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**Thermoplastic pipes for the conveyance of fluids — Inspection of polyethylene electrofusion socket joints using phased array ultrasonic testing**

*Tubes en matières thermoplastiques pour le transport des fluides — Contrôle des assemblages par emboîtures électrosoudables en polyéthylène au moyen de la technique pas ultrasons multi-éléments*

**DTS stage**

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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.

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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html), 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 5, *General properties of pipes, fittings and valves of plastic materials and their accessories* — *Test methods and basic specifications*.

This second edition cancels and replaces the first edition (ISO/TS 16943:2019), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Clarified definition — the definitions of "cold fusion" and "lack of fusion" have been clarified;
- Revision of procedure qualification (Clause 10) has been revised.

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).



# Thermoplastic pipes for the conveyance of fluids — Inspection of polyethylene electrofusion socket joints using phased array ultrasonic testing

## 1 Scope

This document describes the phased array ultrasonic testing (PAUT) of polyethylene electrofusion (EF) socket joints used for the conveyance of fluids. This document provides a test whereby the presence of imperfections such as voids, wire dislocation, misalignment, pipe under-penetration, particulate contamination and lack of fusion in electrofusion socket joints can be detected. The technique is only applicable to polyethylene electrofusion socket fittings without a barrier to ultrasonic waves.

This document also provides requirements for procedure qualification and guidance for personnel qualifications, which are essential for the application of this test method.

This document also covers the equipment, the preparation and performance of the test, as well as the indication assessment and the reporting for polyethylene BF joints. The acceptance criteria are not covered in this document.

NOTE 1 At the time of publication, experience only exists on the use of PAUT for polyethylene (PE80 and PE100) electrofusion socket joint sizes between 90 mm and 710 mm (SDR 11 and 17).

NOTE 2 ~~Round robin~~ Interlaboratory testing has shown that PAUT is a viable method for enhancing the integrity assessment of electrofusion joints.

NOTE 3 This document does not apply to the detection of unscrapped pipe. Such detection can be achieved by a simple visual inspection, provided mechanical scraping tools are employed.

NOTE 4 PAUT techniques for cold fusion detection are known to be available. However, further research, verification and experience are needed to transfer the technique into an ISO International Standard. This document does not provide any information regarding the detection of cold fusions.

## 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 5577, *Non-destructive testing — Ultrasonic testing — Vocabulary*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

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 23243, *Non-destructive testing — Terminology — Terms used in ultrasonic — Ultrasonic testing with phased arrays — Vocabulary*

### **3 Terms and definitions**

For the purposes of this document, the terms and definitions given in ISO 5577, ISO 23243 and the following apply.

ISO and IEC maintain **terminological 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 <http://www.electropedia.org/https://www.electropedia.org/>

#### **3.1 cold fusion**

incomplete intermolecular diffusion of polymer chains for proper molecular entanglement at the joint interface due to reasons other than contamination.

Note 1 to entry: Cold fusion results in insufficient joint integrity, including significant reduction of joint ductility.

#### **3.2 inclusion**

foreign material trapped in the fusion joint

#### **3.3 lack of fusion**

absence of intermolecular diffusion of polymer chains for molecular entanglement at the interface.

Note 1 to entry: A lack of fusion flaw results in complete separation at the flaw location.

#### **3.4 pipe under-penetration**

incomplete penetration of the pipe into the electrofusion socket

#### **3.5 melt fusion zone MFZ**

zone containing the fusion interface and having boundaries on either side of the interface which reflect the limits of crystalline melting during the electrofusion socket jointing process

Note 1 to entry: The **melt fusion zone MFZ** is shown in Figure 1.

**3.6****misalignment**

angular offset between the axis of the *electrofusion socket fitting* (3.15) and the axis of the pipe

**3.7****particulate contamination**

fine particles (e.g. airborne dust) or coarse particles (e.g. sand and grit) that are present at the fusion interface

**3.8****void**

empty space (or air pocket) in an *electrofusion socket joint* (3.16)

**3.9****wire dislocation**

displacement of heating wires from their original position in the fitting

**3.10****phased array image**

one-, two-, or three-dimensional display, constructed from the phased array data

**3.11****phased array set-up**

probe arrangement defined by probe characteristics (e.g. frequency, probe element size, beam angle, wave mode), *probe position* (3.12) and the number of probes

**3.12****probe position**

axial and radial position of the probe with respect to the heating wire coil in the *electrofusion socket joint* (3.16)

**3.13****scan increment**

distance between successive data collection points in the direction of scanning

**3.14****false call**

reporting an imperfection when none exists

**3.15****electrofusion socket fitting**

part containing one or more integral heating elements that are capable of converting electrical energy to heat to make a joint between pipes

**3.16****electrofusion socket joint**

fused combination of one or more pipe components using an *electrofusion socket fitting* (3.15)

**3.17****fusion zone**

one side of an *electrofusion socket joint* (3.16)

Note 1 to entry: There are two fusion zones in a straight joint.

## **4 General**

This document covers the PAUT equipment, the preparation and performance of the test and the reporting for polyethylene electrofusion socket joints.

This document ~~can~~may be used to draft a detailed procedure for phased array ultrasonic testing of polyethylene electrofusion socket joints.

## **5 Information required prior to testing**

### **5.1 -Items required for test procedure development**

Information on the following items is required:

- a) purpose and extent of testing;
- b) reference sample;
- c) requirements for getting access to the electrofusion socket joints, the surface condition of the pipe and the temperature range;
- d) personnel qualifications;
- e) reporting requirements;
- f) manufacturing or operation stage of electrofusion socket joints at which the testing is to be carried out.

### **5.2 -Specific information required by the operator before testing**

Before any testing of an electrofusion socket joint begins, the operator shall have access to all the information as specified in 5.1 together with the following additional information:

- a) written test procedure, qualified in accordance with ~~clause~~Clause 10;
- b) all relevant pipe and fitting dimensions.

### **5.3 -Written test procedure**

For all testing a written test procedure is required. This test procedure shall include at least the following information:

- a) ~~-~~purpose and extent of testing;
- b) reference sample;
- c) requirements for access to the electrofusion socket joints, surface conditions and temperature;
- d) personnel qualifications;
- e) reporting requirements;