TECHNICAL REPORT

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Polyethylene pipes and fittings for the supply of gaseous fuels or water — Training and assessment of fusion operators

Tubes et raccords en polyéthylène pour le transport de combustibles gazeux — Formation et évaluation des opérateurs de soudage

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 19480 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

Introduction

The quality of a piping system for the supply of gaseous fuels or water is to a large extent determined by the skills of the operators involved in installing the network. When installing polyethylene (PE) pipes, the quality of the fusion joints is essential for the piping system.

Since fusion joints in PE piping systems can be made using various technologies, it is important that the fusion operators are trained and competent in the fusion technology employed in constructing PE networks.

Continued competence of the fusion operator is covered by periodic re-training and re-assessment.

Polyethylene pipes and fittings for the supply of gaseous fuels or water — Training and assessment of fusion operators

1 Scope

This Technical Report gives guidance and other provisions for the training, assessment and approval of fusion operators, with the aim of establishing and maintaining their competency in the construction of polyethylene (PE) piping systems for the supply of gaseous fuels in accordance with ISO 10839, for the supply of water, or in the construction of such systems used in other pressure applications. It covers the butt fusion, electrofusion and socket fusion jointing techniques and considers both the theoretical and practical knowledge necessary for making high-quality fusion joints.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4427, *Polyethylene (PE) pipes for water supply — Specifications*

ISO 4437, *Buried polyethylene (PE) pipes for the supply of gaseous fuels —Metric series — Specifications*

ISO 8085-1, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 1: Fittings for socket fusion using heated tools*

ISO 8085-2, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 2: Spigot fittings for butt fusion, for socket fusion using heated tools and for use with electrofusion fittings*

ISO 8085-3, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 3: Electrofusion fittings*

ISO/TS 10839:2000, *Polyethylene pipes and fittings for the supply of gaseous fuels — Code of practice for design, handling and installation*

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*

ISO 13953:2001, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954:1997, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 13955:1997, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
butt fusion cycle
pressure/time diagram for a defined fusion temperature, representing the butt fusion operation

3.2
drag resistance
⟨peak drag⟩ frictional resistance due to the weight of the length of pipe fixed in the moveable clamp at the point at which movement of the moveable clamp is initiated

3.3
drag resistance
⟨dynamic drag⟩ friction occurring during movement

3.4
frictional resistance
⟨butt fusion machine⟩ force necessary to overcome friction in the whole mechanism of the machine

3.5
fusion operator
person trained to carry out fusion jointing between polyethylene (PE) pipes and/or fittings based on a fusion procedure

NOTE The fusion operator is trained for one or more fusion procedures, involving the operation of manual and/or automatic fusion-jointing machines.

3.6
fusion operator certificate
approval certificate issued by the examiner/assessor stating that the knowledge and skill of the fusion operator is sufficient to produce fusion joints following a given fusion procedure

3.7
fusion procedure
document agreed by the pipeline operator providing in detail the required variables and values for a specific fusion process, in order to ensure repeatability

EXAMPLE Butt fusion procedure, electrofusion procedure.

3.8
pipeline operator
private or public organization authorized to design, construct and/or operate and maintain the supply system

3.9
training centre
establishment for training of fusion operators

4 Training organization

4.1 Training course

A trainee fusion operator for underground PE systems should follow a training course at a training centre, in order to obtain a fusion operator certificate for PE pipes. The training centre should provide the training courses under the conditions described in this Technical Report.

Where applicable, the training centre shall be as required by national authorities.

The courses should be delivered by a competent trainer having the required experience of fusion processes and mastery of the fusion technique involved.

Where applicable, the trainer shall have a level of qualification as required by national authorities.

The training centre should have a range of fusion machines representative of the equipment encountered on worksites for installing pipes, in order for the trainee fusion operator to become acquainted with the fusion equipment commonly used. The trainee fusion operator may be trained on one of these fusion machines or on a machine from his or her own company if accepted by the training centre. The fusion equipment shall comply with ISO 12176-1 for butt fusion equipment and ISO 12176-2 for electrofusion equipment.

Preferably, a training centre should not carry out activities related to contracting, supervision of construction work, or inspection of fusion joints.

4.2 Operator assessment

A trainee fusion operator who has followed a training course as described above should then pass a theoretical and practical assessment in order to be qualified as a fusion operator for PE systems.

The assessor should not be the trainer and should have appropriate assessment qualifications.

NOTE The assessor is a person accepted by the contracting parties or an accredited body, e.g. EN 45004 [1] or a certification body e.g. EN 45013 [2].

5 Training

5.1 Training curriculum

The training course should consist of any combination of fusion packages based on the requirements of the pipeline operators. These packages may be given as individual modules or combined to suit requirements.

During the training, attention should also be drawn to safety. The course related to safety should deal with safety related to the fusion process.

5.2 Course

5.2.1 General

The training should be provided by a trainer having the qualification according to 4.1.

All consumables and tools necessary for the training package should be available during the training session.

The pipes and fittings to be used shall be those in accordance with ISO 4437, ISO 8085-1, ISO 8085-2 and ISO 8085-3 for the supply of gaseous fuels, and ISO 4427 for the supply of water, and corresponding to what is normally used locally for the construction of PE piping systems.

The lessons should be designed so that the trainee fusion operator learns to master the fusion technique and also to master the materials and practical problems involved in laying a pipe in a trench, with or without obstacles. In connection with the latter aspect, the trainee fusion operator should construct at least one three-dimensional configuration (connection between two pipes laid in different axes).

The trainee fusion operator should receive a written manual covering all the elements dealt with in the training. The course should be drawn up in one of the national languages.

5.2.2 Theoretical course on general information

The theoretical course should deal with general information in connection with raw materials, pipes and fittings, but also with theoretical knowledge on preparation, tools and devices and joining components. It should

include details of the different fusion techniques — namely electrofusion, butt fusion or socket fusion — of materials (e.g. PE 80, PE 100) and SDR series, as well as on correct and incorrect parameters.

The safety course should include information concerning the fusion process, such as protective clothing, general safety regulations for electrical equipment, and the handling of heater plates. The main features are given in Table 1.

Table 1 — Theoretical course on general information

Characteristics of PE compounds	
Typical properties of thermoplastics, PE 80, PE 100, UV behaviour and typical colours Physical and mechanical behaviour of PE compounds: temperature effects, strain/stress, creep, elongation/shrinkage, stress cracking, etc.	
Manufacturing of pipes and fittings	
Extrusion of pipes	Overview of the manufacturing process, packaging and marking Transport, handling and storage of pipes
Injection moulding of fittings	Overview of the manufacturing process, packaging and marking
Standardization of PE piping systems	
Dimensional data: nominal outside diameter and wall thickness (SDR), out of roundness Maximum allowed pressure, standards for pipes, fittings and accessories (valves) Overview of relevant test methods with this document	
Fusion operator certificate	
Identification number, time period validity, skill	
Health and safety considerations	
General	Principle of risk management Clothing, shoes, hard hat, gloves Risks related to cleaning fluids, handling and storage of pipes Use of fire extinguishers Working in trenches, lifting equipments References to national regulations related to working on piping systems with pressure
Butt fusion	Electricity safety, use of generators, heating plates
Electrofusion	Electricity safety, use of generators
Socket fusion	Electricity safety, use of generators, heating tools
Environmental aspects	
Use of cleaning fluid Disposal of packaging materials	

5.2.3 Theoretical and practical course on fusion jointing techniques

5.2.3.1 Electrofusion jointing

The trainee should become familiar with the electrofusion jointing technique and the associated fusion procedure by making a sufficient number of electrofusion joints.

The fusion procedure shall be carried out in accordance with the instructions supplied by the manufacturer of the electrofusion fitting and the electrofusion equipment and/or as written in national specifications. The fusion parameters are laid down by the manufacturer, and are normally implemented automatically by the fusion machine itself (by reading in a bar code or equivalent).

The trainee should begin by fabricating an assembly with an electrofusion socket coupling between two pipes, and should then be taught to make joints with more specific electrofusion fittings such as T-fittings, reducers, saddles and tapping tees. Consideration should also be given to the preparation and cleanliness of the pipe, fitting and fusion equipment.

NOTE For practical reasons and if accepted by the pipeline operator, the assembly can be limited to the complete jointing procedure without starting the final fusion cycle.

The trainee should learn how to detect and to avoid typical fusion defects.

The trainee should learn how to assess the quality of an electrofusion joint and to know the available test methods.

ISO/TS 10839 may be used as a guide for a general electrofusion jointing procedure, in particular for quality control.

The main features of the theoretical and practical courses on electrofusion jointing technique are given in Table 2.

5.2.3.2 Butt fusion jointing

The trainee fusion operator should become familiar with the butt fusion jointing technique and associated fusion procedure by making a sufficient number of butt fusion joints.

In some cases, the butt fusion cycle can vary according to the diameter, e.g. with double fusion pressure being used for larger diameters. In such cases, the fusion operator should also be made familiar with this technique.

Attention should also be paid to the differences between automatic and manual fusion machines, as regards, among other things, drag resistance and frictional resistance in the butt fusion machine.

The trainee should start by making a butt joint between two pipes, and then learn to make butt fusion joints with pipes and fittings such as tees, reductions, etc.

The trainee should learn how to detect and to avoid typical fusion defects.

The trainee should learn how to assess the quality of a butt fusion joint, and know the available test methods.

ISO/TS 10839 may be used as a guide for a general butt fusion jointing procedure, in particular for quality control.

The main features of the theoretical and practical courses on butt fusion jointing technique are given in Table 2.

5.2.3.3 Socket fusion jointing

The trainee fusion operator should become familiar with the socket fusion jointing technique and the associated fusion procedure by making a sufficient number of socket fusion joints.

The fusion procedure shall be carried out in accordance with the instructions supplied by the manufacturer of the socket fusion fitting. The fusion operator should be made familiar with type A and B fittings, and with the fact that these two systems are not compatible with each other. The fusion parameters should be as laid down by the manufacturer of the socket fusion fitting.

The trainee should start by making a socket fusion joint between two pipes, and then learn to make joints with more specific socket fusion fittings.