


Technical Specification

WELDING OF POLYETHYLENE PIPES

ET 605


Revision No. 3 | 10 April 2023



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Register of revisions

Revision number	Date	Motif
0	2006-12-20	Initial wording.
1	2012-12-11	General review.
2	2018-12-20	General review.
3	2023-04-10	General revision carried out by IDOM Consulting, Engineering, Architecture, SAU

Information classification

Confidential	<input type="checkbox"/>	Restricted	<input type="checkbox"/>	Internal use	<input type="checkbox"/>	Public	<input checked="" type="checkbox"/>
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Distribution of the document

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Internal	CA <input type="checkbox"/> AT <input checked="" type="checkbox"/> ACR <input checked="" type="checkbox"/>
	AT-ED <input type="checkbox"/> AT-EX <input type="checkbox"/> AT-GE <input type="checkbox"/> AT-MS <input type="checkbox"/>
	ACR-DC <input type="checkbox"/> ACR-GC <input type="checkbox"/> ACR-RD <input type="checkbox"/>
Nominal	< name, function, position >

Caption:

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

Elaborated:	Check:	Approved:
Carlos Correia	Ricardo Moreira	Rui Bessa
The approval of this document formalised in this page, prevails over the totality of its contents.		

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Preamble

As part of the "H2 REN Programme" aimed at adapting technical specifications to prepare 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 the work conducted by IDOM Consulting, Engineering, Architecture, SAU, which introduced the necessary changes to the specification in order to ensure that the "Welding of polyethylene pipes" performed in accordance with this specification ensures that the infrastructure is ready to receive hydrogen.

This revision of ET 605 cancels and replaces the previous revision dated 20 December 2018, 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

This technical specification for construction establishes and defines the requirements, standards and technical conditions applicable, as well as the evaluation criteria to be met, when carrying out welding on polyethylene pipes and fittings used in fuel gas distribution networks.

2. Scope

This Technical Specification applies to the welding of polyethylene pipes and fittings used in the construction, maintenance and renovation of fuel gas distribution networks and classified in accordance with Despacho nº 806-B/2022.

Given the mechanical characteristics of polyethylene, its use for hydrogen transport is limited to low-pressure networks, with a maximum admissible pressure of 4 bar.

3. References

All undated documents should be considered in their latest version.


3.1. External references

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

"Regulamento da Rede Nacional de Distribuição de Gás."

Decreto-Lei n.º 97/2017 de 10 de agosto

Estabelece o regime das instalações de gases combustíveis em edifícios.

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Lei 15/2015, de 16 de fevereiro

Estabelece os requisitos de acesso e exercício da atividade das entidades e profissionais que atuam na área dos gases combustíveis, dos combustíveis e de outros produtos petrolíferos, conformando-o com a disciplina da Lei n.º 9/2009, de 4 de março, e do DL n.º 92/2010, de 26 de julho, que transpuseram as Diretivas n.ºs 2005/36/CE, de 7 de setembro, relativa ao reconhecimento das qualificações profissionais, e 2006/123/CE, de 12 de dezembro, relativa aos serviços no mercado interno, e procede à quinta alteração ao DL n.º 267/2002, de 26 de novembro.

NP EN 1555-5

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

EN 13067

"Plastics welding personnel. Approval testing of welders - Thermoplastics welded assemblies."

EN 13100-1

"Nondestructive testing of welded joints of thermoplastics semi-finished products - Part 1: Visual examination."

EN 12814-1

"Testing of welded joints of thermoplastics semi-finished products - Part 1: Bend test."

DVS 2202-1

"Imperfections in thermoplastic welding joints; features, descriptions, evaluation."

DVS 2207-1

"Welding of thermoplastics heated tool welding of pipes, pipeline components and sheets made of PE-HD."

ISO 13954

"Plastics pipes and fittings - Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm."

ISO 12176-1


"Plastics pipes and fittings -- Equipment for fusion jointing polyethylene systems -- Part 1: Butt fusion"

ISO 12176-2

"Plastics pipes and fittings -- Equipment for fusion jointing polyethylene systems -- Part 2: Electrofusion"

DS/INF 70-2

"Plastic pipes - Butt fusion of polyolefin pipe systems - Fusion methodology."

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WIS 4-32-08

"Specification for the fusion jointing of polyethylene pressure pipeline systems using PE80 and PE100 materials."

3.2. Internal references

ET 301 - "Polyethylene Pipes for Gas

ET 302 - "Polyethylene gas fittings".

ET 651 - "Mechanical resistance and leakage tests: Distribution network - secondary network"

ET 1105 - "Personal Protective Equipment".

ET 1106 - "Guidelines for quality, environment and safety in operations".

ET 1126 - "Regulation: Quality, Environmental and Safety requirements for specific infrastructure contracts"

4. Definitions / Acronyms

Qualified welder

Welder accredited by DGGE under the terms of Lei 15/2015, of February 16, 2015, and qualified, according to standard EN 13067 by Officially recognised Inspection Entity.

Butt welding


It is a process in which the connection between the elements to be welded is achieved through controlled contact between the ends to be joined, after their heating. The variables of the process are temperature, pressure and time.

Electro welding

It is a welding process which uses fittings made of the same material as the elements to be welded (electro weldable fittings), which have internally incorporated electrical resistances that, when subjected to an electrical voltage under well-defined conditions, heat the elements to be welded to a temperature that makes the connection possible.

Construction site safety coordinator (CSO)

Natural or legal person who, during the execution of the work, performs the safety and health coordination tasks set out in this document.

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Contractor

Entity accredited as an Installing Entity by the Directorate-General for Energy and Geology (DGEG), with staff organization, competence and suitability to ensure, according to the established criteria, the execution of works intrinsic to construction, maintenance and intervention in gas infrastructures.

Construction Manager


Portgás employee assigned the task of managing the work relating to a specific contract.

Inspection

Entity accredited as an Inspection Entity by the Portuguese Accreditation Institute (IPAC), whose mission is to ensure the conformity of work carried out by third parties for Portgás, respecting and enforcing what is contractually established and guaranteeing compliance with all legally applicable standards from local, national or community sources, as well as Portgás' technical specifications and procedures.

5. Quality, Environment and Safety on site

- a) The infrastructure-specific service provision activities as presented in this document are governed by the accreditation requirements set out in ET 1126.
- b) In order to minimise/eliminate the environmental impacts associated with the "welding of polyethylene pipes", the Contractor should bear in mind that:
 - b1) The works to be carried out within the framework of this technical construction specification shall comply with all the provisions set out in technical specification ET 1106, supplemented by the provisions explained in this same specification.
 - b2) Waste resulting from the work carried out within the scope of this specification shall be collected daily and sent to the Contractor's yard, where it shall be separated, stored and identified by type of waste, for subsequent delivery to properly licensed waste operators.
- c) The Construction Inspector/Manager is responsible for ensuring that all requirements in terms of Quality, Environment and Safety are met by all those involved in the work.

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6. Responsibilities

Contractor

It is your responsibility to comply fully with this technical specification.

Inspector / Construction Manager

It is their responsibility to coordinate, monitor and supervise the methodology for executing the work under the terms defined in this technical specification.

Site safety coordinator

It is their responsibility to verify and control the technical and legal aspects, within the scope of their attributions, under the terms defined in this technical specification.

7. Welding: definitions and principles

7.1. Welding processes

Any of the following processes may be used in the construction of fuel gas distribution networks, but threaded connections are not permitted.

7.1.1. Butt welding with heating interface


Butt welding can only be used for the connection of pipes and fittings with a nominal diameter (DN) of 160 mm or more. In special situations, butt welding may be used on DN 110, if it is duly authorised by Portgás. This process, butt welding, is limited to welding between pipes of the same diameter and the same SDR class.

7.1.2. Electro welding

Applicable for the connection of polyethylene pipes and fittings of all diameters.

7.2. Qualification of welders

- a) All welders engaged in construction, renovation or maintenance work on gas distribution networks must be in possession of the following documents:
 - Installer Licence for gas installations and gas distribution networks and branches under the terms of the provisions of Article 34 of Lei 15/2015 of 16 February.
 - Valid Welder's Qualification Certificate for the welding process they carry out, issued by an officially recognised Inspection Entity,
 - Specific accreditation by Portgás.

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- b) Before starting the work, the Contractor must provide Portgás with a list of the names of the welders assigned to the work. The admission of welders not previously known and accepted by Portgás is strictly forbidden.
- c) Qualification of welders will be carried out according to EN 13067: Plastics welding personnel. Approval testing of welders - Thermoplastic welded assemblies.
- d) Each welder will clearly identify the weld they perform by the following items:
 - Welder's initials
 - Welding number
- e) A welder's qualification is valid for two years if there is no interruption of their activity for a period exceeding six months.
- f) Portgás reserves the right to submit welders to examinations or training, even if they hold a certificate issued by a duly recognised entity, and to refuse those it considers to be unqualified.

7.3. Materials

- a) The characteristics of the materials are those indicated in the following Portgás Technical Specifications:

ET 301: "Polyethylene gas pipes"


ET 302: "Polyethylene gas fittings".
- b) The Contractor may not start any welding without having the Certificates proving that the characteristics of the material correspond to the specified quality.

7.4. Welding specifications and procedures

- a) The contractor should have Welding Technical Specifications and Welding Procedures, qualified by an officially recognised Inspection Body.

The Technical Specifications should be drawn up in accordance with the following standards, considering the different types of welding that you intend to perform:

 - DVS 2207 - 1;
 - WIS 4-32-08;
 - DS/INF 70-2;
- b) Whenever requested by Portgás or the Inspection Entity, the contractor is obliged to present their qualified Technical Specifications and Welding Procedures, as well as demonstrate their suitability for the welding equipment used, requiring the presentation of copies of the technical instructions from the manufacturers of the materials/equipment used.

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7.5. Welding equipment

7.5.1. General

- Butt welding and electro welding must be carried out using equipment certified and accepted by Portgás. Welding equipment certificates must be valid for one year and must remain on site.
- All welding equipment must meet the applicable technical requirements, namely Decree-Law no. 120/2008, Series I of 24 June, be in perfect state of conservation and equipped with the measuring instruments required for permanent control of the main welding parameters.
- During the course of use, Portgás may suspend work, whenever it suspects the conformity of a piece of welding equipment and may require that it undergo tests to confirm its conformity.
- If the breakdown of a machine is evident, or the result of the tests referred to above is not conclusive, Portgás may demand that it be taken out of service.


7.5.2. Certification of welding equipment

- All welding equipment shall have a Qualification Certificate issued by an officially recognised Inspection Entity in accordance with ISO 12176-1/2 Standards or equivalent.
- The contractor must ensure that all identification elements / nameplates of the equipment are legible.
- The certification is valid for one year.
- Any welding equipment that has been repaired must undergo a new certification process.

7.6. Performing the weld

7.6.1. General

- Whenever possible the welds will be made outside the trench.
- The pipes to be welded must be at a temperature between $0^{\circ}\text{C} \leq T \leq 40^{\circ}\text{C}$. Welding must be carried out in a dry place, protected from rain and wind until completely cool (below 40°C).
- During polyethylene welding operations (electrofusion and butt welding), under rainy or foggy atmospheric conditions, the site should be properly protected by using a welding tent.
- When welding with nets in service, the pipes to be welded must be earthed beforehand with a cotton thread soaked in water.

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7.6.1.1. Ovalisation of tubes

- a) Before carrying out any welding, always check the surface condition and ovality of the pipe ends. If necessary, the surfaces to be welded should be cut. The cut should be made perpendicular to the longitudinal axis of the pipes. Each pipe end should be cut at 50 mm ± 10 mm.
- b) The ovalisation of the pipes to be welded must not exceed the value of 1.5% calculated using the following formula:

$$Ov = \frac{De_{\max} - De_{\min}}{De} \times 100$$

Where:

Ov = ovalisation

De = Nominal Pipe Diameter

From_{max} = Diameter measured near maximum ovalisation

From_{min} = Minimum tube outer diameter


- c) Any ovalisation greater than 1.5% must be corrected using appropriate processes.
- d) All pipes that have been subjected to crushing operations must be unbolted using tools suitable for this purpose. Subsequently, in the area of the pipe affected by the crushing, it is necessary to perform a reinforcement weld using an electro weldable fitting.

N.I.: If the pipe is SDR17, after the crushing and de-ovalisation operation, the reinforcement weld should not be carried out.

7.6.2. Butt welding with heating interface

7.6.2.1 Principle of welding

The connection by this process is made by heating the ends of the pipes or fittings to be welded using a heating plate, internally equipped with an electrical resistance, which raises the temperature of the polyethylene until the surfaces in contact melt. At the interface between the contact surfaces, the macromolecules are mixed to join the elements.

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7.6.2.2 Process variables

- a) In this process, the variables to consider are:
- Temperature
 - Pressure
 - Time
- b) The welding temperature should be $210^{\circ}\text{C} \pm 10^{\circ}\text{C}$

7.6.2.3. Operating mode


- a) The operating mode may be different depending on the type of machine to be used. They differ in the type of hydraulic drive, which can be with a hand pump (manual drive) or electric (automatic or semi-automatic drive).
- b) So, if the machine is manually operated, the operator will have to enter the values of the process variables.
- c) Since the machine has an automatic drive, the operator will only have to enter the data relating to the pipe to be welded, since the values of the process variables are already stored in the machine's software.
- d) In automatic machines, once the straightening of the pipe ends has been determined, the welding process is controlled by the machine itself. The welder does not have to intervene in the welding process. The machine records all welding parameters step by step.

7.6.2.3.1 Preparation and protection of the welding station

- a) Check the atmospheric conditions and in the conditions mentioned in paragraph c) of point 7.6.1, secure the site with a welding tent.
- b) The welder must plug the free ends of the elements to be welded in order to avoid sudden cooling of the welding zone due to air currents inside the pipe/fitting elements.
- c) Before any welding begins, the welding equipment should be assembled, and a quick test carried out to ensure that it is working properly.

7.6.2.3.2 Pre-assembly of the components to be welded

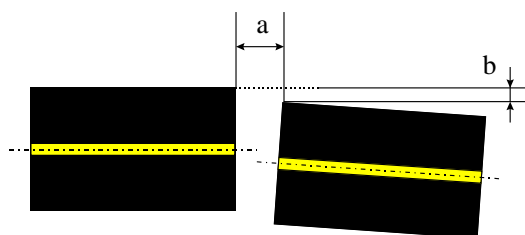
The welder should calculate and check the degree of roundness in accordance with 7.6.1.1 and pre-assemble the elements to be welded on the welding equipment.

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7.6.2.3.3 Alignment and levelling of the elements to be welded

- Aligning and levelling the elements to be welded in relation to the welding equipment in such a way as to make their axes coincide, either by displacing the support points or by rotating the elements to be welded or by any other technique, always bearing in mind that the elements to be welded cannot cause stress on the fixing devices of the welding equipment.
- The following values for misalignment are permissible:


$$a \leq 0,3\text{mm}; b \leq 0,5\text{mm}$$



- Set the clamping jaws of the welding equipment by lightly tightening them manually.
- Determine the drag pressure, which depends on the length and type of tube placed on the movable jaw of the clamping module. This operation is done by progressively increasing the pressure in the hydraulic circuit that controls the movement of the movable jaw until it is displaced. The welding pressure, supplied by the machine manufacturer, is then added to this pressure.

7.6.2.3.4 Assembling the cutting and grinding module for the ends to be welded

- Mount the cutting/preparation interface in the gap between the elements to be welded so that the module is perpendicular to them.
- Prepare the surfaces to be welded using the cutting/preparation interface. The clamping force must not reach values that cause excessive effort on this unit. This grinding operation should last until at least one complete polyethylene band has been removed from each end of the pipes to be welded, ensuring that the entire perimeter of the pipes is correctly ground.
- Remove the cutting/preparation interface and the chips resulting from the respective operation. The cutting operation should be finished after the chip has been completely removed from all its perimeter and thickness. It is not allowed the existence of any chip trace on the surface of these elements.

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7.6.2.3.5. Check the parallelism and alignment of the faces to be welded

- Check the finishing and parallelism between the two ends to be welded by visually observing and bringing the two elements to be welded closer together.
- Check the alignment between the elements to be welded.

7.6.2.3.6. Cleaning of the heating plate between the welding ends

Degrease the heating interface and the ends of the elements to be welded using volatile degreasing products prescribed or accepted by Portgás (usually acetone or methanol solution) in order to eliminate any residues of thermoplastic material.

7.6.2.3.7. Placing the heating plate between the ends to be welded


- Check the surface temperature of the heating interface. The comparison value is given by the equipment manufacturer: $T_1 = 210 \pm 10^\circ \text{C}$.
- Place the heating plate on the clamping module so that it is positioned between the pipe ends and start the welding cycle.

7.6.2.3.8. Welding cycle

- Check the value of the force to be applied, (preheating force) and the corresponding time of contact with the heating unit, (preheating time). The pressure corresponding to the force to be applied (effective welding pressure) is equal to the sum of the drag/thrust pressure and the welding pressure (values tabulated by the equipment manufacturer) in order to provide the appearance of the fusion edge defined by its height.
- Place the heating interface between the two surfaces to be welded.
- Move the components to be welded up to the contact with the heating interface and apply the preheating force corresponding to the pressure $P_1 = 0,18 \text{ MPa} \pm 0,02 \text{ MPa}$, until the appearance, on the whole periphery of the edge of the components to be welded, of the fusion edge (welding seam), the height of which shall be that defined by the welding equipment manufacturer. In the absence of information, consider the values shown in the following table:

Pipe diameter [mm]	Strand height [mm]
$\text{DN} \leq 180$	$1 < h \leq 2$
$180 < \text{DN} \leq 315$	$2 < h \leq 3$

- After the welding seam has been formed the force applied should be reduced to a value close to zero corresponding to the pressure $P_2 = 0,03 \text{ MPa} \pm 0,02 \text{ MPa}$ in order to prepare for the heating of the

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surfaces to be welded. This value must be maintained at least during the time specified by the manufacturer of the equipment or in the absence thereof: $t_2 = 30 + DN/2 \pm 10s$.

- e) Remove the heating interface after moving away from the surfaces to be welded, paying attention to the output time of the unit defined by the equipment manufacturer, so as not to cause an exaggerated cooling of the pipes. This phase is the most important and critical of the welding operation. In the absence of information one can use as a reference value: $t_3 = 3 + DN/100 \pm 1s$, a maximum of 8 s.
- f) Apply slowly but progressively a pressure which allows welding to take place considering the times defined by the equipment manufacturer or in their absence: $t_4 = 3 + 3DN/100 \pm 1s$, to a maximum of 6s.
- g) Maintain welding pressure $P_3 = 0,18 \text{ MPa} \pm 0,02 \text{ MPa}$ during cooling down according to the time set by the equipment manufacturer or material supplier. In the absence of the manufacturer's information the following times may be used:

$t_5 = 10$ minutes as a minimum

$t_6 \geq 1.5 \times \text{Nominal thickness}$, being at least 20 minutes (*)


(*) During the summer period the time should be used: $t_6 = 2 \times t_5$

Note: When calculating the times, consider the nominal diameters and thicknesses in mm and the result of the times in seconds.

- h) During the cooling period, keep the clamping jaws tight without mechanical stress. Forced cooling is prohibited.
- i) Unscrew the jaws of the welding equipment after the cooling phase is complete.
- j) Carry out a visual and dimensional control of the external edge resulting from the welding.
- k) Remove randomly, by appropriate means, the edge of at least 10% of the welds made for subsequent radiographic examination, as described in 8.6.2.4 of this document.

7.6.2.4. Assessment of weld quality. Testing

All welds shall be subjected to visual inspection, pressure tests, destructive tests where applicable and radiographic examinations. The following aspects should be observed:

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7.6.2.4.1 Visual check

- Profile and surface condition of the weld bead. Attention must be paid to the depth of the notch in the weld bead, alignment between the elements to be welded, notching on the surfaces of the elements to be welded, height and width of the welding edges and bead symmetry.
- Misalignment of the yellow pipe stripes. The pipes should be positioned so that the yellow stripes are misaligned, so that the weld location can be identified.
- Weld bead size. The permissible width is given by the welding equipment manufacturer or by abacuses. As a rule of good practice, welding beads should never be wider than 1 mm.
- Welder identification / weld number identification. Each weld must be identified on site by the welder who performed the welding.

7.6.2.4.2 Pressure tests

Absence of leaks in the pressure test (mechanical resistance and tightness), in accordance with Portgás' ET 651.

7.6.2.4.3. X-ray examination

In butt welds, radiographic examination is mandatory for at least 10% of welds, selected at random. In the case of overhead pipes or pipes laid in galleries or sleeves, radiographic examination is mandatory for 100% of the welds.

7.6.2.4.4 Destructive tests

When applicable and if requested by the Inspection Body or Portgás, destructive tests are carried out on welds, namely bend tests, in accordance with EN 12814-1.


7.6.2.5 Acceptance criteria

The acceptance criteria will be as defined in the German standard DVS 2202 - 1, quality level 1.

7.6.3. Electro welding

7.6.3.1 Principle of welding

This connection process uses fittings made of the same material (electro weldable fittings) that have an electric filament inside, which, when subjected to an electric voltage for a specific time, subjects the polyethylene to a temperature that causes fusion and allows the connection of the elements to be welded. When the electric current flows through them, the resistances heat up, causing both the pipe and the fitting to melt in a homogeneous way, thus obtaining the weld by cooling down.

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7.6.3.2 Operating mode

7.6.3.2.1 Preparation and protection of the welding station


- a) Check the atmospheric conditions and under the conditions shown in point 7.6.1 secure the premises with a welding tent.
- b) The welder must plug the free ends of the elements to be welded in order to avoid sudden cooling of the welding zone due to air currents inside the pipe/fitting elements.

7.6.3.2.2 Preparation of the ends to be welded

- a) Always check the surface condition and ovality of the pipe ends. If necessary, the surfaces to be welded should be cut. The cut should be made perpendicular to the longitudinal axis of the pipes. Each pipe end should be cut at 50 mm \pm 10 mm
- b) Any of the following equipment can be used for cutting the pipes:
 - Tube cutters,
 - Guillotine.
- c) After the cut, the ends to be welded will be superficially scraped. This procedure aims to eliminate any irregularities. The scraping must be done in the axial direction of the pipe.
- d) This cleaning can be done either manually, using scrapers, or mechanically with the aid of surfacers. There should be a scraping signal with a length of at least 10 mm for both sides of the accessory.
- e) Atmospheric influences, in particular UV rays, cause an oxide layer to form on the surface of pipes and fittings. Depending on the thickness of this layer, the quality of the connection may be affected to a greater or lesser extent and may even become impossible if the layer is too thick. It is advisable to remove a maximum of 0.1 mm.

7.6.3.2.3 Pre-assembly and marking

The pipes are fitted to the fitting and the depth of engagement is marked on the pipes. Normally the fittings have a central stop inside and the fitting is fitted until the pipes touch on both sides. If fittings without this stop are used, the length of the fitting is measured and half that length is marked on each end. The pipes, in the welding zone, should be placed with the smallest possible curvature, so as not to exert stress in that zone.

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7.6.3.2.4 Dismantling and degreasing

- Once the marking operation has been completed, the assembly is dismantled and the external surfaces of the pipes to be welded and the internal surfaces of the fitting are degreased.
- The surfaces to be welded should only be cleaned using volatile degreasing products prescribed or accepted by Portgás (usually acetone or methanol solution).
- It is forbidden to use cloths made of synthetic fibre or dirty paper. The use of clean cotton cloths or appropriate paper is mandatory, provided it is accepted by Portgás. It is also forbidden to treat the surfaces to be welded with sandpaper or non-appropriate abrasives, and only abrasive fabric with a minimum grain of 80 may be used.

7.6.3.2.5 Assembly and positioning


After cleaning, final assembly is carried out and the assembly is placed on the positioner. Mounting the positioner is mandatory because it will prevent movement of the assembly during welding. The positioners fix the pipes and minimise the risk of movement of the pipes and, at the same time, align the pipes correctly in the welding zone.

7.6.3.2.6. Performing the weld

- Once the assembly has been properly fixed, remove the protective caps from the accessory terminals and connect the welding machine terminals to the accessory.
- The machine is then switched on and welding is performed. If the machine is manual, the correct fusion time of the accessory must be entered into it, a value that is tabulated by the manufacturer. If the machine is automatic, the barcode of the accessory is scanned. If it is not possible to read the accessory optically, the numerical code of the accessory must be entered.
- Then the start button is turned on and the accessory fusion time starts to count down. At the end of this time the machine will give an acoustic signal indicating the end of the welding cycle. After the end of the process, the melted material should be visible through the holes (welding testimonials), indicating that there was a correct fusion of the polyethylene.

7.6.3.2.7. Cooling

- The cables are removed from the terminals of the accessory and the cooling period begins. As a rule of good practice, this period should be equal to or greater than 20 minutes. The cooling must be natural, and any kind of forced cooling is forbidden.
- Disassemble positioner. In general, positioners can be removed after the cooling-down time has elapsed, during which time the welded elements should remain at rest. In case of immediate testing

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and/or gassing, as a rule of good practice, the cooling time should be twice as long as specified, unless the attachment already indicates the appropriate time for this situation.

NI: If by any incident the welding cycle is interrupted, the welding procedure must be restarted using a new welding attachment and a new welding cycle. Reusing an attachment that has already undergone an incomplete welding cycle is not permitted.

7.6.3.3 Assessment of weld quality. Tests

All welds shall be subject to visual inspection, pressure tests and destructive tests where applicable. The following aspects should be observed:

7.6.3.3.1 Visual check

- Check the alignment between the elements to be welded by checking the radial gap, which should be uniform along the entire perimeter of the pipe.
- Check for signs of scraping which should be visible and uniform on a maximum of 10 mm on each side of the fitting.
- Checking the depth of engagement markings.
- Checking the fusion indicators (welding testimonials).
- Checking for the presence of irregular runs, which are a sign of a badly executed weld.

7.6.3.3.2 Pressure tests

Absence of leaks in pressure tests (mechanical resistance and tightness) according to Portgás ET 651.

7.6.3.3.3 Destructive tests

When applicable and if requested by the Inspection Entity or Portgás, destructive tests are carried out on the welds, namely debonding tests, using test pieces with standardised dimensions.

7.6.3.4 Acceptance criteria

The acceptance criteria will be based on the standards indicated:

DVS 2202-1 - Quality Level I

EN 13100-1

7.6.4. Registration of welds

The Contractor shall record the welding parameters. The data shall refer, in addition to the welding parameters, to the identification of the welder, welding equipment, date and time of execution.