



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 40385-2021

**Non-destructive testing of steel tubes - Digital radiographic
testing of the weld seam of welded steel tubes for the detection
of imperfections**

Issued on: August 20, 2021

Implemented on: March 1, 2022

Issued by: SAMR; SAC

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1 Scope

This document specifies the requirements for X-ray digital testing techniques of the longitudinal weld seam or helical weld seam of automatic fusion arc-welded steel tubes for the detection of imperfections, including the radiographic testing of computed radiography (CR) or digital detector arrays (DDAs). This document also specifies the acceptance levels and calibration procedures of digital radiographic testing.

This document also applies to the testing of circular hollow sections.

Note: The digital radiographic testing method is used as an alternative of film-based radiographic X-ray testing, as shown in ISO 10893-6 [8].

2 Normative references

The following documents are normatively referenced in this document and are indispensable for its application. For dated references, only the version corresponding to that date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

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 11484, Steel products - Employer's qualification system for non-destructive testing (NDT) personnel

ISO 17636-2:2013, 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 19232-2, Non-destructive testing - Image quality of radiographs - Part 2:

Determination of the image quality value using step/hole-type image quality indicators

ISO 19232-5, Non-destructive testing - Image quality of radiographs - Part 5:

Determination of the image unsharpness and basic spatial resolution value using duplex wire-type image quality indicators

3 Terms and definitions

Terms and definitions determined by ISO 5576 and ISO 11484, as well as the following, are applicable to this document.

3.1 Tube

Hollow elongated product, open at both ends, of any cross-sectional shape.

3.2 Welded tube

Tube (3.1) made by welding together adjacent edges of a flat rolled product. After welding, it can be processed by cold working or hot working to obtain the final dimensions.

3.3 Manufacturer

Organization that produces and manufactures products in accordance with relevant standards and declares the conformity of the delivered products with all applicable provisions of the standards.

3.4 Agreement

Contractual agreement between the manufacturer (3.3) and the purchaser at the time of enquiry and order.

3.5 Signal-to-noise ratio

SNR S/N Ratio of the average value of the linearized grey values TO the standard deviation of the linearized grey values (noise) in a given region in a digital image.

[Source: ISO 17636-2:2013, 3.10, modified: The symbol S/N is added.]

3.6 Spatial basic resolution of a digital detector

RbSdetector The employer shall issue a testing (operation) authorization according to a written procedure. The non-destructive testing (NDT) shall be authorized by a level 3 NDT personnel approved by the employer.

Note: The definitions of levels 1, 2 and 3 personnel are shown in relevant standards such as ISO 9712 and ISO 11484.

4.3 The tube under test shall be straight enough and shall be free of foreign matters, so as to ensure the validity of the test. Surfaces of the weld seam and the adjacent base material shall be free of foreign matters and surface irregularities, which may interfere with the interpretation of the radiographic testing.

To gain an acceptable surface quality of the finished product, surface grinding is permitted.

4.4 When the weld reinforcement is removed, markers (usually lead arrows) shall be

placed on both sides of the weld seam, so that the position of the weld seam can be identified on the radiographic image; alternatively, an integrated automatic positioning system can be used to identify the position of the weld seam.

4.5 Usually, the identification symbol, in the form of lead letters, shall be placed on

each part of the weld seam radiograph such that the lead letters are projected on the radiographic image, so that the weld seam of each part can be clearly identified in the radiographic image; alternatively, an integrated automatic positioning system can be used to identify the position of the tube weld seam corresponding to each radiographic image.

4.6 Marks shall be displayed on the radiographic images to provide accurate position

reference points for each radiographic image; alternatively, the automatic measurement may be carried out on the digital image viewing screen by software to achieve accurate positioning of the image.

4.7 When the size of the detector is smaller than the length of the penetrated weld

seam, the steel tube or the detector shall be moved in a step-by-step mode, and the digital radiographic testing shall be performed when the steel tube is not moving.

Warning - Exposure of any part of the human body to X-rays can be highly injurious to health. Wherever X-ray equipment is used, appropriate safety measures shall be applied. National safety precautions shall be strictly applied.

5 Test equipment

The following digital imaging methods can be used instead of the radiographic film testing:

- a) Computed radiography (CR) using storage fluorescent material imaging plates (such as EN 14784-1[21] or GB/T 21355[1], EN 14784-2[22] or GB/T 26642[2]);
- b) Radiology using digital detector arrays (such as ASTM E2597-07[14] or GB/T 38240[4], ASTM E2698[15] or GB/T 35388[3]);
- c) Digital radiographic testing method using image integration (such as EN 13068-1[18] or GB/T 23909.1[5], EN 13068-2[19] or GB/T 23909.2[6], EN 13068-3[20] or GB/T 23909.3[7]).

6.1 The digital radiographic testing technique specified in a) ~ c) of Chapter 5 shall

be used to inspect the weld seam.

6.2 According to the provisions of ISO 17636-2, the image quality classes shall be divided into A and B:

- a) Class A: basic technique;
- b) Class B: enhanced technique.

Note: Class A imaging technique is used in most cases. Class B imaging technique is used when enhanced sensitivity is required to visualize all imperfections being detected.

The required image quality class should be specified in the relevant product standard.

6.3 The digital-to-image display shall meet the technical requirements of Class A or

Class B.