

---

---

**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*



iTeh STANDARD PREVIEW  
(standards.iteh.ai)

ISO/TS 16486-8:2022  
<https://standards.iteh.ai/catalog/standards/sist/54855306-5be8-4d14-8294-a93e4276285f/iso-ts-16486-8-2022>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2022

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Training organization</b> .....	<b>2</b>
4.1 Training course.....	2
4.2 Operator assessment.....	3
<b>5 Training</b> .....	<b>3</b>
5.1 Training curriculum.....	3
5.2 Courses.....	3
5.2.1 General.....	3
5.2.2 Theoretical course on general information.....	4
5.2.3 Theoretical and practical courses on fusion jointing techniques.....	5
<b>6 Assessment</b> .....	<b>7</b>
6.1 Valid fusion operator certificate.....	7
6.2 Re-assessment.....	7
<b>7 Periodic operator certificate renewal</b> .....	<b>8</b>
<b>Annex A (normative) Examination</b> .....	<b>9</b>
<b>Bibliography</b> .....	<b>10</b>

ISO/TS 16486-8:2022

<https://standards.iteh.ai/catalog/standards/sist/54855306-5be8-4d14-8294-a93e4276285f/iso-ts-16486-8-2022>

## 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.

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](http://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](http://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](http://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 SC 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](http://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 in accordance with this document, a valid operator certificate in accordance with ISO/TR 19480 is required.

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

ISO/TS 16486-8:2022

<https://standards.iteh.ai/catalog/standards/sist/54855306-5be8-4d14-8294-a93e4276285f/iso-ts-16486-8-2022>



# 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 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 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/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**

<butt fusion machine> force necessary to overcome friction in the whole mechanism of the machine

## 3.4

### **fusion operator**

person trained 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 in accordance with ISO/TR 19480 is required prior to obtaining PA-U training 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.



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

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 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 in accordance with ISO/TR 19480. The trainee shall follow a supplemental training course as described 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.

## 5 Training iTeh STANDARD PREVIEW

### 5.1 Training curriculum (standards.iteh.ai)

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. <https://standards.iteh.ai/catalog/standards/sist/54855306-5be8-4d14-8294-a03e4d276285f/iso-ts-16486-8-2022>

During the training, attention shall also be drawn to safety. The course curriculum shall address safety related to the fusion process.

### 5.2 Courses

#### 5.2.1 General

The training shall be provided by a trainer having the qualification 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 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 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 (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 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 bar<sup>1)</sup>. The main features are given in [Table 1](#).

**Table 1 — Theoretical course on general information**

<b>Characteristics of PA-U compounds</b>	
Typical properties of thermoplastics, PA-U 11, PA-U 12, UV behaviour and typical colours.	
Physical and mechanical behaviour of PA-U compounds: temperature effects, strain/stress, creep, elongation/shrinkage, stress cracking, etc.	
<b>Manufacturing of pipes and fittings</b>	
Extrusion of pipes	Refresh by referencing the qualification represented by the valid operator certificate in accordance with ISO/TR 19480. <sup>a,b</sup>
Injection moulding of fittings	Refresh by referencing the qualification represented by the valid operator certificate in accordance with ISO/TR 19480. <sup>a,b</sup>
<b>Standardization of PA-U piping systems</b>	
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.	
<b>PA-U valid fusion operator certificate</b>	
General	Requirement of valid certification in accordance with ISO/TR 19480.
Specific	Identification number, time period validity and skill.
<b>Health and safety considerations</b>	
General	Refresh by referencing the qualification represented by the valid operator certificate in accordance with ISO/TR 19480 regarding: <ul style="list-style-type: none"> <li>— principle of risk management;</li> <li>— clothing, shoes, hard hat and gloves;</li> <li>— risks related to cleaning fluids, handling and storage of pipes;</li> <li>— use of fire extinguishers;</li> <li>— working in trenches and lifting equipment.</li> </ul> Refresh by referencing the qualification represented by the valid operator certificate in accordance with ISO/TR 19480 and eventual extension for plastics pressure piping systems for MOP up to and including 18 bar. NOTE National regulations related to working on piping systems with pressure can apply.
<sup>a</sup>	ISO/TR 19480 includes an overview of the manufacturing process, packaging and marking, which is also valid for PA-U.
<sup>b</sup>	ISO/TR 19480 includes information about transport, handling and storage of pipes, which is also valid for PA-U.
<sup>c</sup>	ISO/TR 19480 includes information about the use of cleaning fluid and the disposal of packaging materials, which is also valid for PA-U.

1) 1 bar = 0,1 MPa = 10<sup>5</sup> Pa; 1 MPa = 1 N/mm<sup>2</sup>.