ISO/TC 138/SC 5 N

Date: 2022-~~06-27~~09

ISO/DTS 22499:2022(E)

Revision: Second Edition

Secretariat:~~—~~ NEN

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

~~DTS stage~~

~~**Warning for WDs and CDs**~~

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~~

Website: www.iso.org

Published in Switzerland

Contents

Foreword vi

1 Scope 1

2 Normative references 1

3 Terms and definitions 1

4 General 3

5 Information required prior to testing 3
5.1 Items required for test procedure development 3
5.2 Specific information required by the operator before testing 3
5.3 Written test procedure 4

6 Personnel qualifications 4

7 Equipment 4
7.1 General 4
7.2 Ultrasonic instrument and display 5
7.3 Ultrasonic probes 5
7.4 Scanning mechanisms 5
7.5 Couplant 5

8 Range and sensitivity settings 6
8.1 Settings 6
8.1.1 General 6
8.1.2 Range setting — Test volume 6
8.1.3 Sensitivity setting 7
8.2 Reference sample 8
8.2.1 General 8
8.2.2 Reference block 9
8.2.3 Reference reflectors 9
8.3 Checking of the settings 9

9 Equipment checks 9

10 Test procedure 9
10.1 Procedure qualification 9
10.2 Scan increment 11
10.3 Component geometry 11
10.4 Preparation of scanning surfaces 11
10.5 Component temperature 11
10.6 Testing 11
10.7 Data storage 12

11 Interpretation and analysis of test data 12
11.1 General 12
11.2 Assessing the quality of the test data 12
11.3 Identification of relevant indications 13
11.4 Classification of relevant indications 13
11.5 Determination of location and size of indications 13
11.6 Assessment of indications 13

12 Test report 13

Annex A (informative) Example of reference reflectors and reference blocks 15

Annex B (informative) Example procedures for producing imperfections in BF joints 20

~~Bibliography~~ 24

Foreword vi

1 Scope 1

2 Normative references 1

3 Terms and definitions 1

4 General 3

5 Information required prior to testing 3
5.1 Items required for test procedure development 3
5.2 Specific information required by the operator before testing 3
5.3 Written test procedure 4

6 Personnel qualifications 4

7 Equipment 4
7.1 General 4
7.2 Ultrasonic instrument and display 5
7.3 Ultrasonic probes 5
7.4 Scanning mechanisms 5
7.5 Couplant 5

8 Range and sensitivity settings 6
8.1 Settings 6
8.1.1 General 6
8.1.2 Range setting — test volume 6
8.1.3 Sensitivity setting 7
8.2 Reference sample 8
8.2.1 General 8
8.2.2 Reference block 9
8.2.3 Reference reflectors 9
8.3 Checking of the settings 9

9 Equipment checks 9

10 Test procedure 9
10.1 Procedure qualification 9
10.2 Scan increment 11
10.3 Component geometry 11
10.4 Preparation of scanning surfaces 11
10.5 Component temperature 11
10.6 Testing 11
10.7 Data storage 12

11 Interpretation and analysis of test data 12
11.1 General 12
11.2 Assessing the quality of the test data 12
11.3 Identification of relevant indications 13
11.4 Classification of relevant indications 13
11.5 Determination of location and size of indications 13
11.6 Assessment of indications 13

12 Test report 13

Annex A (informative) Example of reference reflectors and reference blocks 15

Annex B (informative) Example procedures for producing imperfections in butt fusion joints 20
Bibliography 24

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).

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 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 compared to the previous edition are as follows:

— Clarified definition — the definitions of "cold fusionfusions" 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.

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 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 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]~~ [7][8][9][10][11] Field experience on BF joints in PE80 and PE100 materials has been reported~~[6]~~.[12]

NOTE 2 ~~Round robin~~Interlaboratory testing has shown that PAUT is a viable method for enhancing the integrity assessment of butt-fusion joints~~[7]~~[13][16]~~.~~

NOTE 3 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.[16]

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~~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
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 ~~1to~~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~~centreline

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 PAUT equipment, the preparation and performance of the test, the indication assessment and the reporting for polyethylene butt fusion joints. The acceptance criteria are not covered in this document.

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

~~Characterisation~~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 test procedure development

Information on the following items is required:

— purpose and extent of testing;

— reference sample;

— requirements for getting access to the butt fusion joints, the surface condition of the pipe~~;~~, and the temperature range;

— personnel qualifications;

— reporting requirements;

— manufacturing or operation stage of butt fusion joints at which the testing is to be carried out.

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~~ 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 at least the following information:

a) purpose and extent of testing;

b) reference sample;

c) requirements for access to the butt fusion joints and surface conditions and temperature;

d) personnel qualifications;

e) reporting requirements;

f) equipment requirements and settings (including but not limited to frequency, sampling rate, pitch between elements and element size);

g) evaluation of indications;

h) environmental and safety issues;

i) 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.

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

NoteNOTE 1: For selecting the system components (hardware and software), ISO 13588[8] and ISO/TS 16829[9] provide useful information.

NoteNOTE 2: Ultrasonic equipment used for phased array testing is described in ISO 18563-1[10], ISO 18563-2[11] and ISO 18563-3[12] and contains some useful information.