Technical Specification

POLYETHYLENE GAS PIPES

ET 301

Revision No. 5 | 07 February 2023

Index

Register of revisions

Revision number	Date	Motif
0	2004-11-18	Initial wording.
1	2006-07-03	Preamble, chapters 3, 4, 5, 6, 7 and 11.
2	2012-12-11	General review.
3	2015-09-21	Chapter 5.
4	2020-03-30	General revision and replacement of the reference "EDP Gás Distribuição" by "Portgás".
5	2023-02-07	General revision carried out by IDOM Consulting, Engineering, Architecture, SAU

Information classification

Confidential	☐	Restricted	☐		Internal use	☐	Public	☒

Distribution of the document

External	Contractors ☒ Qualified for Allotments ☒ Internet ☒ Other ☐
Internal	CA ☐ AT ☒ ACR ☒
	AT-ED ☐ AT-EX ☐ AT-GE ☐ AT-MS ☐ ACR-DC ☐ ACR-GC ☐ ACR-RD ☒
Nominal	< name, function, position >

Caption:

CA: Board of Directors
AT: Technical Area
AT-ED: Technical Area - Engineering and Development
AT-EX: Technical Area - Exploration
AT-GE: Technical Area - Energy Management
AT-MS: Technical Area - Maintenance and Systems
ACR: Clients and Networks Area
ACR-DC: Clients and Networks Area - Commercial Development
ACR-GC: Clients and Networks Area - Large Consumption
ACR-RD: Clients and Networks Area - Networks

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Preamble

Portgás, in view of the technological developments that have taken place, decided in November 2004 to introduce pipes with a thickness in accordance with SDR 17.6. This led to the revision of this specification in July 2006, increasing the use of SDR 17.6 type pipes in large diameters.

Subsequently, in December 2012, a general revision was made to this specification, which, among other points, drew special attention to the replacement of the SDR 17.6 series with the SDR 17 series.

Later, in September 2015, due to the fact that the supply of PE80 resin was discontinued in the market, the need arose to provide for the use of pipes made with PE100 resin in all diameters.

As part of the "H2 REN Programme" aimed at adapting the technical specifications for the preparation of assets to receive hydrogen up to 100%, Portgás identified this regulation to be subject to assessment and consequent revision.

The revision now presented results from work conducted by IDOM Consulting, Engineering, Architecture, SAU, who have made the necessary changes to the specification to ensure that "Polyethylene gas pipes" supplied under this specification are prepared to receive up to 100% hydrogen.

This revision of ET 301 cancels and replaces the previous revision dated 30 March 2020, and it is advisable to read this technical specification in full for a correct application of its provisions.

This technical specification should be given the status of a Portgás standard which establishes the rules to be followed to achieve the discriminated objective.

1. Objective

The purpose of this material technical specification is to define the main characteristics of manufacture and operation of polyethylene gas pipes, as well as the technical requirements and conditions to be met with a view to approval of the materials.

2. Scope

This technical specification applies to all gas pipes made of polyethylene, intended for use in the gas distribution system allowing, under normal operating conditions, a pressure of 4 bar (maximum), classified in accordance with Despacho n° 806-B/2022 and for operating temperatures between -5 °C and 50 °C.

This specification is valid for pressures up to 4 bar. Polyethylene is technically unsuitable for the carriage of hydrogen at pressures above 4 bar. For transporting hydrogen at pressures above 4 bar it is recommended to use another material (i.e. polyamide 12).

3. References external

Despacho nº 806-B/2022, de 19 de janeiro

"Regulamento da Rede Nacional de Distribuição de Gás."

ENV 1046

"Plastics piping systems and protective piping systems - External Plastics systems - Recommendations for the installation above and below ground."

NP EN 1555 - 1

"Plastic piping systems for gaseous fuel supply. Polyethylene (PE). Part 1: General aspects".

NP EN 1555 - 2

"Plastic piping systems for gaseous fuel supply. Polyethylene (PE). Part 2: Pipes."

NP EN 1555 - 5

"Plastic piping systems for gaseous fuel supply. Polyethylene (PE). Part 5: Fitness for use of the system."

CEN/TS 1555-7

"Plastic piping systems for the supply of gaseous fuels. Polyethylene (PE). Part 7: Assessment of conformity."

DVS 2202-1

"Imperfections in thermoplastic welded joints. Features, descriptions, evaluation."

ISO 3

"Preferred numbers - series of preferred numbers."

ISO 228-1

"Pipe threads where pressure type joints are made on the threads - Part I: designation, dimensions and tolerances."

ISO 4065

"Thermoplastics pipes -- Universal wall thickness table."

ISO 9969

"Thermoplastics pipes. Determination of ring stiffness."

ISO 11922-1

"Thermoplastic pipes for the conveyance of fluids -- Dimensions and tolerances -- Part 1: Metric series."

4. Definitions / Acronyms

For the purposes of this document the terms, definitions and symbols expressed in ISO 4065 apply, to which the following are added:

4.1. Absolute ovalisation

Value, in mm, obtained by subtracting the minimum outer diameter from the maximum outer diameter, both diameters measured on the same cross section.

4.2. Compound

Homopolymer or copolymer polyethylene resins with their additives in homogenised granules.

4.3. Compound accepted

The compound that has been approved by the user.

4.4. Composite with coloured fillet

Homopolymer or copolymer polyethylene resins with their additives in homogenised granules.

5. Material specifications

5.1. General conditions

a) The present technical specification of materials takes into consideration the following processes:

- Approval process: process whose final objective is the approval of a resin, as well as the approval of the pipe production capacity by the manufacturer/supplier.
- Continuity process: process initiated with the pipe order and whose objective is the approval of the manufactured pipe.

b) The safety coefficient to be used to calculate the admissible stress shall be in accordance with Chapter 4 of the standard NP EN 1555-1.

c) Each of these processes has an associated set of inspections and tests, and respective conclusions, presented in table 1.

Process	Inspections and Tests	Conclusion
Approval[1]	• Tests performed on a resin in granule form; • Tests performed on resin in tube form (by diameter range); • Inspections and tests carried out on the piping (by diameter range).	• Approved resin; • Approved production capacity (per diameter range); • Lots of approved pipe (by diameter range).
Continuity[2]	• Tests performed on a batch of resin, in granule form, used for the production of pipes. • Inspections and tests carried out on the manufactured piping.	• Lot of tube manufactured and approved.

Table 1: Inspections, tests and conclusions of the approval and continuity processes

d) Portgás is responsible for the approval process.

e) The continuity process will be carried out whenever an order is placed with the pipe manufacturer by the purchasing entity.

f) The completion of each process necessitates the preparation of:

- Approval Process: Approval Report as specified in this document;
- Continuity Process: Certificate of Manufacture as specified in this document.

5.2. Raw material

All the documents listed below must be submitted to the Surveying Authority for approval, with a view to their inclusion in the Final Construction Site Report (RFO).

a) Only compounds accepted by Portgás may be used in the production of pipes and must comply with the manufacturer's technical dossier.

b) The pipe must contain only the homopolymer or copolymer resin and the antioxidant, pigments and ultraviolet (UV) stabilisers required for manufacture and end use, including weldability. The polyethylene (PE) resin results from adding, to the base polymer, only the additives necessary for the production of the pipe, without affecting its fusibility and storage. All additives are uniformly dispersed in the pipe.

[1] Inspections and tests to be carried out by an independent entity (3rd party) recognised by Portgás.

[2] Inspections and tests to be carried out by the pipe manufacturer

c) It is forbidden:

- The use of recycled material;
- The introduction of complementary additives or others that are not necessary for the manufacture of the pipe;
- The mixing of resins.

d) Black pipes containing black carbon, according to this specification, offer high resistance to weathering. The use of coloured pipes (yellow) is only permitted if the polyethylene used contains UV stabilisers creating good resistance to ageing caused by the climate and its use, on a special basis, is duly authorised by Portgás.

e) The use of black gas lines can lead to confusion with other lines intended for other purposes. To avoid this confusion, gas pipes should be identified by the use of longitudinal fillets marked in yellow.

f) The characteristics of the raw material in granule and tube form are specified in tables 2 and 3 respectively.

Tests	References	Units	Approval	Continuity	Acceptance Criteria
• Density at 23°C	NP EN 1555-1 Section 4.2.3.1	kg/m^3	✓	✓	≥ 930 kg/m ^{3} (Base Compound)
• Thermal Stability (ILO)		min.	✓	✓	> 20 min.
• Fluidity Index		g/10 min	✓	✓	0.2 to 1.4 g/10min
• Volatile Content		mg/kg	✓	✓	≤ 350 mg/kg
• Water content ( )[3]		mg/kg	✓	✓	≤ 300 mg/kg
• Carbon Black content		%	✓	✓	(2.0 to 2.5)% by mass
• Carbon Black Dispersion			✓	✓	≤ grade 3

Table 2: Tests to be performed on raw material in granule form

[3] This test will only be required if the result obtained for the volatile products content does not meet the requirement

Tests	References	Units	Approval	Continuity	Acceptance Criteria
• Resistance to Gas Constituents	NP EN 1555-1 Section 4.2.3.2		✓		No failure during the test
• Resistance to Rapid Crack Propagation (Pc S4) (e >15mm)			✓		≥ (MOP/2.4)-(13/18) bar
• Resistance to Slow Crack Growth (dn: 110 - SDR11)			✓		No failure during the test
• Classification and Designation (LIC)	NP EN 1555-1 Section 4.4		✓		PE 80 - MRS 8.0 PE 100 - MRS 10.0
• Welding Compatibility	NP EN 1555-1 Section 4.3		✓		Declaration by the accessory manufacturer

Table 3: Tests to be performed on the raw material in tube form

g) During the raw material approval process, the pipe supplier must prepare a report that proves that the tests, set out in this document, have been carried out by an independent entity.

h) In the continuity process the pipe supplier shall carry out the tests listed in Table 2 and present the results of these tests on the manufacturing certificate.

i) Both the raw material approval process and the continuity process shall be carried out according to the sampling plan in CEN/TS 1555-7 Tables 2 and 6 respectively.

5.3. Tubes

5.3.1. General characteristics

5.3.1.1 Appearance

a) The pipes must have interior and exterior surfaces that are smooth, clean and free of any defects.

b) The pipe ends should be flat and perpendicular to the pipe axis, and any kind of irregularities in the cutting surface, namely those caused by the pipe, are not acceptable.

5.3.1.2. Colour

a) The pipes should be black, uniform in colour throughout, with four evenly spaced yellow longitudinal identification stripes.

b) Characteristics of yellow identification lists:

- Colour close to the reference "RAL 1021";
- Same type of tube resin;
- Co-extruded on the tube surface;
- Width and depth such that they do not modify the physical and mechanical characteristics of the pipe.

c) The manufacturer of the base compound must indicate the compound(s) with coloured fillet compatible by extrusion with the base compound.

d) The yellow lists should have the following dimensions as a reference:

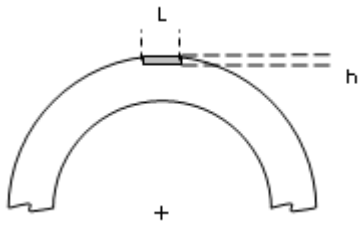

Fig. 1: Detail of the yellow identification lists

Pipe DN	L List Width (mm)	h List Depth (mm)
20 a 32	1.5 - 4.0	0.2 - 0.5
40 e 63	2.0 - 5.0	0.2 - 1.0
110	3.0 - 8.0	0.2 - 1.5
160	4.0 - 10.0	0.2 - 1.5
200	5.0 - 15.0	0.2 - 2.5

Table 4: Dimensions of the yellow identification lists

5.3.2. Geometric characteristics

a) Nominal outer diameters, minimum mean outer diameters, maximum mean outer diameters and ovalisation as well as their tolerances must comply with EN 1555-2 chapter 6.2.

- The average outer diameter (dem) must comply with the grade B tolerance (ISO 11922-1).
- For coiled pipes, the ovalisation must not exceed 6% of their nominal diameter (DN).

b) The minimum wall thickness (emin) and its tolerance are given in chapter 6.3. of NP EN 1555-2.

- Pipes with a wall thickness of less than 3.0 mm are not admissible.
- With regard to pipe thickness, Portgás only allows the use of two series, in duly specified situations, namely: the SDR 11 and SDR 17.

5.3.3. Mechanical characteristics

The pipes must have the mechanical characteristics in accordance with the requirements indicated in Table 5.

Tests	References	Approval	Continuity	Acceptance Criteria
• Resistance to Internal Hydraulic Pressure at 20°C (≥ 100h)	NP EN 1555-2 Section 7	✓		No failure during the test
• Internal Hydraulic Pressure Resistance at 80°C (≥ 165h)			✓	No failure during the test
• Internal Hydraulic Pressure Resistance at 80°C (≥1000h)		✓		No failure during the test
• Elongation at Break		✓	✓	≥ 350%
• Resistance to Slow Crack Growth (e < 5mm)		✓		No failure during the test
• Resistance to Slow Crack Growth (e ≥ 5mm)		✓		No failure during the test
• Resistance to Rapid Crack Propagation $(P)_{c\,S4}$		✓		≥ (MOP/2.4)-(13/18) bar
• Thermal Stability (ILO)	NP EN 1555-2 Section 8	✓	✓	> 20 min.
• Fluidity Index (*)		✓	✓	0.2 to 1.4 g/10min
• Longitudinal Deflection		✓		≤ 3% (The initial appearance of the tube should remain the same)

Table 5: Physical characteristics of the manufactured pipe

5.3.4. Compatibilities

5.3.4.1 General

a) Pipes should be compatible with:

- Other pipes made with different PE resins (approved);
- All PE fittings, complying with ET 302, from different sources;
- The following gases: natural gas, propane air and propane.

b) In order to verify compatibility between welded resins (butt and butt weld and electroweld) a visual and dimensional control of the weld obtained should also be carried out.

5.3.4.2. Butt welding

a) The weld seam should be uniform around its entire perimeter and have a closed development close to the pipe surface. No gap greater than 5% of the pipe thickness is permissible, nor are variations in the width of the weld bead greater than 1mm.

b) The permissible weld bead width shall follow the criteria given by "DVS 2202 - frame A.

c) Butt welding should only be used on materials of the same series (same thickness).

5.3.4.3. Electrowelding

a) The tube/accessory clearance should be evenly distributed and in no case should it exceed the values in table 6.

DN	20	32	40	63	110	160	≥ 200
Clearance (mm)	2.0	3.5	3.5	4.0	4.5	5.5	6.0

Table 6: Maximum permitted clearance between tube and fitting in an electroweld

b) No deformation or run-off after welding is admissible.

5.3.5. Designation

a) The designation and respective marking of the pipes must be in accordance with the standard established by NP EN 1555-2 section 10.

b) The marking must have a minimum height of 3 mm and 5 mm for DN 63 and DN > 63 mm, respectively, and a depth of less than 0.1 mm or 0.2 mm for DN 110 and DN > 110 mm, respectively.

c) For pipes supplied in coils, the marking shown below is increased by the printing of the number of metres at the end of each metre.

d) Each pipe should be clearly visible, indelible and repeated from metre to metre with the marking as shown in the example below:

Identification of the Manufacturer	Material Technical Specification	Resin Name	Gas / Maximum pressure (bar)(MPa)	DN / Thickness Series*	Year/Week Production	Manufacture Batch No.
# # # # # #	EN 1555	PE # # #	Gas 4 bar (0,4 MPa)	# # # / SDR # #	# # / # #	# # # #

* for pipes DN≤32 - nominal outer diameter X nominal thickness

Table 7: Example of pipe marking

5.3.6 Choice of polyethylene pipe series

a) The choice of polyethylene pipe is made, taking into consideration:

- The polyethylene resin class,
- Operation requirement and
- The maximum working pressure.

b) The diameters to be used are those given in the following lists, depending on the SDR to be used:

D_n (mm)	S (mm)	D_{int} (mm)
20	3.0	14.0
32	3.0	26.0
40	3.7	32.6
63	5.8	51.4

Table 8: Pipes SDR 11/PE100 - MRS 10.0 MPa

D_n (mm)	S (mm)	D_{int} (mm)
110	6.6	96.8
160	9.5	141.0
200	11.9	176.2

Table 9: Pipes SDR 17/PE100 - MRS 10.0 MPa

Dn - Nominal Diameter
S - Thickness
Dint - Inside Diameter

c) The diameters 20, 32 and 40 are only used in branches.

6. Packaging

6.1. Handling

The use of cables, chains or other equipment that may damage the product in any way is prohibited, and the use of suitable straps for this purpose is mandatory.

6.2. Storage

a) Pipes are delivered in coils or in rods. The ends of the pipes should be cut straight off perpendicularly to the axis of the pipe and protected against shocks and the entry of foreign bodies by means of plugs. The plugs should be made of PE or other material that will not damage the pipe. The colour of the plug should be other than black. Metal or PVC plugs are not allowed.

b) The ends of the pipes, when supplied in coils, should be properly secured.

c) The length of pipes, measured at 20 °C ± 5 °C is combined with a tolerance of ± 3% for lengths less than 500m and a tolerance of ± 1.5% for lengths of 500m or more.

d) It is not permitted, in storage:

- Place tubes in contact with solvents,
- Stack loose pipes higher than 1 metre,
- Stack more than three pallets of pipes,
- Submit the tubes to a temperature higher than 40 °C.

6.3. Packaging

6.3.1. reel

a) The packaging in coils should protect the pipe during handling and transport operations, as well as from UV rays.

b) This packaging will be left to the manufacturer. However, its design must reconcile the requirements of transport and storage with the requirements of use, allowing the coils to be unrolled from the inside while the initial geometrical shape is maintained as the tubing is unrolled.

c) The inside diameter of the coils should not be less than 20 times the outside diameter of the pipe to be coiled, with a minimum value of 0.6 m.

6.3.2. Rod

The packaging of pipes supplied in rod form must meet the following requirements (Fig. 2):

- The transport/storage structure for the pipes should be made of wood at least 35 mm thick,
- The transportation/storage structure must not exert any type of stress on the pipes, and the overlap between rails must be greater than 2/3 of the thickness of the rails,
- Each set of sleepers should rest on a sponge strip which is wider than the width of the sleepers,
- Each set of sleepers will be closed by means of a galvanised steel strap,
- The pipes should be unmatched by about 200mm per row in order to facilitate dimensional control at reception.

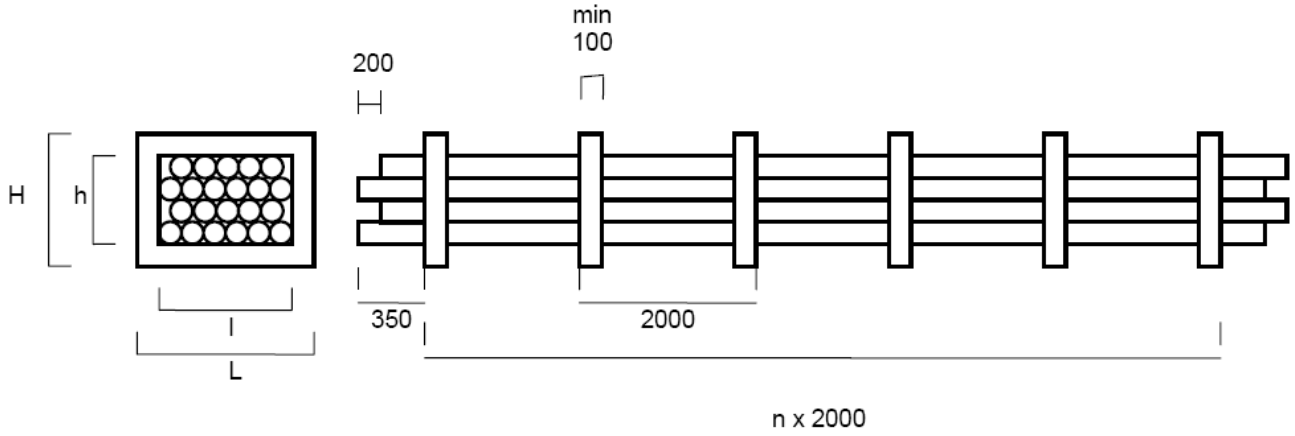

Fig. 2: Requirements for the packaging of pipes supplied in rods

DN	Quantity	Spinners	Number	l	h	L	H
110	43	5	9-8-9-8-9	1035	495	1060	600
160	17	3	6-5-6	1005	440	1030	545
200	14	3	5-4-5	1045	550	1070	655

Table 10: Maximum crossbars for packaging PE pipes on a pole (dimensions in mm)

6.4. Expedition

a) During loading, movements should be smooth and there should be no stretching, knocking or dragging.

b) The loading must be carried out in such a way as not to damage the material.

c) Pipes of DN ≥ 110mm, when supplied in coils, should be transported with the coils in the vertical position, in devices designed for this purpose.

d) It is not permitted to transport pipes with other materials.

7. Documentation to accompany the pipe

7.1. Documentation related to the type of tests

a) The approval process for the raw material and the pipe requires the preparation of a Technical Report, which is the responsibility of the pipe supplier, containing the following information:

- Identification of the approval report,
- Tests performed on the raw material,
- Inspections and tests carried out on the pipe.

b) The approval report should be identified as follows:

- Manufacturer identification / raw material identification / date,
- Diameter range identification (CEN/TS 1555-7).

c) The approval report shall contain the results of the tests performed on the raw material and manufactured pipe, contained in this document and in the applicable standards.

7.2 Manufacturer's certificates

a) For each tube shipment, the supplier must issue a manufacturing certificate (according to standard NP EN 10204 / 3.1) containing the following information:

- Identification of the manufacturing certificate,
- Guarantee that the raw material used has not changed,
- Tests performed on the raw material,
- Inspections and tests carried out on the pipe.

b) The certificate of manufacture shall be identified as follows:

- Manufacturer's identification / resin designation / DN and Thickness Series / Year and Week of Production / Production Batch No.

c) The certificate of manufacture shall contain a statement in which the pipe manufacturer shall confirm that the material used has the same characteristics as those contained in the approval report for the same.

d) The manufacturing certificate should contain the results of tests conducted on the raw material and the pipe made from the raw material approved by Portgás, as contained in this document and in the applicable standards.

e) The certificate of manufacture for the raw material must be attached to the certificate of manufacture.

f) The inspected pipes should be identified with a sequential numbering.

g) The certificate shall identify the inspection equipment used for dimensional inspection.

7.3 Reception of piping

a) During the manufacturing operations, the Manufacturer shall provide all requested information, in detail, on the pipe manufacturing activity.

b) The purchasing entity will only conclude reception after analysing the manufacturing certificate (NP EN 10204 / 3.1) and concluding the quality control actions it intends to carry out during the reception process, namely visual and dimensional control.

c) The purchasing entity will inform, in the manner deemed most convenient, of the acceptance or non-acceptance of the order in view of its Quality status.

d) In case of rejection of the piping, the manufacturer must immediately promote, at no cost to the purchasing entity, the replacement of the rejected piping, or its recovery if accepted, and will submit the new piping to a new inspection and test.

e) Inspections or tests carried out by the purchasing entity do not exclude or diminish in any way the Manufacturer's responsibility.

f) The contractor shall attach the manufacturing certificate mentioned in paragraph b in the final site report.