

# JIS

## **JAPANESE INDUSTRIAL STANDARD**

### **Methods of radiographic examination for welded joints in steel**

**JIS Z 3104—1995**

**Translated and Published**

**by**

**Japanese Standards Association**

JIS Z\*3104 95 ■ 4933608 0526932 661 ■

In the event of any doubt arising,  
the original Standard in Japanese is to be final authority.

## JAPANESE INDUSTRIAL STANDARD

J I S

Methods of radiographic examination  
for welded joints in steel

Z 3104-1995

1. Scope This Japanese Industrial Standard specifies the methods of radiographic examination for welded joints in steel by the direct radiography by X-ray or  $\gamma$ -ray (hereafter referred to as "radiation") using X-ray films for industrial use.

Remarks 1. The standards cited in this Standard are as follows:

- JIS G 3101 Rolled steel for general structure
- JIS G 4304 Hot rolled stainless steel plates, sheets and strip
- JIS G 4305 Cold rolled stainless steel plates, sheets and strip
- JIS K 7652 Photography – Density measurements - Part 2:  
Geometric conditions for transmission density [ISO 5-2: 1991]
- JIS K 7653 Photography – Density measurements - Part 3:  
Spectral conditions [ISO 5-3: 1984]
- JIS Z 2300 Glossary of terms used in nondestructive testing
- JIS Z 2306 Radiographic image quality indicators for non-destructive testing
- JIS Z 3861 Standard qualification procedure for radiographic testing technique of welds
- JIS Z 4560 Industrial  $\gamma$ -ray apparatus for radiography
- JIS Z 4561 Viewing illuminators for industrial radiograph
- JIS Z 4606 Industrial X-ray apparatus for radiographic testing

2. The corresponding International standards of this standard are given in the following:

- ISO 1106/1 : 1984 Recommended practice for radiographic examination of fusion welded joints – Part 1:  
Fusion welded butt joints in steel plates up to 50 mm thick
- ISO 1106/2 : 1985 Recommended practice for radiographic examination of fusion welded joints – Part 2:  
Fusion welded butt joints in steel plates thicker than 50 mm and up to and including 200 mm in thickness
- ISO 1106/3 : 1984 Recommended practice for radiographic examination of fusion welded joints – Part 3:  
Fusion welded circumferential joints in steel pipes of up to 50 mm wall thickness
- ISO 5579 : 1984 Non-destructive testing – Radiographic examination of metallic materials by X- and gamma rays – Basic rules

2. **Definitions** The definitions of principal terms used in this Standard shall be in accordance with those given in JIS Z 2300 apply, and others shall be as specified in the following:

- (1) **thickness of base metal** The nominal thickness of steel being used. When the thickness of the base metal is different on both sides of the joint, as a rule, the smaller value of the thickness shall be taken.
- (2) **test part** The part including the weld metal and the heat affected zone under examination.

3. **Kind of image quality of radiograph** The image quality of the radiograph shall be classified into 5 kinds of class A, class B, class P1, class P2 and class F. Class A can be obtained in the regular radiographic technique, and class B can be obtained by the radiographic technique with greater sensitivity in the detection of flaws. Class P1 is the regular image quality obtained when one side of the circumferential welded joint in the steel pipe is radiographically examined and class P2 is the regular image quality when both sides of the circumferential welded joint in the steel pipe is radiographically examined, respectively, with respect to the radiographing method where the radiation penetrates double walls of the pipe of the circumferential welded joint in the steel pipe. Class F is the regular image quality obtained by the radiographic examination of T welded joint.

Those image qualities shall be applied as shown in Table 1 according to the type of the welded joint.

Table 1. Classification of application of image quality of radiograph

| Type of welded joint                                                                                                                           | Kind of image quality                |
|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| Butt welded joint in steel plates and other welded joints deemed as equivalent thereto in geometric conditions in the radiographic examination | Class A, Class B                     |
| Circumferential welded joint in steel pipes                                                                                                    | Class A, Class B, Class P1, Class P2 |
| T-welded joint in steel plates                                                                                                                 | Class F                              |

4. **Examination engineer** The examination engineers in charge of radiographic testing shall be those who passed the tests in accordance with JIS Z 3861 or those of ability at least equivalent thereto.

#### 5. **Radiographic testing apparatus and its accessories**

5.1 **Radiographic testing apparatus** The radiographic testing apparatus shall be the X-ray apparatus specified in JIS Z 4606, the X-ray generating apparatus by the electron accelerator, the  $\gamma$ -ray apparatus specified in JIS Z 4560 or any other apparatus with performance at least equivalent thereto.

**5.2 Sensitive material** The X-ray film for industrial use (hereafter referred to as "film") shall be of low sensitivity and ultra super-fine particle type, low sensitivity and super-fine particle type, medium sensitivity and fine particle type or high sensitivity and fine particle type. When the intensifying screen is used, the lead foil intensifying screen, the fluorescent intensifying screen or the metallic fluorescent intensifying screen shall be used.

**5.3 Penetrameter** The penetrameter shall be general type one of type F or type S penetrameter specified in JIS Z 2306 or those at least equivalent thereto in performance.

For making radiograph of the circumferential welded joint, as a rule, the strip-shaped penetrameter of type F or type S shall be used, but general type penetrameter of type F or type S or those at least equivalent thereto in performance may be used.

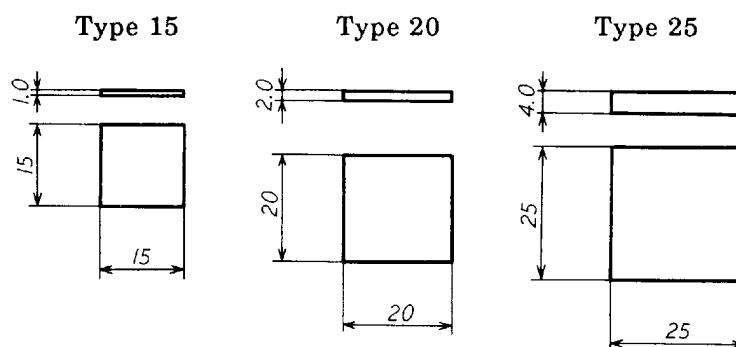
**5.4 Contrast indicator** The type, structure, dimensions and material of the contrast indicator shall be as follows:

- (1) The type, structure and dimensions of the contrast indicator shall be as shown in Fig. 1.

The dimensional tolerances for the contrast indicator shall be  $\pm 5\%$  for thickness, and  $\pm 0.5$  mm for side length.

- (2) The material of the contrast indicator shall be steels specified in JIS G 3101, SUS 304 specified in JIS G 4304, or SUS 304 specified in JIS G 4305.

Fig. 1 Type, structure and dimensions of contrast indicator



**5.5 Viewing illuminator** The viewing illuminator shall be one specified in JIS Z 4561 or that at least equivalent thereto in performance.

**5.6 Densitometer** The densitometer which conforms to JIS K 7652 and JIS K 7653 shall be used.

## 6. Technique for making radiograph

**6.1 Combination of radiation source with sensitive material** The radiation source shall be combined with the sensitive material so as to identify the minimum perceptible wire diameter of the penetrameter.

**6.2 Symbol** Symbols shall be used so as to collate the radiograph with the records in making radiograph.

**6.3 Radiation field** The radiation field is preferably not increased more than required by using a diaphragm or a tubular diaphragm in making radiograph.

**6.4 Technique for making radiograph** The technique for making radiograph shall be in accordance with the Annex shown in Table 2 according to the type of the welded joint.

Table 2. Annex to specify radiographing method

| Type of welded joint                                                                                                                           | Annex   |
|------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Butt welded joint in steel plates and other welded joints deemed as equivalent thereto in geometric conditions in the radiographic examination | Annex 1 |
| Circumferential welded joint in steel pipes                                                                                                    | Annex 2 |
| T-welded joint in steel plates                                                                                                                 | Annex 3 |

**7. Necessary conditions for radiograph** Necessary conditions for the radiograph having been taken shall be in accordance with Annex shown in Table 3 according to the type of the welded joint.

Further, the radiograph shall be free from irregular development, defects in the film or the like which may interfere evaluation of the image quality and classification of the image of the flaw.

Table 3. Annex to specify necessary conditions for radiograph

| Type of welded joint                                                                                                                           | Annex   |
|------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Butt welded joint in steel plates and other welded joints deemed as equivalent thereto in geometric conditions in the radiographic examination | Annex 1 |
| Circumferential welded joint in steel pipes                                                                                                    | Annex 2 |
| T-welded joint in steel plates                                                                                                                 | Annex 3 |

## 8. Interpretation of radiograph

8.1 Viewing illuminator The viewing illuminator specified in 5.5 shall be used according to the classification shown in Table 4 in the interpretation of the radiograph.

Table 4. Classification of application of viewing illuminator

| Type of viewing illuminator | Maximum density of radiograph <sup>(1)</sup> |
|-----------------------------|----------------------------------------------|
| Type D10                    | 1.5 or under                                 |
| Type D20                    | 2.5 or under                                 |
| Type D30                    | 3.5 or under                                 |
| Type D35                    | 4.0 or under                                 |

Note<sup>(1)</sup> Maximum value of the density shown in the test part on the individual radiographs.

8.2 Viewing method The radiograph shall be evaluated by using a fixed mask suitable for the dimensions of the radiograph in a darkened room.

9. Method for classification of image of flaw The image of flaws on a radiograph shall be classified in accordance with Annex 4.

10. Records The test results shall include the following items to enable to collate the records with the tested part.

(1) Items related to test part

(1.1) Builder or manufacturer

(1.2) Name of work or product

(1.3) Symbol or number of location of test part

(1.4) Material

(1.5) Thickness of base metal (wall thickness and outside diameter of pipe)

(1.6) Type of welded joint (with/without weld reinforcement)

(2) Date of making radiograph

(3) Affiliation and name of examination engineer

(4) Test conditions

(4.1) Apparatus and material being used

- (a) Name of radiograph test equipment and its effective focal spot
  - (b) Type of film and intensifying screen
  - (c) Type of penetrameter
  - (d) Type of contrast indicator
- (4.2) Conditions of radiography
- (a) Voltage of tube being used or kind of radio-isotope
  - (b) Current of tube being used or intensity of radioactivity
  - (c) Time of exposure
- (4.3) Radiographing arrangement
- (a) Distance between the radiation source and the film, ( $L_1 + L_2$ )
  - (b) Distance between the surface on the radiation source side of the test part and the film, ( $L_2$ )
  - (c) Effective length  $L_3$  of the test part (both sides of double walls:  $L_3 \approx L_3' + L_3''$ )
- (4.4) Conditions of development
- (a) Developer, temperature of development and time of development (manual development)
  - (b) Name of automatic developing machine and developer (automatic development)
- (5) Confirmation of necessary conditions of radiograph
- (5.1) Kind of viewing illuminator and viewing conditions
  - (5.2) Kind of image quality (class A, class B, class P1, class P2 or class F)
  - (5.3) Minimum perceptible wire diameter of penetrameter
  - (5.4) Density of test part
  - (5.5) Value of contrast indicator (difference in density/density)
  - (5.6) Acceptance or rejection of radiograph
- (6) Date of classification of images of flaws

(7) Results of classification of images of flaws

(7.1) Results of classification of images of flaws according to the score of flaw

- (a) Classification of images of flaws of type 1
- (b) Classification of images of flaws of type 4
- (c) Presence of coexistence of images of flaws of type 1 and type 4
- (d) Classification of images of coexistent flaws

(7.2) Classification of images of flaws of type 2

(7.3) Classification of images of flaws of type 3

(7.4) Presence of coexistence of images of flaws of type 2 to the test field of vision

(7.5) Comprehensive classification

(8) Other necessary matters

(9) Remarks

## Annex 1 Radiographing method of butt welded joints in steel plates and necessary conditions for radiograph

1. Scope This Annex specifies the radiographing method and necessary conditions for radiographs when the direct radiographic examination of butt welded joints in steel plates is executed.

### 2. Technique for making radiograph

2.1 Kind of image quality of radiograph The image quality of the radiograph shall be class A and class B.

2.2 Irradiating direction of radiation As a rule, the radiograph shall be taken by irradiating the radiation from the direction where the transmitting thickness of the test part becomes minimum.

2.3 Application of penetrameter Each one penetrameter including the minimum perceptible wire diameter (see Annex 1 Table 4) shall be placed across the welded joint on the surface on the radiation source side of the test part as shown in Annex 1 Fig. 1 so that the thinnest wire of the penetrameter may be located in the vicinity of each end of the effective length  $L_3$  of the test part. With this respect the thinnest wire shall be placed outside. The penetrameter may be placed on the film side if the distance between the penetrameter and the film is apart by at least 10 times the minimum perceptible wire diameter. In this case, the symbol F is placed on each part of the penetrameter so as to identify on the radiograph that the penetrameter is placed on the film side.

If the effective length of the test part is 3 times the width of the penetrameter or less, one penetrameter may be located in the middle.

Annex 1 Fig. 1 Radiographing arrangement

