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**Digital radiographic examination for the
weld seam of welded steel tubes**

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In the event of any doubts arising as to the contents,
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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 General requirements	4
4.1 Timing of inspection	4
4.2 Inspection operators	4
4.3 Steel tube properties	4
4.4 Identification of weld seam position	4
4.5 Identification symbols	4
4.6 Markings	5
4.7 Image exposure	5
5 Digital imaging methods	5
6 Test method	5
6.1 General	5
6.2 Image quality classes	5
6.3 Digital image	6
6.4 Direction of the beam of radiation	6
6.5 Diagnostic length	6
6.6 Exposure techniques	6
6.7 Detector-to-weld distance	6
6.8 DDA systems	7
6.9 Exposure conditions	8
6.10 X-ray tube voltage	8
7 Image quality	9
7.1 Image quality and image quality indicator	9
7.2 Basic spatial resolution of detector	10
7.3 Image quality classes	10
7.4 Image quality of the double wall penetration technique	13
7.5 Application of representative quality indicators (RQIs)	13
8 Image processing	16
8.1 Evaluation of image	16
8.2 Additional image processing	17
9 Classification of indications	17
9.1 Classification	17

9.2	Imperfections	17
9.3	Defects	17
10	Acceptance limits	17
10.1	General	17
10.2	Cracks, incomplete penetration and lack of fusion	17
10.3	Slag inclusions and gas pockets	17
10.4	Elongated imperfections	17
10.5	Undercuts	18
10.6	Undercuts on the inside and outside welds	18
11	Acceptance	18
11.1	Steel tubes without defects	18
11.2	Tubes with defects	18
11.3	Handling of suspect tubes	18
12	Image storage and display	19
13	Test report	19
Annex A (informative)	Examples of distribution of imperfections	21
Annex JA (informative)	Comparison table between JIS and corresponding International Standard	26

Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS G 0804**:2015), which has been technically revised.

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Digital radiographic examination for the weld seam of welded steel tubes

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 10893-7 : 2019**, Edition 2, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies requirements for digital radiographic X-ray testing of the longitudinal or helical weld seams of automatic fusion arc-welded steel tubes (hereafter referred to as steel tubes) for the detection of imperfections.

NOTE 1 As an alternative, see JIS G 0803 established based on **ISO 10893-6** for film radiographic testing.

NOTE 2 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 10893-7 : 2019 *Non-destructive testing of steel tubes — Part 7 : Digital radiographic testing of the weld seam of welded steel tubes for the detection of imperfections* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS G 0431 *Steel products — Employer's qualification system for non-destructive testing (NDT) personnel*

JIS Z 2300 *Terms and definitions of nondestructive testing*

JIS Z 2305 *Non-destructive testing — Qualification and certification of NDT personnel*

JIS Z 2306 *Radiographic image quality indicators for non-destructive testing*

JIS Z 2307 *Determination of the image unsharpness value using duplex wire-type*

image quality indicators

JIS Z 3110 *Non-destructive testing of welded joints — Methods of radiographic testing for 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*

ASNT SNT-TC-1A *Recommended Practice No. SNT-TC-1A, and ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel (ANSI/ASNT CP-105)*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions, and those given in **JIS G 0203**, **JIS G 0431** and **JIS Z 2300** apply.

3.1

tube

hollow long product open at both ends

3.2

welded steel tube

steel tube made by forming a hollow profile from a flat steel product and welding adjacent edges together

Note 1 to entry It can be further processed after welding, either hot or cold, into its final dimensions.

3.3

manufacturer

organization that manufactures products in accordance with the relevant standard(s) and declares the conformity of the delivered products with all applicable provisions of the relevant standard(s)

3.4

SN ratio, signal-to-noise ratio (SNR)

ratio of mean value of the linearized grey values to the standard deviation of the linearized grey values (noise) in a given region of interest in a digital image

3.5

basic spatial resolution of a digital detector, SR_b^{detector}

resolution that corresponds to half of measured detector unsharpness in a digital im-

age and to the effective pixel size, and indicates the smallest geometrical detail, which can be resolved with a digital detector at a magnification equal to one

- Note 1 to entry For this measurement, the duplex wire type image quality indicator (IQI) is placed directly on the digital detector array or imaging plate.
- Note 2 to entry The measurement of unsharpness is described in **JIS Z 2307**, see also **ASTM E2736** and **ASTM E1000**.
- Note 3 to entry In the corresponding International Standard, the symbol SR_b^{detector} has been changed to R_{bs}^{detector} .

3.6

basic spatial resolution of a digital image, SR_b^{image}

resolution that corresponds to half of total unsharpness in a digital image and to the effective pixel size, and indicates the smallest geometrical detail, which can be resolved in a digital image

- Note 1 to entry For this measurement, the duplex wire type image quality indicator (IQI) is placed directly on the test object (source side).
- Note 2 to entry The measurement of unsharpness is described in **JIS Z 2307**.
- Note 3 to entry In magnification exposure technique using a small focal spot, SR_b^{image} is used for basic spatial resolution, SR_b .

3.7

representative quality indicator, RQI

real part, or a fabrication of similar geometry in radiologically similar material to a real part, that has features of known characteristics that represent those features of interest for which the parts to be purchased are being examined

3.8

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

3.9

imaging plate method, CR method

radiographic test method using an integrated system comprised of a corresponding output unit which converts the information recorded on an imaging plate (storage phosphor) to a digital image

- Note 1 to entry Computed radiography (CR) is defined in **JIS Z 2300** as “procedure to carry out the radiography by using an imaging plate in place of X-ray film and to obtain the digital image read by laser”.

3.10

digital array method, DDA method

radiographic test method using a digital detector array system (3.8)

4 General requirements

4.1 Timing of inspection

Unless otherwise specified by the product standard or agreed on by the manufacturer and the purchaser, a radiographic inspection specified by this Standard shall be carried out on tubes after completion of all the primary production process operations (rolling, heat treating, cold and hot working, sizing, primary straightening, etc.)

4.2 Inspection operators

This inspection shall be carried out by trained operators who are certified (e.g. **JIS Z 2305**) or qualified (e.g. **JIS G 0431** or **ASNT SNT-TC-1A**), and supervised by competent personnel nominated by the manufacturer. In the case of third-party inspection, this shall be agreed on between the manufacturer and the purchaser.

The operating authorization issued by the employer shall be according to a written procedure. Non-destructive testing (NDT) operations shall be authorized by a level 3 NDT individual approved by the employer.

NOTE The definitions of level 1, 2 and 3 can be found in the appropriate standards, e.g. **JIS G 0431** and **JIS Z 2305**.

4.3 Steel tube properties

The steel tubes under test shall be sufficiently straight and free of foreign matter as to ensure the validity of the test. The surfaces of the weld seam and adjacent parent metal shall be sufficiently free of such foreign matter and surface irregularities ¹⁾, which can interfere with the interpretation of the radiographs.

Note ¹⁾ Scratches, craters or other defects which can interfere with the interpretation.

Surface grinding is permitted in order to achieve an acceptable surface finish.

4.4 Identification of weld seam position

In cases where the weld reinforcement is removed, markers, usually in the form of lead arrows, shall be placed on each side of the weld seam such that its position can be identified on the radiograph. Alternatively, an integrated automatic positioning system may be used to identify the position of the weld seam.

4.5 Identification symbols

Identification symbols, usually in the form of lead letters, shall be placed on each section of the weld seam radiograph such that the projection of these symbols appears in each radiographic image to ensure unequivocal identification of the section. Alternatively, an integrated automatic positioning system may be used to identify the position of each radiographic image along the weld seam of the steel tube.

4.6 Markings

Markings shall be displayed on the recorded radiographic images to provide reference points for the accurate relocation of the position of each radiograph. Alternatively, the automated measured image position may be displayed on the digital image viewing screen by software for accurate position relocation.

4.7 Image exposure

When the detector size is smaller than the applicable weld length, the tube or the detector shall move into start-stop mode and digital radiographs shall be taken when the steel tube is not moving.

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 safety measures shall be applied.

Local, national or international safety precautions when using ionizing radiation shall be strictly applied.

5 Digital imaging methods

One of the following digital imaging methods shall be used.

- a) Computed radiography (CR) with storage phosphor imaging plates

NOTE 1 Examples can be found in ASTM E2033, ASTM E2446, EN 14784-1 and EN 14784-2.

- b) Radiology with digital detector arrays (DDA)

NOTE 2 Examples can be found in ASTM E2597 and ASTM E2698.

- c) Digital radioscopy (with image integration)

NOTE 3 Examples can be found in EN 13068-1, EN 13068-2 and EN 13068-3.

6 Test method

6.1 General

The weld shall be tested by a digital radiographic technique, corresponding to 5 a) to 5 c).

6.2 Image quality classes

Two image quality classes A and B, in accordance with JIS Z 3110, shall be specified :

- class A : X-ray examination technique with standard sensitivity;
- class B : X-ray examination technique with enhanced sensitivity.

NOTE Most applications are covered by the use of image quality class A. Image quality class B is intended exclusively for more important and difficult applications.