO 4628-3 Rusting Ri (0) NEN-EN-ISO 4628-4 Cracking 0 (S0) NEN-EN-ISO 4628-5 Flaking 0 (S0) NEN-EN-ISO 2409 Class 0 or 1; NEN-EN-ISO 4624 Pull Off test ≥ 5 MPa (No adhesive break)
Determination of resistance to humid atmospheres containing sulphur dioxide	NEN-EN-ISO 3231 (720 h)	Corrosion from scribe ≤ 1 mm NEN-EN-ISO 4628-2 Blistering 0 (S0) NEN-EN-ISO 4628-3 Rusting Ri (0) NEN-EN-ISO 4628-4 Cracking 0 (S0) NEN-EN-ISO 4628-5 Flaking 0 (S0) NEN-EN-ISO 2409 Class 0 or 1; NEN-EN-ISO 4624 Pull Off test ≥ 5 MPa (No adhesive break)
Cyclic ageing test	NEN-EN-ISO 12944-6 (1680 h)	Corrosion from scribe ≤ 1 mm NEN-EN-ISO 4628-2 Blistering 0 (S0) NEN-EN-ISO 4628-3 Rusting Ri (0) NEN-EN-ISO 4628-4 Cracking 0 (S0) NEN-EN-ISO 4628-5 Flaking 0 (S0) NEN-EN-ISO 2409 Class 0 or 1; NEN-EN-ISO 4624 Pull Off test ≥ 5 MPa (No adhesive break)
Humidity (air)	n/a	$< 80\%$
Temperature (air)	n/a	$5\text{ }^{\circ}\text{C} < T < 35\text{ }^{\circ}\text{C}$
ΔT surface to be coated at least $3\text{ }^{\circ}\text{C}$ above dew point	n/a	$> 3\text{ }^{\circ}\text{C}$
Abrasive free from oil and grease	Practical test. Abrasive in pure water for 5 minutes	Visual: no grease/oil contamination
Water soluble salt and chlorides	NEN-EN-ISO 8502-6	$< 20\text{ mg/m}^2$
Surface roughness of blasted steel	NEN-EN-ISO 8503-4	$R_z\ 50\text{ }\mu\text{m} - 100\text{ }\mu\text{m}$

PQT tests to be performed and reported	Test method according to:	Gasunie requirements
Visual inspection of cleanliness blasted surface	NEN-EN-ISO 8501-1	At least C Sa 2½
Presence of dust after dust removal	NEN-EN-ISO 8502-3	Class and rating ≤ rate 2
Elapsed time between blasting and coating	n/a	At least C Sa 2½ shall be guaranteed
Film thickness(DFT)	NEN-EN-ISO 19840	According to this specification (MSW-11-E)
Stripe coat applied on all critical parts	n/a	According to this specification (MSW-11-E)
Visual assessment	NEN-EN-ISO 12944-7	No sags, runs and the like, fulfilling NEN-EN-ISO standard
Adhesion test, Pull Off test	NEN-EN-ISO 4624	≥ 8 MPa (after 3 days)
Low voltage holiday detection	NEN-EN-ISO 29601	No holidays