INTERNATIONAL STANDARD

ISO 20769-2

First edition
2018-09

Non-destructive testing — Radiographic inspection of corrosion and deposits in pipes by X- and gamma rays —

Part 2: Double wall radiographic inspection

Essais non destructifs — Examen radiographique de la corrosion et des dépôts dans les canalisations, par rayons X et rayons gamma —

Partie 2: Examen radiographique double paroi

Reference number
ISO 20769-2:2018(E)

© ISO 2018



COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

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
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

 © ISO 2018 – All rights reserved

Contents

Page

Foreword ..... **v**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **2**

4 Classification of radiographic techniques **3**

5 General **3**
5.1 Protection against ionizing radiation 3
5.2 Personnel qualification 4
5.3 Identification of radiographs 4
5.4 Marking 4
5.5 Overlap of films or digital images 4
5.6 Types and positions of image quality indicators (IQI) 4
5.6.1 Single wire IQI 4
5.6.2 Duplex wire IQI (digital radiographs) 5

6 Recommended techniques for making radiographs **5**
6.1 Test arrangements 5
6.1.1 General 5
6.1.2 Double wall single image (DWSI) 5
6.1.3 Double wall double image (DWDI) 7
6.1.4 Alignment of beam and film/detector 9
6.2 Choice of radiation source 9
6.3 Film systems and screens 10
6.4 Screens and shielding for imaging plates (computed radiography only) 11
6.5 Reduction of scattered radiation 13
6.5.1 Filters and collimators 13
6.5.2 Interception of back scattered radiation 13
6.6 Source-to-detector distance 13
6.6.1 Double wall single image 13
6.6.2 Double wall double image 14
6.7 Axial coverage and overlap 14
6.8 Circumference coverage 15
6.8.1 General 15
6.8.2 DWSI 16
6.8.3 DWDI 16
6.9 Selection of digital radiographic equipment 16
6.9.1 General 16
6.9.2 CR systems 17
6.9.3 DDA systems 17

7 Radiograph/digital image sensitivity, quality and evaluation **17**
7.1 Minimum image quality values 17
7.1.1 Wire image quality indicators 17
7.1.2 Duplex wire IQIs (digital radiographs) 17
7.1.3 Minimum normalized signal to noise ratio (digital radiographs) 17
7.2 Density of film radiographs 18
7.3 Film processing 18
7.4 Film viewing conditions 18

8 Measurement of differences in penetrated thickness **18**
8.1 Principle of technique 18
8.2 Measurement of attenuation coefficient 19
8.3 Source and detector positioning 19
8.4 Image grey level profiles 19
8.5 Validation 19

© ISO 2018 – All rights reserved

8.6 Key points 20
9 Digital image recording, storage, processing and viewing 20
9.1 Scan and read out of image 20
9.2 Calibration of DDAs 20
9.3 Bad pixel interpolation 20
9.4 Image processing 21
9.5 Digital image recording and storage 21
9.6 Monitor viewing conditions 21
10 Test report 21
Annex A (normative) **Minimum image quality values 23**
Annex B (normative) **Penetrated thickness measurements from image grey levels 25**
Annex C (normative) **Determination of basic spatial resolution 27**
Bibliography 30

 © ISO 2018 – 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 135 *Non-destructive testing*, Subcommittee SC 5 *Radiographic testing*.

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.

A list of all parts in the ISO 20769 series can be found on the ISO website.

© ISO 2018 – All rights reserved

Non-destructive testing — Radiographic inspection of corrosion and deposits in pipes by X- and gamma rays —

Part 2: Double wall radiographic inspection

1 Scope

This document specifies fundamental techniques of film and digital radiography with the object of enabling satisfactory and repeatable results to be obtained economically. The techniques are based on generally recognized practice and fundamental theory of the subject.

This document applies to the radiographic examination of pipes in metallic materials for service induced flaws such as corrosion pitting, generalized corrosion and erosion. Besides its conventional meaning, "pipe" as used in this document is understood to cover other cylindrical bodies such as tubes, penstocks, boiler drums and pressure vessels.

Weld inspection for typical welding process induced flaws is not covered, but weld inspection is included for corrosion/erosion type flaws.

The pipes can be insulated or not, and can be assessed where loss of material due, for example, to corrosion or erosion is suspected either internally or externally.

This document covers double wall inspection techniques for detection of wall loss, including double wall single image (DWSI) and double wall double image (DWDI).

Note that the DWDI technique described in this document is often combined with the tangential technique covered in ISO 20769-1.

This document applies to in-service double wall radiographic inspection using industrial radiographic film techniques, computed digital radiography (CR) and digital detector arrays (DDA).

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 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 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors*

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 19232-5, *Non-destructive testing — Image quality of radiographs — Part 5: Determination of the image unsharpness value using duplex wire-type image quality indicators*

© ISO 2018 – All rights reserved

ISO 20769-1, *Non-destructive testing of welds — Radiographic inspection of corrosion and deposits in pipes by X- and gamma rays — Part 1: Tangential radiographic inspection*

EN 14784-1, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 1: Classification of systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20769-1 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 http://www.electropedia.org/

3.1
digital detector array system
DDA system
electronic device converting ionizing or penetrating radiation into a discrete array of analogue signals which are subsequently digitized and transferred to a computer for display as a digital image corresponding to the radiologic energy pattern imparted upon the input region of the device

3.2
double wall double image technique
DWDI
technique where the radiation source is located outside and away from the pipe, with the detector on the opposite side of the pipe and where the radiograph shows details from both the pipe walls on the detector and source sides of the pipe

Note 1 to entry: See Figure 3.

3.3
double wall single image technique
DWSI
technique where the radiation source is located outside the pipe and close to the pipe wall, with the detector on the opposite side of the pipe and where the radiograph shows only detail from the pipe wall on the detector side

Note 1 to entry: See Figure 1.

3.4
object-to-detector distance
b
distance between the radiation side of the test object and the detector surface measured along the central axis of the radiation beam

3.5
penetrated thickness
w
thickness of material in the direction of the radiation beam calculated on the basis of the nominal thickness

Note 1 to entry: For double wall radiographic inspection of a pipe, the minimum value for w is twice the pipe wall thickness. For multiple wall techniques (pipes in pipe or liners), the penetrated thickness is calculated from the nominal wall thicknesses t.

© ISO 2018 – All rights reserved

3.6
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

3.7
total effective penetrated thickness
w_{tot}
total equivalent thickness of metallic material in the direction of the radiation beam calculated on the basis of the nominal thickness, with allowance for any liquid or other material present in the pipe and any insulation

4 Classification of radiographic techniques

The double wall radiographic techniques are divided into two classes:

— basic techniques DWA;

— improved techniques DWB.

The basic techniques are intended for double wall radiography of generalized and localized wall loss.

For the basic techniques, DWA, when using Ir 192 sources for pipes with penetrated thicknesses between 15 mm and 35 mm, the sensitivity for detection is high for imperfections, provided their diameters are greater than or equal to 2 mm and the material loss is typically greater than or equal to 5 % of the pipe penetrated thickness, in the absence of liquid or other products in the pipe. When using Se 75, the corresponding detection sensitivity is high for 2 mm diameter or larger imperfections with material loss greater than or equal to 4 % of the pipe penetrated thickness. The detection sensitivity is improved for flaws with larger diameters, whereas the presence of liquid or other products, and external insulation, can reduce the sensitivity for material loss depending on their properties. Different detection sensitivities may apply for penetrated thicknesses less than 15 mm and greater than 35 mm.

The presence of external corrosion product can reduce the techniques sensitivity to corrosion due to the increased radiation attenuation in the product, which can even exceed the reduced attenuation caused by the loss of steel. Build-up of internal solid material (e.g. scale) in pipes can similarly reduce sensitivity to internal degradation.

These techniques can also be used for detection of deposits inside the pipe.

The improved techniques should be used where higher sensitivity is required such as for radiography of fine, localized corrosion pitting.

Further improvements, beyond the improved techniques described herein, are possible and may be agreed between the contracting parties by specification of all appropriate test parameters.

The choice of radiographic technique shall be agreed between the concerned parties.

5 General

5.1 Protection against ionizing radiation

WARNING — Exposure of any part of the human body to X-rays or gamma-rays can be highly injurious to health. Wherever X-ray equipment or radioactive sources are in use, appropriate measures shall be taken to ensure the safety and health of personnel.

© ISO 2018 – All rights reserved