INTERNATIONAL STANDARD

ISO 17636-1

Second edition
2022-07

Non-destructive testing of welds — Radiographic testing —

Part 1: X- and gamma-ray techniques with film

Essais non destructifs des assemblages soudés — Contrôle par radiographie —

Partie 1: Techniques par rayons X ou gamma à l'aide de film

Reference number
ISO 17636-1:2022(E)

© ISO 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
Website: www.iso.org

Published in Switzerland

© ISO 2022 – All rights reserved

Contents

Page

Foreword ..... **v**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **2**

4 Symbols and abbreviated terms **3**

5 Classification of radiographic techniques **4**

6 General preparations and requirements **4**
6.1 Protection against ionizing radiation 4
6.2 Surface preparation and stage of manufacture 4
6.3 Location of the weld in the radiograph 5
6.4 Identification of radiographs 5
6.5 Marking 5
6.6 Overlap of films 5
6.7 Types and positions of image quality indicators (IQIs) 5
6.8 Evaluation of image quality 6
6.9 Minimum image quality values 6
6.10 Personnel qualification 7

7 Recommended techniques **7**
7.1 Test arrangements 7
7.1.1 General 7
7.1.2 Single-wall penetration of plane objects (see Figure 1) 8
7.1.3 Single-wall penetration of curved objects with the source outside the object (see Figures 2 to 4) 8
7.1.4 Single-wall penetration of curved objects with the source inside the object for panoramic exposure (see Figures 5 to 7) 9
7.1.5 Single-wall penetration of curved objects with the source located off-centre and inside the object (see Figures 8 to 10) 10
7.1.6 Double-wall penetration and double-image evaluation (DWDI) of pipes with the elliptic technique and the source and the film outside the object (see Figure 11) 11
7.1.7 Double-wall penetration and double-image evaluation (DWDI) with the perpendicular technique and source and film outside the object (see Figure 12) 11
7.1.8 Double-wall penetration and single-image evaluation (DWSI) of curved objects for evaluation of the wall next to the film (see Figures 13 to 16) 11
7.1.9 Penetration of objects with different material thicknesses (see Figure 17 to 19) 13
7.2 Choice of tube voltage and radiation source 13
7.2.1 X-ray devices up to 1 000 kV 13
7.2.2 Other radiation sources 14
7.3 Film systems and metal screens 15
7.4 Alignment of beam 17
7.5 Reduction of scattered radiation 17
7.5.1 Metal filters and collimators 17
7.5.2 Interception of backscattered radiation 17
7.6 Source-to-object distance 18
7.7 Maximum area for a single exposure 20
7.8 Optical density of radiograph 20
7.9 Processing 21
7.10 Film viewing conditions 21

8 Test report **21**

© ISO 2022 – All rights reserved

Annex A (normative) **Number of exposures for acceptable testing of a circumferential butt weld** **23**
Annex B (normative) **Minimum image quality values** **28**
Annex C (informative) **Calculation of maximum X-ray tube voltages from Figure 20** **35**
Bibliography **36**

© ISO 2022 – All rights reserved

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 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 17636-1:2013), which has been technically revised.

The main changes are as follows:

— the normative references have been updated;

— the Figures have been updated;

— references to Figures 1 to 19 have been updated throughout the document;

— in 6.7 the use of ASTM wires and other image quality indicators (IQIs) by agreement of contracting parties has been added;

— in 6.7 a) the acceptance of a shorter wire visibility than 10 mm for pipes with an external diameter < 50 mm has been added;

— in 6.7, 6.8 and 6.9 a clarification for the IQI usage for the double-wall double-image (DWDI) technique has been added;

— in 6.9 and 7.2.2 the lower thickness limit for Se 75 applications has been deleted;

— measurement of optical density in the root of the weld has been clarified;

— IQI use for the DWDI technique has been clarified.

A list of all parts in the ISO 17636 series can be found on the ISO website.

© ISO 2022 – All rights reserved

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. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

© ISO 2022 – All rights reserved

Non-destructive testing of welds — Radiographic testing —

Part 1:
X- and gamma-ray techniques with film

1 Scope

This document specifies techniques of radiographic testing of fusion-welded joints in metallic materials using industrial radiographic film techniques with the object of enabling satisfactory and repeatable results. The techniques are based on generally recognized practice and fundamental theory of the subject.

It applies to the joints of plates and pipes in metallic materials. Besides its conventional meaning, "pipe" as used in this document covers other cylindrical bodies, such as tubes, penstocks, boiler drums and pressure vessels.

This document does not specify acceptance levels for any of the indications found on the radiographs. The ISO 10675 series provides information on acceptance levels for weld evaluation.

If contracting parties apply lower test criteria, it is possible that the quality achieved will be significantly lower than when this document is strictly applied.

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 5576, *Non-destructive testing — Industrial X-ray and gamma-ray radiology — Vocabulary*

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

ISO 11699-1, *Non-destructive testing — Industrial radiographic film — Part 1: Classification of film systems for industrial radiography*

ISO 11699-2, *Non-destructive testing — Industrial radiographic films — Part 2: Control of film processing by means of reference values*

ISO 19232-1, *Non-destructive testing — Image quality of radiographs — Part 1: Determination of the image quality value using wire-type image quality indicators*

ISO 19232-2, *Non-destructive testing — Image quality of radiographs — Part 2: Determination of the image quality value using step/hole-type image quality indicators*

ISO 19232-4, *Non-destructive testing — Image quality of radiographs — Part 4: Experimental evaluation of image quality values and image quality tables*

ASTM E 747, *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology*

EN 12543 (all parts), *Non-destructive testing — Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing*

EN 12679, *Non-destructive testing — Radiographic testing — Determination of the size of industrial radiographic gamma sources*

© ISO 2022 – All rights reserved

JIS Z2306, *Radiographic image quality indicators for non-destructive testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5576 and the following 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
nominal thickness
t
thickness of the parent material only where manufacturing tolerances do not have to be considered

3.2
penetration thickness change
Δt
change of *penetrated thickness* (3.3) relative to the *nominal thickness* (3.1) due to beam angle

3.3
penetrated thickness
w
thickness of material in the direction of the radiation beam calculated on the basis of the *nominal thicknesses* (3.1) of all penetrated walls

3.4
object-to-film distance
b
distance between the radiation side of the radiographed part of the test object and the film surface, measured along the central axis of the radiation beam

Note 1 to entry: The abbreviated term OFD can also be used.

3.5
source size
d
size of the radiation source or focal spot size

Note 1 to entry: See the EN 12543 series or EN 12679.

3.6
source-to-film distance
SFD
distance between the source of radiation and the film, measured in the direction of the beam

Note 1 to entry: $SFD = f + b$

where

f is *source-to-object distance* (3.7);

b is *object-to-film distance* (3.4).

© ISO 2022 – All rights reserved

3.7
source-to-object distance
f
distance between the source of radiation and the source side of the test object, measured along the central axis of the radiation beam

Note 1 to entry: The abbreviated term SOD can also be used.

3.8
external diameter
D_e
nominal diameter of the outer surface of the pipe

3.9
weld area to evaluate
WAE
area to be evaluated on the radiograph, which contains the weld and the *heat-affected zone* (3.11) on both sides

3.10
area of interest
AoI
minimum area which should be evaluated on the radiograph and which contains the weld, the *heat-affected zone* (3.11) on both sides and all lead letters, markers and image quality indicators (IQIs)

3.11
heat-affected zone
HAZ
area beside the weld influenced by the heating and cooling process of the welding

Note 1 to entry: This is considered to be the two areas beside the weld, each with the same width as the weld cap but with at least 10 mm to be considered for evaluation.

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in Table 1 apply.

Table 1 — Symbols and abbreviated terms

Symbol or abbreviated term	Definition
AoI	area of interest
b	object-to-film distance
b'	object-to-film distance perpendicular to test object
d	source size, focal spot size (see EN 12679 and the EN 12543 series)
D_e	external diameter
d_f	value of the diagonal extension of the film, used for testing
DWDI	double-wall double-image
DWSI	double-wall single-image
f	source-to-object distance
f'	source-to-object distance perpendicular to test object
F	film
f_{min}	minimum source-to-object distance
NOTE The source-to-detector-distance (SDD), as used in digital radiography (see ISO 17636-2), is equivalent to SFD in film radiography.	

© ISO 2022 – All rights reserved