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**Plastics piping systems for the supply of gaseous fuels —
Unplasticized polyamide (PA-U) piping systems with fusion
jointing and mechanical jointing — Part 8: Training and
assessment of fusion operators**

*Systèmes de canalisations en matières plastiques pour la distribution de combustibles gazeux —
Systèmes de canalisations en polyamide non plastifié (PA-U) avec assemblages par soudage et
assemblages mécaniques — Partie 8: Formation et évaluation des opérateurs de soudage*

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138 *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee **SC4SC 4**, *Plastics pipes and fittings for the supply of gaseous fuels*.

A list of all parts in the ISO 16486 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The quality of a piping system for the supply of gaseous fuels is to a large extent determined by the skills of the operators involved in installing the network. When installing unplasticized polyamide (PA-U) pipes, the quality of the fusion joints is essential for the integrity of the piping system.

Since fusion joints in PA-U 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 PA-U networks.

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

For the training and assessment or re-training and re-assessment of fusion operators ~~according to~~ accordance with this ~~standard~~ document, a valid operator certificate ~~according to~~ accordance with ISO/TR 19480 is required.

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Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 8: Training and assessment of fusion operators

1 Scope

This ~~Technical Specification document~~ specifies the training, assessment and approval of fusion operators, with the aim of establishing and maintaining their competency in the construction of unplasticized polyamide (PA-U) piping systems for the supply of gaseous fuels in accordance with ISO ~~WD~~-16486-6. It covers the butt fusion and electrofusion fusion jointing techniques and considers both the theoretical and practical knowledge necessary for making high-quality fusion joints.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 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 16486-1, Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 1: General

ISO 16486-2, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 2: Pipes*

ISO 16486-3, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 3: Fittings*

ISO 16486-4, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 4: Valves*

ISO 16486-5, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 5: Fitness for purpose of the system*

ISO 16486-6, *Plastics piping systems for the supply of gaseous fuels - Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 6: 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, Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt fused joint~~

~~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 13955, Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies~~

~~ISO 13956, Plastics pipes and fittings — Decohesion test of polyethylene (PE) saddle fusion joints — Evaluation of ductility of fusion joint interface by tear test~~

ISO/TR 19480, Polyethylene pipes and fittings for the supply of gaseous fuels or water — Training and assessment of fusion operators

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

3.1

butt fusion cycle

pressure/time relationship for a defined fusion temperature, representing the butt fusion operation

3.2

drag pressure

gauge pressure required to overcome, on a given butt fusion machine, the sliding frictional drag force of the machine and pipe

Note 1 to entry: Drag pressure, if present, can be a positive or negative value.

3.3

frictional resistance

$\left\langle \text{butt fusion machine} \right\rangle$ force necessary to overcome friction in the whole mechanism of the machine

3.4

fusion operator

person trained ~~according to this standard~~ to carry out fusion jointing between unplasticized polyamide (PA-U) pipes and/or fittings based on a *fusion procedure* (3.6)

Note 1 to entry: The fusion operator is trained for one or more fusion procedures, involving the operation of manual and/or automatic fusion-jointing machines.

3.5

valid fusion operator certificate

approval certificate issued by the examiner/assessor stating that the knowledge and skill of the *fusion operator* (3.4) is sufficient to produce fusion joints following a given *fusion procedure* (3.6)

3.6

fusion procedure

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

EXAMPLE Butt fusion procedure, electrofusion procedure.

3.7

pipeline operator

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

3.8

training centre

establishment for the training of *fusion operators* (3.4)

4 Training organization

4.1 Training course

A valid operator certificate ~~according to~~ in accordance with ISO/TR 19480 is required prior to obtaining PA-U training ~~according to~~ in accordance with this document.

For underground PA-U systems, a trainee fusion operator shall follow a supplemental training course at a training centre. The training centre shall provide a supplemental training course under the conditions described in this document.

~~Where applicable, the training centre shall fulfil requirements of the national authorities.~~

The courses shall 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 shall have a range of fusion machines and related equipment (e.g. re-rounding clamps, scraper tools, roller supports), 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~~ conform to ISO 12176-1 for butt fusion equipment and ISO 12176-2 for electrofusion equipment.

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

4.2 Operator assessment

A trainee fusion operator for PA-U shall own a valid operator certificate ~~according to~~ in accordance with ISO/TR 19480. The trainee shall follow ~~an~~ supplemental training course as described ~~above~~ in 4.1. Then the trainee shall pass a theoretical and practical assessment in order to be qualified as a fusion operator for PA-U systems.

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

NOTE The assessor is a person accepted by the contracting parties ~~or an accredited body~~.

5 Training

5.1 Training curriculum

The supplemental training course for PA-U shall 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 shall also be drawn to safety. The course curriculum shall address safety related to the fusion process.

~~5.2 Course~~

5.2 Courses

5.2.1 General

The training shall be provided by a trainer having the qualification ~~according to~~described in 4.1.

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

The pipes, fittings and valves to be used shall be those in accordance with ISO 16486-2, ISO 16486-3 and ISO 16486-4 for the supply of gaseous fuels, and shall correspond to what is normally used locally for the construction of PA-U piping systems.

Operators previously certified ~~according to~~in accordance with ISO/TR 19480 have received training to master the fusion technique and also to master the thermoplastic materials and practical problems involved in laying a pipe in a trench, with or without obstacles. The training ~~according to~~in accordance with this document shall cover all aspects specific to PA-U.

In connection with the latter aspect, the trainee fusion operator shall construct at least one three-dimensional configuration (connection between two pipes laid in different axes).

The trainee fusion operator shall receive a written manual covering all the elements dealt with in this supplemental training for PA-U. The course shall be provided in one of the national languages.

5.2.2 Theoretical course on general information

The theoretical course shall deal with PA-U specific information in connection with raw materials, pipes and fittings, but also with theoretical knowledge on preparation, tools and devices, and joining components. It shall include PA-U specific details of the different fusion techniques ~~—namely (i.e. electrofusion or butt fusion—)~~ of materials (e.g. PA-U 11 or PA-U 12) and the standard dimension ratio (SDR) series, as well as on correct and incorrect parameters.

On the basis of ISO/TR 19480, the supplemental safety course ~~according to~~in accordance with this document shall include PA-U specific differences and/or extensions of information concerning the fusion process and its raised meaning for piping systems, which potentially operate under pressures up to and including 18 bar¹. The main features are given in Table 1.

Table 1 — Theoretical course on general information

Characteristics of PA-U compounds
Typical properties of thermoplastics, PA-U 11, PA-U 12, UV behaviour and typical colours.

¹ 1 bar = 0,1 MPa = 10⁵ Pa; 1 MPa = 1 N/mm².