IS : 1182 - 1983
(Reaffirmed 1991)
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Indian Standard

RECOMMENDED PRACTICE FOR RADIOGRAPHIC EXAMINATION OF FUSION WELDED BUTT JOINTS IN STEEL PLATES

(*Second Revision*)

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NEW DELHI 110002

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Indian Standard

RECOMMENDED PRACTICE FOR RADIOGRAPHIC EXAMINATION OF FUSION WELDED BUTT JOINTS IN STEEL PLATES

(*Second Revision*)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 25 April 1983, after the draft finalized by the Non-Destructive Testing Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1957 and was subsequently revised in 1967. It has now been revised in the light of the experience gained since its last revision. The recommendations given in this revision are based primarily on radiographic techniques which have been used successfully in industry for examination of welded joints.

0.3 In this standard two different techniques, a general technique and a special technique for application in more important and difficult fields where higher sensitivity is required, have been specified.

0.4 This standard should be used in conjunction with IS : 2595 - 1978*.

1. SCOPE

1.1 This standard prescribes recommendations for the radiographic examination of fusion welded butt joints in steel plates.

1.2 This standard covers two techniques, namely, Technique A and Technique B. No attempt is made to define which technique should be used for any particular application because this is a matter for agreement between the contracting parties.

2. RADIOGRAPHIC TECHNIQUES

2.1 The two techniques covered in this standard are classified as follows:

Technique A — This technique is particularly intended for general

*Code of practice for radiographic testing (*first revision*).

application for radiographic examination. Most applications are covered by the use of this technique.

Technique B — This technique is intended for more important and critical applications, where Technique A may not have enough sensitivity to reveal all the defects desired to be detected. In this technique only fine-grained films or ultra-fine-grained films and lead screens shall be used. This technique generally requires longer exposure time.

3. TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS : 812-1957* and IS : 2478-1981† shall apply.

4. PROTECTION OF PERSONNEL

4.1 Since exposure of any part of the human body to X-rays or gamma-rays may become highly injurious to health, it is essential that wherever X-ray equipment or radioactive sources are in use, adequate precautions are taken to protect the radiographer and other persons in the vicinity. For details about radioactive protection, reference may be made to IS : 2598-1966‡.

5. WELD SURFACE PREPARATION

5.1 In order to simplify interpretation of radiographs, it is advisable to remove surface irregularities before radiographic examination. In general surface preparation is not necessary for radiography, but where surface irregularities might cause difficulty in detecting internal defects, the surface may be conditioned by any suitable process.

6. LOCATION OF THE WELD IN THE RADIOGRAPH

6.1 Markers, usually in the form of lead arrows or other symbols, shall be placed along side the weld on each sides of it, so that the position of the weld can be identified on the radiograph.

7. IDENTIFICATION OF RADIOGRAPHS

7.1 Each section of weld radiographed shall have suitable symbols affixed to it to identify:

a) the job or work piece,

b) the joint,

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*Glossary of terms relating to welding and cutting of metals.

†Glossary of terms relating to industrial radiology (*first revision*).

‡Safety code for industrial radiographic practice.

c) the section of the joint,

d) manufacturer's name or trade-mark, and

e) date.

The symbols consisting of lead letters or numerals, shall be positioned on the work piece so that their images appear on the radiograph to ensure unequivocal identification of the section.

7.1.1 In addition, the radiograph may be marked with manufacturer's identification and dates of radiography, which need not necessarily appear as radiographic images.

8. MARKING

8.1 In general, permanent marking for the work piece shall be used to provide reference points for accurate relocation of the position of each radiograph. Where the nature of the material and its service conditions render stamping undesirable, other suitable means of marking such as painting shall be used.

9. OVERLAP OF FILMS

9.1 In radiographing a continuous length of weld joint with separate films, the separate radiographs of the joint should overlap at least 10 mm to ensure that no portion of the joint remains unexamined.

10. IMAGE QUALITY INDICATORS (IQI)

10.1 Image quality indicator (IQI) sensitivity is a means by which the quality of radiographic techniques used may be compared and is not a measure of flaw sensitivity as the latter is a complex function of the geometry, absorption and location of the flaw. The use of an image quality indicator (IQI) otherwise known as a penetrameter, provides a guide to the quality of the radiographic technique used. An IQI conforming to IS : 3657-1978* should be placed at one or both ends of every section radiographed, on the surface facing the source side of radiation and depending on its type, adjacent to or across the weld. Only where this surface is inaccessible, the IQI shall be placed on the film side. If this has to be done, a lead letter 'F' should be placed near the IQI and this should also be mentioned in the test report, as the IQI indication does not have the same meaning when the IQI is placed in this position.

*Specification for radiographic image quality indicators (*first revision*).

11. RECOMMENDED TECHNIQUES FOR MAKING RADIOGRAPHS

11.1 Films and Screens

11.1.1 The films to be used for Technique A shall be fine grain, very high contrast, medium speed, direct type film while for Technique B they shall be ultra-fine grain, high contrast, direct type film.

11.1.2 For X-rays and gamma-rays, using Iridium-192 source, front and back intensifying lead screens shall have, for both Techniques A and B, a thickness between 0·02 and 0·25 mm.

11.1.3 For X-ray voltages below 120 kV, the absorption of the front screen is greater than the intensifying action produced if lead screens of the usual thickness are employed. For this reason a screen of tin is sometimes recommended for use at low X-ray energies.

11.1.4 For gamma-rays, using Cobalt-60 source, front and back screens of copper, steel or lead may be used. For screens other than lead, a thickness of 0·2 to 0·5 mm shall be used.

11.2 Cassettes — Films and screens should be placed in cassettes which may be rigid or flexible. Rigid cassettes are recommended, but for specimens with curvatures, flexible cassettes may be used. In all cases, precautions shall be taken to ensure good film-screen contact. Pre-packed strip film with integral metal intensifying screens may also be used.

11.3 Alignment of Beam — The beam of radiation shall be directed to the middle of the section under examination and shall be normal to the plate surface at that point; except in a special examination for certain defects which it is known will be best revealed by a different alignment of the beam, for example, defects at a fusion face are revealed when the exposure is made with the beam directed along the fusion face.

11.4 Interception of Undesirable and Scattered Radiation

11.4.1 No back scattered radiation shall reach the film. The film shall be shielded from all back scattered radiation by lead spot of an adequate thickness placed behind the film-screen combination.

11.4.2 In order to reduce the effect of scattered radiation, adequate marking shall be provided so as to limit the area irradiated to the section under examination.

11.5 Source-to-Film Distance/Focus-to-Film Distance

11.5.1 The distance between the film and the adjacent weld surface should be as small as possible. The minimum source-to-specimen distance f (that

is the distance between the radiation source and the surface of specimen facing the X-ray tube or gamma-ray source) depends on the effective dimension d of the focal spot or source of radiation and the distance b between the film and the surface of the specimen (which normally is identical with the thickness s of the specimen).

11.5.2 The minimum source-to-specimen distance f should be chosen so that the ratio of this distance to the effective dimension of focal spot or source of radiation d, that is, the ratio f/d, is not below the values according to the following equation:

$$f/d = 7{\cdot}5\ s^{2/3} \text{ for Technique A, and}$$
$$f/d = 15\ s^{2/3} \text{ for Technique B.}$$

11.5.3 In Fig. 1 these relationships between the ratio f/d and the thickness s of the specimen are plotted in a graph and in Fig. 2, in a nomogram.

11.5.4 If the distance b between the surface of specimen and the film is large compared to the thickness s, then s shall be replaced by b on the abcissa of Fig. 1 or on the right scale of Fig. 2.

11.6 Size of Area Examined — The maximum length of weld to be examined at each exposure should be determined by the difference between the thickness of material penetrated in the centre of the radiation beam and that at the extremities of the exposed area, measure in the direction of the incident beam at that point. The differences in density resulting from this variation of thickness and recorded on the film should be within the density range indicated in **11.7**.

11.7 Density of Radiograph — Exposure conditions should be such that the density of the radiograph of the sound weld metal in the area under examination shall be not less than 1·7 for Technique A and 2·0 for Technique B, and not greater than 3·0 for both the techniques. A maximum density of 3·0 has been quoted as this represents the usual limit of most film viewing equipment, but higher densities may be used with advantage where the viewing light is sufficiently bright to permit adequate interpretation. These values are inclusive of the fog density (density of a processed unexposed film) of not greater than 0·3.

11.8 X-ray Tube Voltage and Type of Gamma-Ray Sources

11.8.1 To maintain a good sensitivity of defect detection, the X-ray tube voltage should be as low as possible. As a basis for choosing an appropriate voltage, the maximum values given in Fig. 3 should not be exceeded. For some applications where there is a thickness change across the area of specimen being radiographed, a modification of technique using a slightly higher voltage, may be used, but it should be noted that an excessively high tube voltage will lead to a loss of defect sensitivity.

11.8.2 The gamma-ray sources given below are generally suitable for penetrating the thickness of steel as specified against each:

Gamma-Ray Source	*Thickness of Steel*
	mm
Cobalt 60	40 to 200
Iridium 192	12·5 to 75
Caesium 137	20 to 100

11.8.2.1 The gamma-ray sources may be used for thickness ranges, other than those indicated above, provided satisfactory sensitivity and density are obtained.

11.8.3 It should be noted that the sensitivity of flaw detection attainable with gamma-rays is generally inferior to that obtained with X-rays. The difference in sensitivity is greatest on thin welds and becomes less marked on thicker sections. The use of gamma-rays should therefore be limited, as far as possible, to applications where the shape, thickness or accessibility of the welds make X-ray examination impraticable.

11.9 Processing — The film shall be processed in accordance with recognized good practice. A standard type of X-ray developer shall be used and the processing solutions shall be maintained in good working condition. Particular attention should be paid to temperature and developing time, which shall be in accordance with film manufacturer's recommendations. The radiographs shall be free from imperfections due to processing, or other defects which would interfere with interpretation.

11.10 Viewing — The radiograph shall be examined by diffused light in a room where extraneous light does not interfere with viewing, and the illuminated area shall be masked to the minimum required for viewing the radiographic image. The brightness of the viewing screen shall preferably be adjustable so as to allow satisfactory viewing of the radiographs.

12. RECORD OF TECHNICAL DATA

12.1 For each radiograph, or set of radiographs information shall be available on the radiographic technique used. In particular the following shall be recorded:

a) type of X-ray equipment, tube voltage and current or type of radioactive source together with its strength and size;
b) time of exposure, type of film and screen, and focus-to-film distance/source-to-film distance;
c) system of marking used; and
d) position of IQI, whether source side or film side.

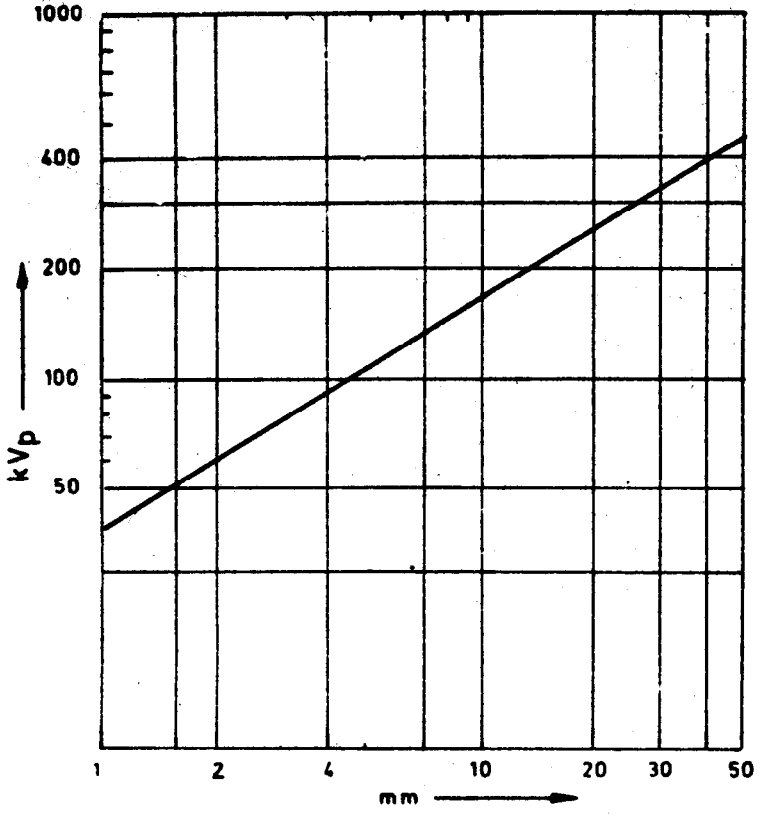

FIG. 3 PERMISSIBLE MAXIMUM X-RAY VOLTAGE

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