



Technical Specification

ISO/TS 22499

Thermoplastic pipes for the conveyance of fluids — Inspection of polyethylene butt fusion joints using phased array ultrasonic testing

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

**Second edition
2024-02**

[ISO/TS 22499:2024](https://standards.iteh.ai/catalog/standards/iso/0d7c259f-26d7-41e2-8e313c6bc08b1f/iso-ts-22499-2024)

<https://standards.iteh.ai/catalog/standards/iso/0d7c259f-26d7-41e2-8e313c6bc08b1f/iso-ts-22499-2024>

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

ISO/TS 22499:2024

<https://standards.iteh.ai/catalog/standards/iso/0d7c259f-26d7-41e2-8ebe-313c6bc08b1f/iso-ts-22499-2024>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

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
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 General	2
5 Information required prior to testing	3
5.1 Items required for procedure	3
5.2 Specific information required by the operator before testing	3
5.3 Written test procedure	3
6 Personnel qualifications	3
7 Equipment	4
7.1 General	4
7.2 Ultrasonic instrument and display	4
7.3 Ultrasonic probes	4
7.4 Scanning mechanisms	4
7.5 Couplant	4
8 Range and sensitivity settings	5
8.1 Settings	5
8.1.1 General	5
8.1.2 Range setting — Test volume	5
8.1.3 Sensitivity setting	6
8.2 Reference sample	7
8.2.1 General	7
8.2.2 Reference block	7
8.2.3 Reference reflectors	7
8.3 Checking of the settings	7
9 Equipment checks	7
10 Test procedure	7
10.1 Procedure qualification	7
10.2 Scan increment	9
10.3 Geometry of the fusion joint tested	9
10.4 Preparation of scanning surfaces	9
10.5 Temperature of fusion joint tested	9
10.6 Testing	9
10.7 Data storage	10
11 Interpretation and analysis of test data	10
11.1 General	10
11.2 Assessing the quality of the test data	10
11.3 Identification of relevant indications	10
11.4 Classification of relevant indications	10
11.5 Determination of location and size of indications	11
11.6 Assessment of indications	11
12 Test report	11
Annexe A (informative) Example of reference reflectors and reference blocks	13
Annexe B (informative) Example procedures for producing imperfections in butt fusion joints^[17]	16
Bibliography	20

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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 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 22499:2019), which has been technically revised.

The main changes are as follows:

- clarification of the definition of "cold fusion" and "lack of fusion";
- revision of the procedure qualification.

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

At the present time, laboratory experiences exist on the use of PAUT for polyethylene BF joints and/or reference blocks of wall thickness between 8 mm to 100 mm^{[1][2][3][4][5]}. Field experience on BF joints in PE80 and PE100 materials has been reported^[6].

Interlaboratory test has shown that PAUT is a viable method for enhancing the integrity assessment of butt-fusion joints^{[7][16]}.

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 Standard. This document does not provide any information regarding the detection of cold fusions^[16].

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/TS 22499:2024](https://standards.iteh.ai/catalog/standards/iso/0d7c259f-26d7-41e2-8ebe-313c6bc08b1f/iso-ts-22499-2024)

<https://standards.iteh.ai/catalog/standards/iso/0d7c259f-26d7-41e2-8ebe-313c6bc08b1f/iso-ts-22499-2024>

Thermoplastic pipes for the conveyance of fluids — Inspection of polyethylene butt fusion joints using phased array ultrasonic testing

1 Scope

This document describes the phased array ultrasonic testing (PAUT) of polyethylene butt fusion (BF) joints, including pipe-to-pipe, pipe-to-fitting and fitting-to-fitting joints, used for the conveyance of fluids. This document provides a test, whereby the presence of imperfections such as voids, inclusions, lack of fusions, misalignment and particulate contamination in the BF joints can be detected. The document is only applicable to polyethylene pipes and 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 technique.

This document also covers the equipment, the preparation and performance of the test, the indication assessment and the reporting for polyethylene BF joints.

Acceptance criteria are not covered in this document.

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

3 Terms and definitions

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

ISO and IEC maintain terminological 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

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

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 butt fusion jointing process

Note 1 to entry: The MFZ is shown in [Figure 1](#).

3.5

misalignment

offset between the axis of the pipes/fittings to be jointed

3.6

particulate contamination

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

3.7

surface imperfection

imperfection on the inner diameter or outer diameter surface of the butt fusion joint

3.8

void

empty space (or air pocket) in a butt fusion joint

3.9

phased array image

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

3.10

phased array set-up

probe arrangement defined by probe characteristics (e.g. frequency, probe element size, beam angle, wave mode), *probe position* ([3.11](#)), and the number of probes

3.11

probe position

point between the front of the wedge (or probe) and the butt fusion center line

3.12

scan increment

distance between successive data collection points in the direction of scanning

3.13

false call

reporting an imperfection when none exists

4 General

This document covers the equipment, the preparation and performance of the test, the indication assessment and the reporting for polyethylene butt fusion joints.

This document may be used to draft a detailed procedure for phased array ultrasonic testing of polyethylene butt fusion joints.

Characterization of imperfections in the parent material adjacent to the butt fusion joint is also possible.

5 Information required prior to testing

5.1 Items required for procedure

Information on the following items shall be provided:

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

5.2 Specific information required by the operator before testing

Before any testing of a fusion 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 10](#);
- b) all relevant joint dimensions.

5.3 Written test procedure

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

- a) documented testing strategy or scan plan.

NOTE The testing strategy gives information on the probe placement, movement and component coverage that provides a standardized and repeatable methodology for fusion joint testing. The scan plan gives information on the volume tested for each butt fusion joint.

- b) equipment requirements and settings (including but not limited to frequency, sampling rate, pitch between elements and elements size);
- c) evaluation of indications;
- d) environmental and safety issues.

6 Personnel qualifications

Personnel performing testing in accordance with this document shall be qualified to an appropriate level in accordance with ISO 9712 or an equivalent standard in the relevant industrial sector.

In addition to a general knowledge of ultrasonic testing, the operator shall be familiar with and have practical experience in the use of phased array systems on polyethylene butt fusion joints.

Specific theoretical and practical training and examination of personnel shall be performed on representative polyethylene butt fusion joints containing natural or artificial reflectors similar to those expected in the field.

These training and examination results shall be documented.

7 Equipment

7.1 General

The complete equipment (i.e. ultrasonic instrument, probe, cables and display monitor) shall be capable of the repetition of test results.

For selecting the system components (hardware and software), ISO 13588 and ISO/TS 16829 provide useful information.

Equipment used for phased array testing is described in ISO 18563-1, ISO 18563-2 and ISO 18563-3 and contains some useful information.

7.2 Ultrasonic instrument and display

The instrument shall be able to select an appropriate portion of the time base within which A-scans are digitized. It is recommended that a sampling rate of the A-scan should be at least six times the nominal probe frequency.

7.3 Ultrasonic probes

Only longitudinal waves are feasible for polyethylene.

Any type of phased array probe can be used if it satisfies the range and sensitivity setting requirements of [Clause 7](#) with the phased array instrument.

The most suitable ultrasonic probe frequency shall be selected in accordance with the pipe wall thickness. [Table 1](#) shows the recommended frequencies for each thickness range. However, the optimal frequency can deviate from these values depending on the attenuation and thickness of the sample to be tested.

The gap between the test surface and the bottom of the wedge shall not be greater than 0,5 mm.

Table 1 — Selection of probe frequency

Recommended frequency MHz	Wall thickness, t mm
1,0 to 2,25	$60 \leq t \leq 100$
2,25 to 4,0	$30 \leq t < 60$
4,0 to 5,0	$8 \leq t < 30$

NOTE In general, higher frequencies provide better resolution and lower frequencies provide better penetration.

7.4 Scanning mechanisms

To achieve consistency of the images (collected data), guiding mechanisms and scan encoder(s) shall be used.

7.5 Couplant

In order to generate proper images, a couplant shall be used which provides a constant transmission of ultrasound between the probe and the fusion joint tested.

The same couplant used for calibration shall be used for the testing.

Any couplant used should be cleaned off after testing.