

# *Indian Standard*

## CODE OF PRACTICE FOR TRAINING AND TESTING OF METAL ARC WELDERS

*( Revised )*

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BUREAU OF INDIAN STANDARDS  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## CODE OF PRACTICE FOR TRAINING AND TESTING OF METAL ARC WELDERS

(Revised)

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# *Indian Standard*

## CODE OF PRACTICE FOR TRAINING AND TESTING OF METAL ARC WELDERS

### *(Revised)*

## 0. FOREWORD

**0.1** This Indian Standard (Revised) was adopted by the Indian Standards Institution on 21 February 1966, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

**0.2** As a part of steel economy programme, it was recommended that welding should be used as a mode of fabrication in preference to riveting. This standard was first prepared in 1957 to lay down a scheme for training and testing in welding to a trainee in order to enable him to undertake normal welding jobs. It, however, specified training and testing in welding in four positions, namely: (a) flat, (b) horizontal-vertical, (c) vertical, and (d) overhead.

But in the actual practice, it was observed that in 85 percent of the cases a welder was required to weld in the flat position in case of butt welds and in the flat and horizontal-vertical position in case of fillet welds. Hence the time spent in training and testing a trainee in all the positions (namely, flat, horizontal-vertical, vertical and overhead) was found to be not directly useful. Further, in case a welder fails to qualify in some of the difficult positions, repeat training is to be given and thus considerable time and energy is wasted.

In order to simplify the course of training and to make the course directly related to the actual requirement of the job, this standard is revised and Section 3 is split into the following three sub-sections:

Sub-section 3A — Butt welds in flat position and fillet welds in flat and horizontal-vertical position,

Sub-section 3B — Butt and fillet welds in vertical position and butt welds in horizontal-vertical position, and

Sub-section 3C — Butt welds and fillet welds in overhead position.

**0.2.1** Welders who, in the normal course of their work, will be required to weld only the types of joints in the positions described under Sub-section

3A, will have to undertake training in Sub-section 3A. Welders who have to, in addition, weld the types of joints in positions described under Sub-section 3B, will be required to be trained in Sub-section 3B also after they have completed the training in Sub-section 3A satisfactorily. Welders who would be required to carry out welding work in all positions, will be required to be trained in Sub-section 3A, 3B and 3C in that order.

**0.2.2** Separate codes for qualifying tests for welders engaged in welding of boilers and penstock pipes are being formulated.

**0.3** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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## SECTION 1 – GENERAL

### 1. SCOPE

**1.1** This code recommends minimum requirements for a course of instruction in manual metal arc welding as applied to mild steel and prescribes certain standard tests, comprising the initial qualification test at the training establishment and subsequent annual and periodic tests for the practising welder.

**1.2** The principal objectives for the course of instruction covered by the code are:

- a) to coach the trainee in the fundamental techniques and safe practices of metal arc welding,
- b) to give the trainee a good understanding of the proper methods of metal arc welding as applied to mild steel,
- c) to enable the trainee to acquire enough skill in welding to pass the qualification tests prescribed in this code, and
- d) to provide the trainee with a basic knowledge of welding theory.

**1.2.1** The course of instruction is not expected to produce an experienced welder, but rather a welder with enough skill and knowledge so that he will have immediate value to industry as a welder on less difficult work, and will be able, by gaining experience in industry, to progress rapidly to work of greater difficulty and responsibility.

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\*Rules for rounding off numerical values (*revised*).

**1.3** The standard tests prescribed in the code comprise the following.

**1.3.1 Initial Qualification Test** — It is the test which the trainee shall be required to pass before completing his course of training. The passing of this test indicates that the welder has enough basic skill and knowledge, to be of value to industry as a welder.

**1.3.2 The Annual and Periodic Tests** — The check tests designed to be applied at regular intervals for ensuring that a welder actually engaged on work has continued to maintain a standard of proficiency, as required by the initial qualification test.

## **2. TERMINOLOGY**

**2.1** For the purpose of this code, all terms relating to arc welding, unless otherwise defined in this code, shall have the meaning assigned to them in IS : 812-1957\*.

## **3. SYMBOLS**

**3.1** For the purpose of this code and unless otherwise defined in this code, the symbols used shall have the meaning assigned to them in IS : 813-1961†.

## **4. MATERIALS**

**4.1** Steel used as parent metal for testing, according to the provisions of this code, shall conform to IS : 2062-1962‡.

**4.2 Electrodes** — Electrodes, used for all tests, according to provisions of this code, shall conform to the requirements of IS : 814-1963§.

## **5. SELECTION OF TRAINEES**

**5.1** Trainees selected to receive the instruction recommended in this code shall have the following qualifications:

- a) Ability to understand the language of instruction;
- b) No physical or mental disability that precludes safe operation of welding equipment or interferes with full performance of duties in industry; and
- c) The minimum age requirements prescribed in the State and Central Labour Laws applicable in the State in which the instruction is conducted.

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

†Scheme of symbols for welding (*amended*).

‡Specification for structural steel (fusion welding quality).

§Specification for covered electrodes for metal arc welding of mild steel (*revised*).

## **6. LENGTH OF COURSE, HOURS OF INSTRUCTION AND TRIAL PERIOD OF INSTRUCTION**

**6.1** It is recommended that each trainee devotes a minimum of 75 hours for Sub-sections 3A and 3B each and 50 hours for Sub-section 3C of Section 3 to actual welding, exclusive of time spent in witnessing demonstrations by the instructor, preparing plates for welding, testing specimens, observing the work of other trainees and receiving instruction in welding theory.

**6.2 Length of Instruction in Welding Theory** — It is recommended that each trainee devotes 50 hours to instruction in welding theory prescribed in Section 3.

**6.3 Length of Welding Practice in Any One Day** — The length of time spent by the trainee in actual welding practice in any one day shall not exceed 6 hours.

**6.4 Trial Period of Instruction** — In the beginning of the course there shall be a trial or probationary period, not to exceed 30 hours, the period to be determined by the training establishment, during which the instructor shall observe the aptitude and interest of the trainee and determine whether in the interest of all concerned the trainee shall continue the course.

## **7. RECORD CARD**

**7.1** Upon completion of the course and fulfilment of the requirements prescribed in this code, the trainee shall be granted a record card indicating that the trainee has passed the tests prescribed in Section 4. Further, these tests together with their results shall be listed on the record card. If the trainee has passed some, but not all the final qualification tests prescribed, the tests which the trainee has not taken or has failed to pass shall be permanently indicated on the card.

**7.2** The record card shall have additional pages for recording the results of annual tests taken by the welder. Additional pages may also be provided for recording any periodic and special tests, for example, welding in special steels, pipe welding, which the welder may take. A recommended form for this card is given in Appendix A.

## **SECTION 2 — EQUIPMENT AND FACILITIES FOR THE TRAINING ESTABLISHMENT**

### **8. APPARATUS**

**8.1 Welding Booths** — Each welding booth shall have an area with sufficient clear floor space to allow adequate freedom of movement for the trainee and the instructor. All four sides of the welding station shall provide complete protection to persons and property on the outside against fire, personal injury or other damage. Internally each booth shall be so



constructed, lighted and ventilated, as to provide complete protection to the trainee. Suitable ventilation, adequate to prevent the accumulation of welding fumes shall be provided for each booth (or each room of booths, if partitions between booths do not extend to the ceiling). Any State or local regulations that are applicable shall be complied with.

**8.2 Positioning Jig** — Suitable positioning jigs shall be provided to facilitate the execution of the welding tests prescribed in Section 4. A suggested design of such equipment is given in Appendix B.

**8.3 Arc Welding Machines** — The training establishment shall be equipped with at least 50 percent as many arc welding machines or welding outlets as there are trainees in the shop class (*see 6.1* for actual welding time for trainees). Each welding machine shall have a rated current of 200 A or more. It is desirable that at least one machine having a manual continuous hand welding current rating of 300 A or more be available.

**8.4 Electrodes** — There shall be an adequate supply of covered metal arc welding electrodes of the types and sizes required for the exercises prescribed in Section 3.

**8.5 Material for Welding** — An adequate supply of mild steel plate of the required quality shall be provided for the exercises prescribed in Section 3.

**8.6 Testing Apparatus** — The training establishment shall possess apparatus suitable for preparing and testing the test specimens as prescribed in Sections 3 and 4 or shall have facilities for having these test specimens prepared and tested elsewhere.

**8.7 Miscellaneous** — In addition to the foregoing, the training establishment shall provide all other apparatus and equipment necessary for the safe and proper execution of the welding course prescribed herein. A list of accessories and equipment recommended for a training establishment is given in Appendix C.

## **9. SUPERVISION**

**9.1 Number of Trainees per Instructor** — Each shop class should be restricted to not more than 12 trainees in attendance per instructor.

**9.2 Record of Trainees' Progress** — A record shall be kept of each trainee's progress, showing the number of hours of individual practice and the results of all tests prescribed in Sections 3 and 4. A recommended form of trainee progress chart is given in Appendix D.

## **10. REFERENCE MATERIAL**

**10.1 Outline of Course** — At the start of the course a prepared outline indicating the syllabus of the course, the tests required, and the subjects

to be covered in the related instruction shall be made available to the trainees. A specimen syllabus for the course is given in Appendix E.

**10.2 Welding Publications** — The training establishment shall have available for trainees' use suitable reference material consisting of books, manuals, periodicals, codes, standards, etc.

## **11. QUALIFICATIONS AND DUTIES OF INSTRUCTOR**

**11.1 General** — The instructions prescribed in this code may be given by one or more instructors, provided each instructor in welding practice possesses the qualifications prescribed under **11.2.1** and each instructor in welding theory possesses the qualification prescribed under **11.2.2**. In addition, each instructor shall have the ability to present effective demonstrations and explanations of those portions of the course which he is to teach.

### **11.2 Qualifications of Instructor**

**11.2.1** Each instructor giving any portion of the instruction in welding practice (*see 13*) shall possess the following qualifications:

- a) A minimum of three years' experience as welder or welding supervisor, of which at least two years shall have been spent as manual metal arc welder;
- b) Proven ability to pass all the tests prescribed for trainees in Section 4 of this code;
- c) A practical knowledge of the physical properties of the metals and the welding process;
- d) Familiarity with the topics in welding theory covered in Section 3; and
- e) Familiarity with the codes and specifications used in welding and capability to read simple drawings relating to welding of structures.

**11.2.2** Each instructor giving any portion of the instruction in welding theory shall have a thorough knowledge of the subjects on which he gives instructions.

**11.3 Duties of Instructor** — The instructional staff shall be charged with the responsibility of giving instruction in welding practice and welding theory, as prescribed in Section 3. The duties shall include the following:

- a) Planning instruction in accordance with the course outlined in this code keeping in view the following four basic steps of instruction:
  - 1) Preparing the trainee for new instruction;
  - 2) Using appropriate methods for presenting the new instruction (demonstration, illustration, explanation, discussion, etc);
  - 3) Providing proper supervision and criticism as the trainee applies his new knowledge and skill; and
  - 4) Supervising and checking tests assigned to trainees.

- b) Instructing the trainee to work safely, emphasizing the training establishment's safety regulations.
- c) Observing acceptable shop management practices, such as (1) care, control and conservation of materials and equipment, and (2) shop cleanliness and orderliness.
- d) Keeping attendance records and recording trainees' progress.

### **SECTION 3 – COURSE OF INSTRUCTION**

#### **12. GENERAL**

**12.1** The instruction shall consist of welding practice and lectures in theory. The practical and theoretical training should be suitably interspersed and related one to the other. The training shall start with instruction in safety precautions, protection of person and protection and care of equipment. This instruction coming at the very commencement of the course will reduce the risk of disablement of the trainees from such causes as arc-eye, electrical shocks, etc, and help in preventing damage to equipment which might be caused by ignorance of its proper use.

**12.1.1** The instruction in safety shall be given before the trainees are permitted to use any regular welding equipment. A list of recommended safety rules is given in Appendix F, and should be used in this instruction.

**12.1.2** For detailed instructions for safety and health requirements in electric and gas welding and cutting operations reference should be made to IS : 818-1957\*.

#### **13. INSTRUCTION IN WELDING PRACTICE**

**13.1** Instruction in welding practice shall be given by means of a series of exercises which shall conform at least to the requirements prescribed in this section. The exercises shall be performed on steel plates of various thicknesses as appropriate for each individual exercise. The steel shall be reasonably free from scale, rust, paint and other defects which adversely affect welding. For the execution of each exercise, the trainee shall have a welding unit for his exclusive use.

**13.1.1** The importance of maintaining uniformity of voltage and current conditions in order to attain uniformity and good quality of welds and the importance of proper cleaning and de-slagging during the welding process shall be emphasized during each exercise.

**13.1.2** In the list of suggested welding exercise no specific recommendations are made with respect to the number of times each exercise should be repeated. The trainee should be required to perform each exercise to the

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\*Code of practice for safety and health requirements in electric and gas welding and cutting operations.

satisfaction of the instructor before being allowed to advance to the next exercise.

**13.1.3** It is recommended that the trainee should test as many of his welds as possible as soon as they have been cooled in still air. Further, the instructor should inspect the tested weld and point out to the trainee any defects that may be in evidence and the reason for such defect or failure of the joint. The techniques of testing shall be as prescribed for the check tests (*see 14*).

**13.1.4** It is recommended that the size of specimen, as indicated in the various illustrations, be maintained wherever possible.

**13.1.5** It is recommended that the pieces be set up and tack welded before welding.

**13.1.6** After completing each group of exercises the trainees shall be required to pass the check tests prescribed for that group designed to demonstrate whether he has acquired a satisfactory degree of skill in the techniques covered by that group of exercises.

### **SUB-SECTION 3A — BUTT WELDS IN FLAT POSITION AND FILLET WELDS IN FLAT AND HORIZONTAL-VERTICAL POSITION**

**13.2 Group A Exercises — Striking Arc and Bead Welding —** Exercises in Group A shall be designed to instruct the trainee to readily strike the arc, maintain the correct arc length, achieve full control of slag and weld metal, and deposit consistently beads of the correct length, width and profile with various sizes of electrodes. All the exercises shall be performed with electrodes of sizes ranging from 3.15 mm to 6.3 mm. The following exercise shall be included in this group:

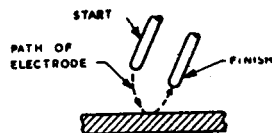
<i>Welding Lesson</i>	<i>Welding Procedure</i>
a) Striking the arc	Tapping method and scratch method ( <i>see Fig. 1</i> ).
b) Running beads (flat position)	With 3.15, 4, 5, and 6.3 mm electrodes. Deposit continuous beads with craters properly filled and without excessive deposits of metals at the points of re-striking the arc, then practice making long continuous beads in all directions ( <i>see Fig. 2B and 3</i> ).
c) Bead welds-weaving technique (flat position)	Practice different weaving techniques ( <i>see Fig. 4</i> ) advancing in all directions, that is, from left to right, right to left, towards and away from the operator, using 3.15, 4, 5, and 6.3 mm electrodes.

**13.2.1** All the exercises in Group A shall be performed in the flat position.

**13.2.2 Check Tests on Exercises in Group A** — No specific tests are prescribed for this group. The trainee should be able to strike the arc by either method at any desired point. He should be able to deposit beads from right to left and *vice-versa* of uniform appearance and width, in continuous lengths with craters properly filled without excessive deposits of metals at the points of re-striking the arc. He should be able to apply the different weaving techniques (see Fig. 4) advancing from left to right, right to left and towards and away from the operator, and obtain beads of uniform width. He should be able to deposit a weld metal pad with several layers, using different weaving techniques and obtain fair uniformity in thickness, width and appearance.

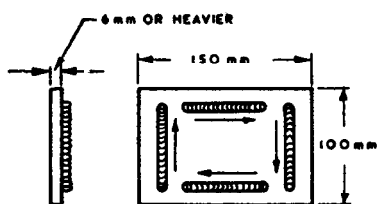


1A Tapping Method

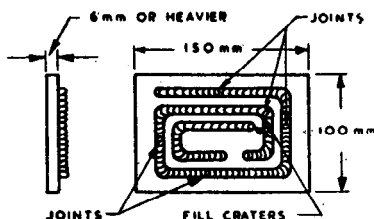


1B Scratch Method

FIG. 1 STRIKING THE ARC



2A Discontinuous Bead



2B Continuous Bead

FIG. 2 BEAD TECHNIQUE

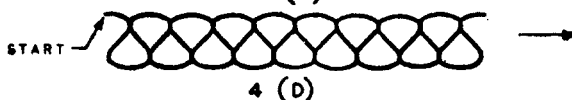
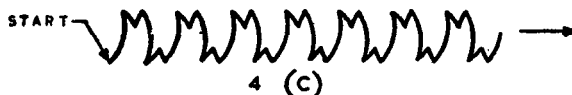
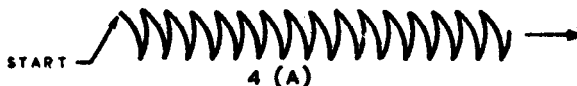


FIG. 4 WEAVER TECHNIQUE

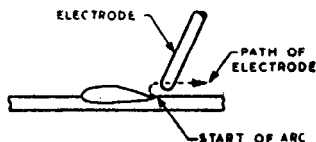


FIG. 3 RE-STRIKING THE ARC

**13.3 Group B Exercises — Welding of Butt Joints and Fillet Joints in Flat Position** — The exercises in Group B shall be designed to instruct the trainee in the technique of making corner, fillet, and butt welds in the flat position. Exercises on the following types of welds shall be included in this group:

<i>Type of Welds</i>	<i>Position of Welding</i>	<i>Joint Preparation</i>	<i>Procedure of Welding</i>
a) Corner welds	As illustrated in Fig. 5B	As illustrated in Fig. 8B	Weld the joint with two runs first with a 4-mm electrode and the second one with a 5-mm electrode using weaving technique.
b) Fillet welds — single run	As illustrated in Fig. 5C or 5D	As illustrated in Fig. 7	Weld the joint with a 4-mm electrode to obtain a 6-mm fillet.
c) Fillet welds — multi-run	As illustrated in Fig. 5C or 5D	As illustrated in Fig. 7	Weld the joint with a 4-mm electrode for the first run and a 6.3 mm electrode for the second run to obtain a 10-mm fillet.
d) Butt welds	As illustrated in Fig. 5A	As illustrated in Fig. 8A	Weld the joint in three runs first run with a 4-mm electrode and the subsequent runs with 5-mm electrodes.
e) Butt welds — multi-run	As illustrated in Fig. 5A	As illustrated in Fig. 6	Make the joint by welding one run on each side using a 5-mm electrode.

**13.3.1 Check Tests on Exercises in Group B** — The trainee shall be required to make two specimen welds conforming to the requirements stated in Table 1.

**TABLE 1 SPECIMEN WELDS FOR CHECK TESTS ON EXERCISES IN GROUP B**

SPECIMEN No.	JOINT PREPARATION	POSITION OF WELDING	PROCEDURE OF WELDING
1	As illustrated in Fig. 7	As illustrated in Fig. 5C or 5D	Weld to be made in a single-run with a 5-mm electrode
2	As illustrated in Fig. 8A	As illustrated in Fig. 5A or 5B	Weld to be made in multi-runs with a 4-mm electrode for the root-run and a 5-mm electrode for the succeeding runs





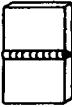
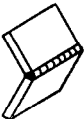


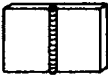


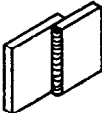


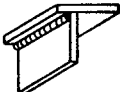

POSITION OF WELDING	BUTT WELD		FILLET WELD	
	BUTT JOINT	CORNER JOINT	TEE JOINT	LAP JOINT
FLAT	 S (A)	 S (B)	 S (C)	 S (D)
HORIZONTAL -VERTICAL	 S (E)	 S (F)	 S (G)	 S (H)
VERTICAL	 S (J)	 S (K)	 S (L)	 S (M)
OVERHEAD	 S (N)	 S (P)	 S (Q)	 S (R)

FIG. 5 ILLUSTRATIONS OF POSITION OF WELDING

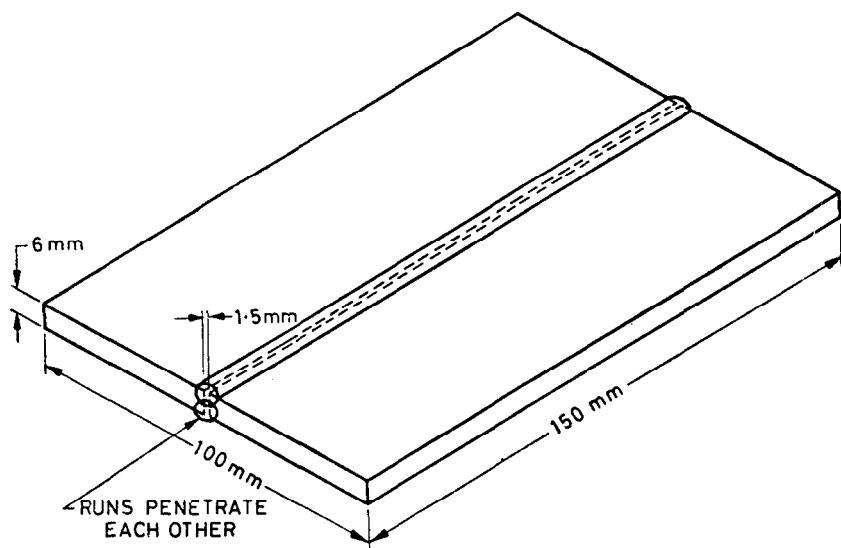
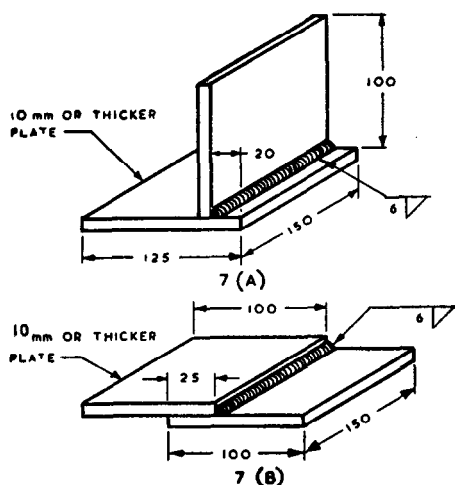


FIG. 6 BUTT WELD (SQUARE EDGE)



All dimensions in millimetres.

FIG. 7 FORMS OF JOINT FOR FILLET WELD SPECIMEN



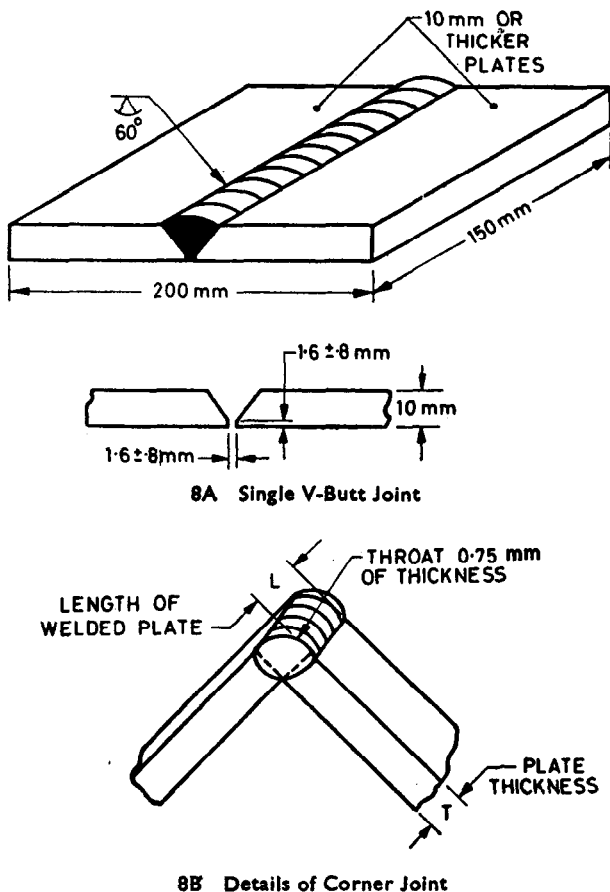


FIG. 8 FORMS OF JOINT FOR BUTT WELD SPECIMEN

**13.3.1.1** The weld shall be inspected visually for appearance, checked for size and contour with a suitable weld gauge and then ruptured for internal examination (see Fig. 9). Each weld shall be assessed on the basis of provisions under 14.

**13.4 Group C Exercises — Welding of Fillet Joints in the Horizontal-Vertical Position** — The exercises in Group C shall be designed to instruct the trainee in the technique of making fillet welds in the horizontal-vertical position. All the exercises shall be performed with 3.15 mm or larger electrodes, leading to the use of 4 and 5 mm electrodes

for check tests. Exercises on the following types of welds shall be included in this Group:

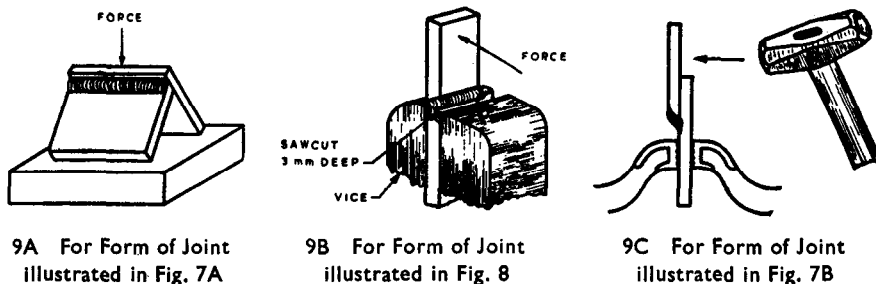


FIG. 9 METHOD OF RUPTURING CHECK TEST SPECIMENS

<i>Type of Welds</i>	<i>Position of Welding</i>	<i>Joint Preparation</i>	<i>Procedure for Welding</i>
a) Fillet welds	As illustrated in Fig. 5G and 5H	As illustrated in Fig. 7	Deposit a single run fillet of 6 mm size using 4-mm and 5-mm electrodes.
b) Fillet welds multi-run	As illustrated in Fig. 5G and 5H	As illustrated in Fig. 7	Deposit a 10 mm fillet weld in three runs with 4-mm electrodes.

**13.4.1 Check Tests on Exercises in Group C** — The trainee will be required to make two specimen welds conforming to requirements stated in Table 2.

**TABLE 2 SPECIMEN WELDS FOR CHECK TESTS ON EXERCISES IN GROUP C**

SPECIMEN No.	JOINT PREPARATION	POSITION OF WELDING	PROCEDURE OF WELDING
3	As illustrated in Fig. 7	As illustrated in Fig. 5G and 5H	Weld to be made in a single run with a 4-mm electrode
4	As illustrated in Fig. 7	As illustrated in Fig. 5G and 5H	Weld to be made in a single run with 5-mm electrode

**13.4.1.1** Each weld shall be inspected visually for appearance and checked for size and contour with a suitable weld gauge and ruptured for internal examination (see Fig. 9). Each weld shall be assessed on the basis of provisions mentioned under 14.

### SUB-SECTION 3B — BUTT AND FILLET WELDS IN VERTICAL POSITION AND BUTT WELDS IN HORIZONTAL-VERTICAL POSITION

**13.5 Group D Exercises — Welding in Vertical Position** — The exercises in Group D, shall be designed to instruct the trainee in the technique of making bead, fillet and butt welds in the vertical position. All the exercises shall be performed with 3·15 mm or larger electrodes, leading to the use of 4-mm electrodes for the check tests. For the exercises requiring welding in the vertical down direction, electrodes suitable only for this purpose shall be selected. Exercises on the following types of welds shall be included in this group:

<i>Type of Welds</i>	<i>Position of Welding</i>	<i>Joint Preparation</i>	<i>Procedure of Welding</i>
a) Bead welds-vertical-up & vertical-down	As illustrated in Fig. 2	As illustrated in Fig. 2	Practice bead welds-both vertical and down using 3·15-mm, 4-mm and 5-mm electrodes.
b) Fillet welds-single-run, vertical-up	As illustrated in Fig. 5L and 5M	As illustrated in Fig. 7	Weld the joint with a 6·3-mm fillet weld using a 4-mm electrode.
c) Fillet welds multi-run, vertical-up	As illustrated in Fig. 5L and 5M	As illustrated in Fig. 7	Weld the joint in two runs to obtain a 10-mm fillet-first run with 4-mm electrode and the second with a 5-mm electrode.
d) Butt welds	As illustrated in Fig. 5J	As illustrated in Fig. 8A	Weld the joint in three runs first run with 3·15-mm second and third with 4-mm electrodes.
e) Corner welds-down direction	As illustrated in Fig. 5K	As illustrated in Fig. 8B	Weld vertical down with a 3·15-mm and 4-mm electrode.

**13.5.1 Check Tests on Exercises in Group D** — The trainee shall be required to make two specimen welds conforming to the requirements stated in Table 3.

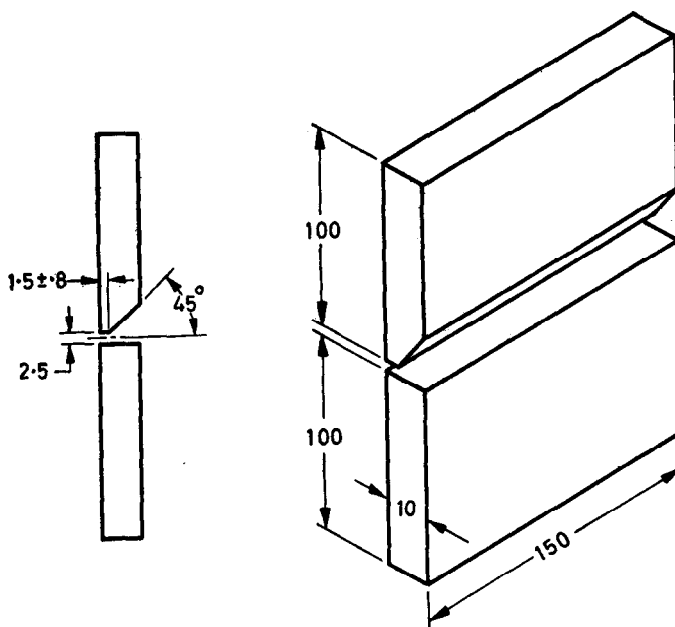
**13.5.1.1** The weld shall be inspected visually for appearance, checked for size and contour with a suitable weld gauge and then ruptured for internal examination (see Fig. 9). Each weld shall meet the requirements specified under 14.

**TABLE 3 SPECIMEN WELDS FOR CHECK TESTS ON EXERCISES IN GROUP D**  
(Clause 13.5.1)

SPECIMEN NO.	JOINT PREPARATION	POSITION OF WELDING	PROCEDURE OF WELDING
5	As illustrated in Fig. 7	As illustrated in Fig. 5L or 5M	Weld as specified in Fig. 7 to be made in a single-run with a 4-mm electrode. After visual inspection and gauging, weld shall be increased in size by one or more additional runs to form a 10-mm fillet weld
6	As illustrated in Fig. 8A	As illustrated in Fig. 5J or 5K	Weld to be made in multi-runs with a 3.15-mm electrode for the first run and 4-mm electrode for the subsequent runs

**13.6 Group E Exercises — Welding in Horizontal-Vertical Position for Butt Welds** — The exercises in Group E shall be designed to instruct the trainee in the technique of making bead and butt welds in horizontal-vertical position. All the exercises shall be performed with 3.15-mm or larger electrodes, leading to the use of 3.15- and 4-mm electrodes for check tests. Exercises on the following types of welds shall be included in this group:

Type of Welds	Position of Welding	Joint Preparation	Procedure of Welding
a) Bead welds and reinforcing pad in horizontal / vertical position	As illustrated in Fig. 2	As illustrated in Fig. 2	Practice deposition of beads using 3.15-mm and 4-mm electrodes.
b) Butt welds	As illustrated in Fig. 5E	As illustrated in Fig. 10	Weld the joint by building up the weld with the required number of straight beads (approximately 4) deposited without weaving. First run to be made with 3.15-mm and the subsequent runs with 4-mm electrodes.
c) Butt welds	As illustrated in Fig. 5E	As illustrated in Fig. 14 (alternative horizontal-vertical position)	Weld the joint by building up the weld with the required number of runs (approx 5) deposited without weaving first run with 3.15-mm and the subsequent runs with 4-mm electrodes.



All dimensions in millimetres.

FIG. 10 JOINT PREPARATION FOR BUTT WELDS

**13.6.1 Check Tests on Exercises in Group E** — The trainee shall be required to make one specimen weld conforming to the following requirements:

<i>Specimen No.</i>	<i>Joint Preparation</i>	<i>Position of Welding</i>	<i>Procedure of Welding</i>
7	As illustrated in Fig. 10	As illustrated in Fig. 5E and 5F	Weld to be made in multi-runs with 3.15-mm electrode for the first run and 4-mm electrode for the subsequent runs.

**13.6.1.1** Each weld shall be inspected visually for appearance and checked for size and contour with a suitable weld gauge and ruptured for internal examination (see Fig. 9B). Each weld shall be assessed on the basis of provisions mentioned under 14.

**SUB-SECTION 3C — WELDING IN OVERHEAD POSITION****13.7 Group F Exercises — Welding in the Overhead Position —**

The exercises in Group F shall be designed to instruct the trainee in the technique of making bead, fillet and butt welds in the overhead position. All the exercises shall be performed with 3·15-mm or 4-mm electrodes, leading to the use of 4-mm electrodes for the check tests. Exercises on the following types of welds shall be included in this group:

<i>Type of Welds</i>	<i>Position of Welding</i>	<i>Joint Preparation</i>	<i>Procedure of Welding</i>
a) Bead welds overhead position	As illustrated in Fig. 2	As illustrated in Fig. 2	Practice striking the arc and depositing beads with 3·15-mm and 4-mm electrodes.
b) Fillet welds-single-run	As illustrated in Fig. 5Q and 5R	As illustrated in Fig. 7	Make a 5-mm fillet weld with a 4-mm electrode.
c) Fillet welds-multi-run	As illustrated in Fig. 5Q and 5R	As illustrated in Fig. 7	Make a 10-mm fillet weld building up the weld in three runs using 4-mm electrode.
d) Butt welds	As illustrated in Fig. 5N	As illustrated in Fig. 8A	Weld the joint in three layers using weaving techniques for the last two layers. Initial two layers with 3·15-mm electrode and the final layer with 4-mm electrode.

**13.7.1 Check Tests on Exercises in Group F** — The trainee shall be required to make two specimen welds conforming to the requirements stated in Table 4.

**TABLE 4 SPECIMEN WELDS FOR CHECK TESTS ON EXERCISES IN GROUP F**

<b>SPECIMEN No.</b>	<b>JOINT PREPARATION</b>	<b>POSITION OF WELDING</b>	<b>PROCEDURE OF WELDING</b>
8	As illustrated in Fig. 7	As illustrated in Fig. 5Q or 5R	Weld as specified in Fig. 7 to be made in a single-run with a 4-mm electrode. After visual inspection and gauging, weld shall be increased in size by one or more additional runs to form a 10-mm fillet weld
9	As illustrated in Fig. 8	As illustrated in Fig. 5N or 5P	Weld to be made with 3·15-mm electrode for first run and 4-mm electrode for subsequent runs in multi-runs.

**13.7.1.1** The weld shall be inspected visually for appearance, checked for size and contour with suitable weld gauge and then ruptured for internal examination (see Fig. 9). Each weld shall be assessed on the basis of the provisions specified under 14.

## **14. ASSESSMENT OF CHECK TEST WELDS**

### **14.1 Inspection Before Fracture**

**14.1.1 Factor 1 — Shape of Profile** — The shape of the profile shall be checked by measuring dimensions of the weld. The finished weld may be slightly over rather than under the specified size.

**14.1.2 Factor 2 — Shape of Profile** — The profile of the weld is affected by the type of filler material or electrodes used, the position of joint and the welding technique.

**14.1.2.1** In butt welds the surface should be slightly convex. Typical profile views for butt welds have been illustrated in Fig. 11.

**14.1.2.2** In fillet welds the contour may vary from concave to convex, according to the type of electrode or filler material, the welding position and technique. Typical profile views for normal fillet welds have been illustrated in Fig. 12.

**14.1.3 Factor 3 — Uniformity of Surface** — Uniformity of height and spacing of the 'ripples' are an indication of the quality of workmanship. The shape and appearance of ripples in the weld surface vary according to the class of welding.

**14.1.4 Factor 4 — Degree of Undercut** — Undercutting is a particularly undesirable fault. When present it is evident as a notch of depression parallel and adjacent to the sides of the weld. The welded joint should be reasonably free from undercut, but slight intermittent occurrences may be disregarded, provided that such undercut is not in the form of a sharp notch.

**14.1.5 Factor 5 — Smoothness of Joint Where Welding is Recommended** — The joint in a weld run where welding has been recommended should show no pronounced lump or recess in the weld surface.

**14.1.6 Factor 6 — Freedom from Surface Cavities and Trapped Slag** — Smoothness of finish and general freedom from surface cavities and trapped slag are desirable. Surface cavities in a weld deposit may be caused by lack of fusion, gas bubbles or trapped slag, due to the use of unsuitable material of incorrect technique. Where suitable materials are used, the presence of these defects may be considered attributable to the quality of workmanship.

**14.1.7 Factor 7 — Disposition of Runs, Single and Multiple** — Where multiple runs are deposited they should, at the surface, be of approximately equal width and there should be no deep notch or groove between adjacent runs nor should the edge of one run produce a sharp ridge or recess in the surface of another run.

**14.1.7.1** The disposition of the lower runs in a multiple run weld can only be ascertained by examination of an etched cross-section of the weld.

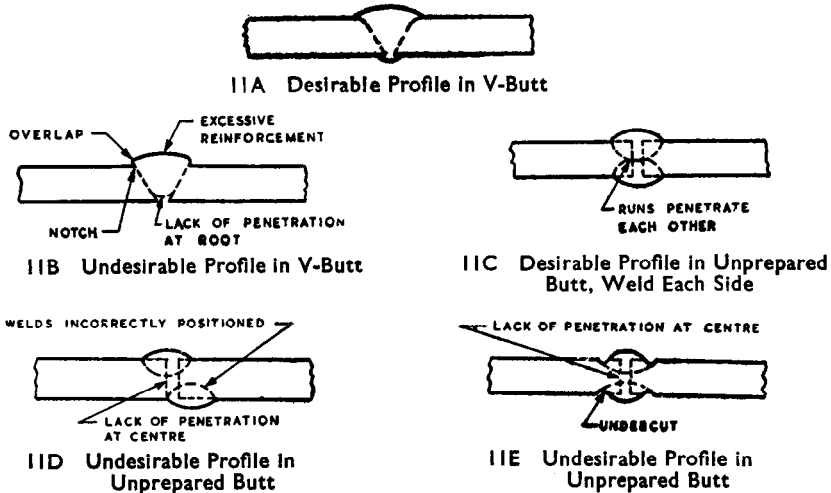


FIG. 11 TYPICAL PROFILES IN BUTT WELDS

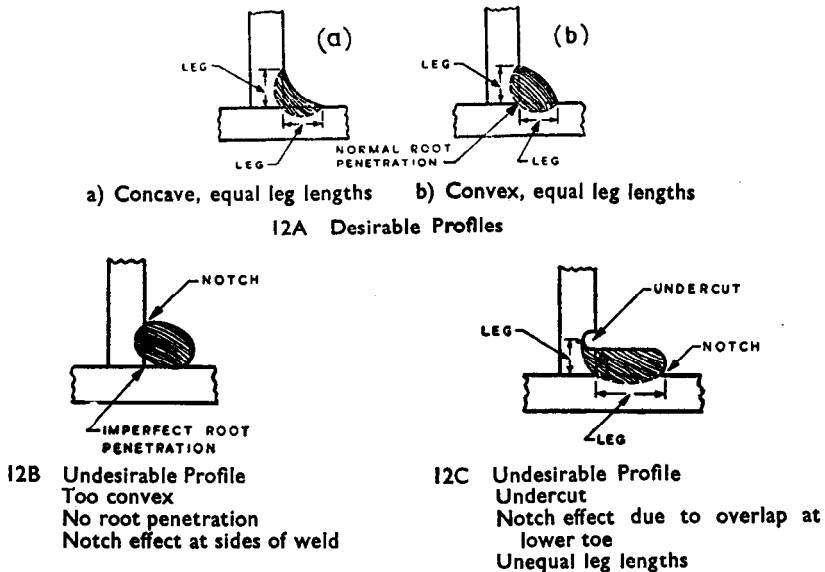
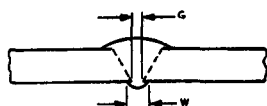


FIG. 12 TYPICAL PROFILES IN FILLET WELDS



**14.1.8 Factor 8 — Penetration Bead in Butt Welds** — The size of the penetration bead, that is, fused metal projecting on the reverse side of the joint, varies according to the materials being welded, the type of joint, the welding process, the welding technique and the skill of the welder. Where a penetration bead is required, it should be reasonably uniform in width and appearance (see Fig. 13).



13A Single Vee Joints

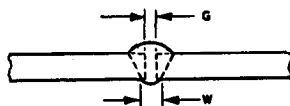
13B Square Butt, 1.6 mm to 6.5 mm  
one run where no backing is  
deposited

FIG. 13 TYPICAL SHAPES OF PENETRATION BEADS IN BUTT WELDS

**14.1.9 Factor 9 — Quality of Weld Metal for Metal Arc Welding** — In the case of weld deposits on good quality material made with covered electrodes, the use of incorrect current or incorrect arc length are usually made evident by porosity both in the body of the weld and in the crater accompanied by a poor surface finish and an irregular profile. A deep crater is not itself a criterion of overheating nor of the use of excessive current but may depend upon the characteristics of the electrode.

**14.2 Inspection of Weld Fracture** — Inspection of weld fractures gives information concerning the disposition of runs and the following faults, if present at the section or fracture: incorrect profile, undercut, slag inclusions, poor root penetration and other lack of fusion, as described in the following factors.

**14.2.1 Factor 10 — Degree of Fusion** — Fusion should be complete over the whole area of the joint surfaces.

**14.2.1.1** The fracture should be inspected for lack of fusion. This may occur at the surfaces to be joined between layers of weld metal. Lack of fusion at the joint surfaces is indicated by the retention of the original form and surface markings; between layers of weld metal it will appear as lines between the layers.

**14.2.2 Factor 11 — Degree of Root Penetration for Butt and Fillet Welds** — Defects are most likely to occur at the root of the weld and in this position they are liable to have the maximum effect in reducing the strength of the weld. A close examination of the root shall, therefore, be made. In V-butt welds the first run should normally penetrate right to the underside of the plates, producing a penetration bead of the size required. In normal fillet welds with good root penetration the weld metal should reach the corner (see Fig. 11 and 12).

**14.2.3 Factor 12 — *Non-Metallic (Slag) Inclusions and Gas Cavities*** — Non-Metallic inclusions may consist of matter from the rod and flux used or from the electrode. Unless they are caused by use of unsuitable materials, they are attributable to the quality of workmanship, the desired result being to achieve a uniform appearance and freedom from cavities.

**14.2.4 Factor 13 — *Quality of Weld Metal*** — Inferior quality of weld metal may be caused by incorrect welding technique. In metal arc welding the defects may generally be due to excessive arc length or speed or incorrect current. The fracture does not possess its customary clean appearance but reveals voids, oxide films and slag inclusions. If present to a considerable extent, they may result in a rough, porous, discoloured and lustreless appearance in the fracture.

## SECTION 4 — TESTS FOR WELDERS

### 15. GENERAL

**15.1** The tests shall be of the following three types:

- a) Initial qualification test,
- b) Annual test, and
- c) Periodic control test.

**15.2** These tests are designed to show that the welder is familiar with the usual welding techniques. Approval of welders for works of special nature may demand additional special trade or approval tests.

### 16. INITIAL QUALIFICATION TEST

**16.1** The Initial Qualification Test shall be conducted after the trainee has completed all the requirements relating to the theoretical instruction and welding practice specified in the relevant Sub-section or Sub-sections for which he intends to qualify.

**16.1.1** A trainee shall not be allowed to take the Initial Qualification Test for Sub-section 3B unless he has a valid Initial Qualification Test Certificate for Sub-section 3A; he shall not be allowed to take the Initial Qualification Test for Sub-section 3C unless he possesses an Initial Qualification Test Certificate for Sub-section 3B.

### 16.2 Preparation of Test Pieces

**16.2.1 General** — The steel shall be reasonably free from scale, rust, oil, paint and other defects which adversely affect welding.

**16.2.2 Butt Weld Test Piece** — The test piece shall conform to the requirements of Fig. 14. The edges to be welded shall be prepared by machining or by machine flame cutting. The joint preparation shall be unbacked single-V. The plates should be slightly pre-set so that they are reasonably

flat after welding. All runs should be deposited with 4-mm filler rod, including the sealing run. The weld shall be back-chipped or flame-gouged to a semicircular groove to a depth of 3 mm. After back-chipping or flame-gouging, the sealing run shall be deposited. Each run of weld shall be stopped and restarted with a fresh filler rod within the central 50 mm of the test piece. In the flat position (*see 20*), the test piece shall be welded using 4-mm electrodes for the first run and sealing run and 5-mm electrodes for the other runs.

**16.2.3 Fillet Weld Break Test Piece** — The test piece shall conform to the requirements of Fig. 15. The test weld should be deposited using 4-mm filler rods to deposit a weld of 6 mm leg length. The weld should be stopped and restarted with a fresh filler rod within the central 50 mm of the test piece. When the trainee is to be tested only for welding in the horizontal-vertical position (*see 20*), the welds shall be deposited using 5-mm filler rods.

### 16.3 Marking of Test Pieces

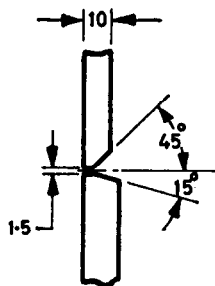
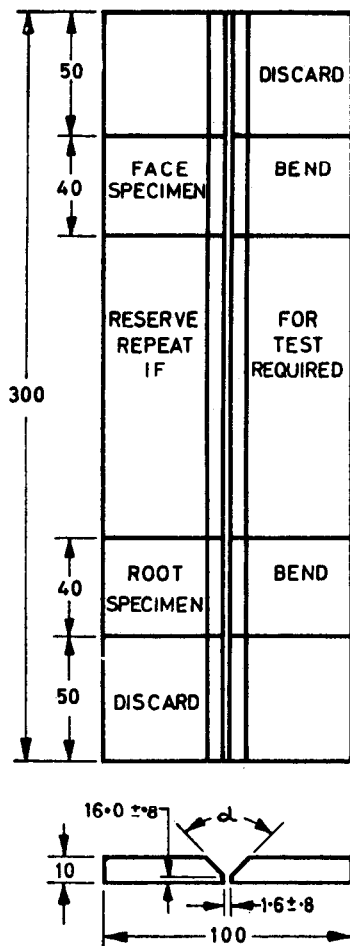
**16.3.1** Each completed test plate shall be indelibly marked in such a manner as to identify each specimen that will be removed therefrom. The marking shall identify:

- a) the trainee,
- b) the position of welding, and
- c) the size of electrode used.

### 16.4 Assessment

**16.4.1 By Visual Examination** — Test pieces for all the three tests shall be visually examined for the following:

- a) *Dimensions of weld deposit* — The dimensions of the weld shall be checked. The finished weld should be slightly over rather than under the specified size.
- b) *Shape of profile* — In butt welds, the surface should be slightly convex. Typical profile views for butt welds have been illustrated in Fig. 11.
- c) *Uniformity of surface* — The height and spacing of ripples shall be uniform.
- d) *Degree of undercut* — The welded joint shall be free from undercut, but slight intermittent occurrences may be disregarded provided that such undercut is not in the form of a sharp notch.
- e) *Smoothness of joint where welding is recommended* — The joint in the weld run where welding has been recommenced shall be as smooth as practicable and shall show no pronounced lump or recess in the weld surface.
- f) *Freedom from surface cavities and trapped slag* — The surface of the weld shall be free from porosity, cavities and trapped slag.



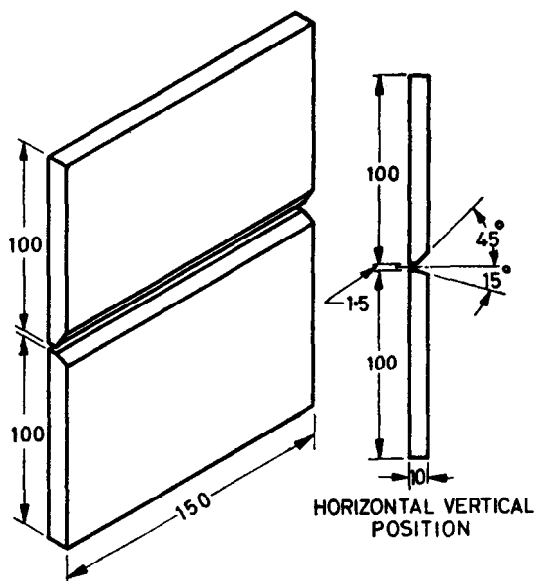
Position	$\alpha$
F	60°-65°
H-V	60°-65°
V (Up)	70°-75°
V (Down)	70°-75°
O	80°-85°

NOTE—Weld to be stopped and re-started with a fresh electrode within central 50 mm.

All dimensions in millimetres.

FIG. 14 METHOD OF MAKING BUTT WELD BEND TEST SPECIMEN FOR INITIAL QUALIFICATION TEST AND ANNUAL TEST

(See alternative to this figure on P 28)



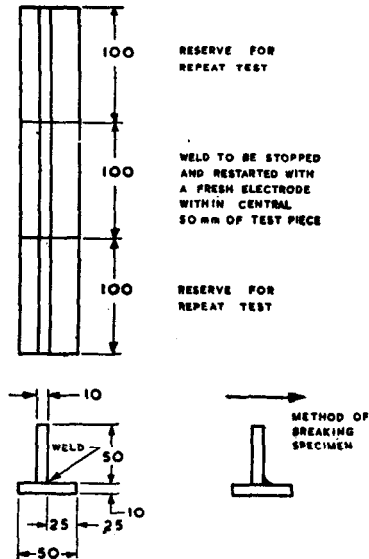
All dimensions in millimetres.

(Alternative for Fig. 14 showing the length of weld specimen)

In fillet welds the contour may vary from concave to convex, according to the type of electrode or filler material, the welding position and technique. Typical profile views for normal fillet welds have been shown in Fig. 12.

#### 16.4.2 By Testing

**16.4.2.1 Butt welds** — After external visual assessment of the butt weld test pieces, two bend test specimens each 40 mm wide shall be cut from the test piece by sawing or machining (*see* Fig. 14). The upper and lower surfaces of the weld shall be filed, ground or machined, level with respective original surfaces of the plates. Tool marks should be avoided as they lead to localization of stress and may cause premature failure. For this reason the direction of machining of the surfaces should be along the specimen and transverse to the weld. The sharp corners of the test specimens shall be rounded to a radius not exceeding 1 mm. The specimen shall then be bent to an angle of 180° over a former having a diameter equal to four times the thickness of the specimen as shown in Fig. 16. One test specimen shall be tested with the face of the weld in tension and the other with the



All dimensions in millimetres.

FIG. 15 METHOD OF MAKING FILLET WELD BREAK TEST SPECIMEN FOR INITIAL QUALIFICATION, ANNUAL AND PERIODIC CONTROL TESTS

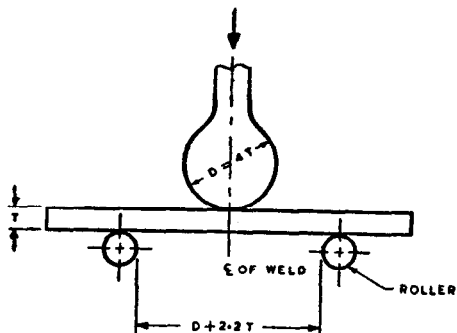


FIG. 16 METHOD OF CARRYING OUT BEND TEST

root of the weld in tension. A good weld should show no crack or defect of a dimension greater than 3 mm measured along the weld and 1.6 mm measured across the weld. Premature failure at the corner of test specimens should not be regarded as cause for rejection. Prior to bending, the edges of the test specimen should be etched to reveal the weld, if this is not sufficiently discernible to ensure that the bending takes place on the centre line of the weld.

**16.4.2.2 Fillet weld break test** — After external-visual assessment of the fillet weld break test piece, the test piece shall be cut into three equal portions by sawing or machining and broken open along the weld and the weld fracture examined (*see* Fig. 15). The weld fracture shall be examined, keeping in view the following factors:

- a) *Degree of fusion* — Fusion should be complete over the whole area of the joint surfaces.  
The fracture should be inspected for lack of fusion. This may occur at the surfaces to be joined and between layers of weld metal. Lack of fusion at the joint surfaces is indicated by the retention of the original form and surface markings; between layers of weld metal it would appear as lines between the layers.
- b) *Degree of root penetration* — Defects are most likely to occur at the root of the weld. In normal fillet welds with good root penetration the weld metal should reach the corner (*see* Fig. 11 and 12).
- c) The fracture shall have a clean uniform appearance and the weld metal should be free from cavities and slag inclusions.

## **16.5 Re-test for Initial Qualification Test**

**16.5.1** In case a trainee fails to meet the requirements of one or more tests mentioned under **16.2** to **16.4**, a re-test may be allowed immediately or after some further training on the following conditions:

- a) An immediate re-test shall consist of two test welds of each type on which he failed. The re-test welds shall meet all the requirements specified for such welds.
- b) If the re-test is made after the trainee has had further training or practice, the complete Initial Qualification Test shall be repeated.

## **16.6 Validity of Initial Qualification Test Certificate**

**16.6.1** The certification implied in passing of the Initial Qualification Test is valid only when the holder is employed as a welder within six months of the passing of the test. The certification shall lapse automatically if, for any reason, he has not worked as a welder for a period of six months or more. Such lapsed certification shall be reinstated provided Periodic Control Tests specified under **18** are passed.

## 17. ANNUAL TESTS

**17.1 General** — The Annual Tests to be taken by a welder and the results of which are to be entered on his Record Card (*see* 7) shall comprise a butt weld bend test and fillet weld break test as specified under 17.2 and 17.3 respectively. Details of test pieces and preparation are given below.

**17.2 Butt Weld Bend Test** — The preparation of test piece and testing procedure for the butt weld bend test shall be the same as those prescribed under 16.2.2 and 16.4.2.1 for the Initial Qualification Test.

**17.3 Fillet Weld Break Test** — The preparation of test piece and testing procedure for the fillet weld break test shall be same as those prescribed under 16.2.3 and 16.4.2.2 for the Initial Qualification Test.

## 18. PERIODIC CONTROL TEST

**18.1** The Periodic Control Test consists of the fillet weld break test and should be done at regular intervals of six months. Welders engaged continually on work that is subject to examination by some non-destructive testing method, such as radiography, need not be subjected to the Periodic Control Test. The preparation of test piece and testing procedure for the Periodic Control Test shall be the same as those prescribed under 16.2.3 and 16.4.2.2 for the Initial Qualification Test.

## 19. RE-TESTS FOR ANNUAL TEST AND PERIODIC CONTROL TEST

**19.1 Annual Test** — If the welder fails in the Annual Test, although Periodic Control Tests have not shown any specific reason to question his ability, he shall be re-tested immediately. The re-test shall consist of two test welds of each type on which he fails. The test welds shall meet all the requirements specified for such welds. If the trainee fails in such a re-test, he shall be employed on unimportant work for some period and then resubmitted to the Annual Test.

**19.2 Periodic Control Test** — If the results of the Periodic Control Tests indicate that there is some reason to question the welder's ability, then he shall be submitted to the tests prescribed for the Annual Test. If he fails in this test, he shall be put on unimportant work for a period and then resubmitted to the Annual Test.

**19.3** The welder shall not be permitted to re-start on important work until he has passed the Annual Test.



**20. POSITION FOR TEST WELDS**

**20.1** In the Initial Qualification Test, the Annual Test and the Periodic Control Test, the position for the test welds would depend on the welding positions for which the trainee or welder is to be certified or passed. The minimum requirements of test welds shall be as given in Table 5.

**20.2** The entries made in the Record Card (*see 7*) shall have a reference to the welding positions for which the tests have been conducted and passed.

---

**TABLE 5 MINIMUM REQUIREMENTS OF TEST WELDS**

(*Clause 20.1*)

SUB-SECTION	TYPE OF JOINT	WELDING POSITION
3A	Butt Weld	Flat
	Fillet Weld	Flat
	Fillet Weld	Horizontal-Vertical
3B	Fillet Weld	Vertical up
	Butt Weld	Vertical up
	Butt Weld	Horizontal-vertical
3C	Fillet Weld	Overhead
	Butt Weld	Overhead

---

**APPENDIX A***(Clause 7.2)***RECOMMENDED FORM FOR RECORD CARD***(Page 1 of Card)*

(Name of Training Establishment issuing the Record Card)

Name of the Trainee .....

Permanent Address .....

Photograph of  
Trainee

Signature of Trainee

This Record Card certifies that.....  
(Full name of trainee)

whose signature and photograph are shown above, has completed a course or courses of training in metal arc welding conforming to a Sub-section or more than a Sub-section of Section 3 of IS : 817-1966 'Code of practice for training and testing of metal arc welders (*revised*)' and has passed the test or tests specified in the said Code of Practice as indicated in the following pages and duly certified by signatures under official seals.

*(Page 2 of Card)*

**Courses of Training Completed and the  
Initial Qualification Tests Passed**

*Sub-section 3A of Section 3 of IS : 817-1966*

Period of Training

From (date).....to (date).....Total.....days

<i>Type of Weld</i>	<i>Position of Welding</i>	<i>Date of Tests</i>	<i>Remarks</i>
Butt	Flat		
Fillet	Flat		
Fillet	Horizontal/Vertical		

(Signature of Training Establishment Officer)  
(Designation of Officer)

Date: (Official Seal of Training Establishment)

*(Continued)*

**IS : 817 - 1966**

**(Page 2 of Card — Contd)**

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**Sub-section 3B of Section 3 of IS : 817-1966**

**Period of Training**

From (date).....to (date).....Total.....days

<i>Type of Weld</i>	<i>Position of Welding</i>	<i>Date of Tests</i>	<i>Remarks</i>
Fillet	Vertical Up		
Butt	Vertical Up		
Butt	Horizontal/Vertical		

(Signature of Training Establishment Officer)  
(Designation of Officer)

Date: (Official Seal of Training Establishment)

**Sub-section 3C of Section 3 of IS : 817-1966**

**Period of Training**

From (date).....to (date).....Total.....days

<i>Type of Weld</i>	<i>Position of Welding</i>	<i>Date of Tests</i>	<i>Remarks</i>
Fillet	Overhead		
Butt	Overhead		

(Signature of Training Establishment Officer)  
(Designation of Officer)

Date: (Official Seal of Training Establishment)

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(Pages 3 to 12 of Card)

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**Record of Annual Tests**

<i>Type of Weld</i>	<i>Position of Welding</i>	<i>Date of Test</i>	<i>Remarks</i>	<i>Signature of Officer with Designation and Official Seal</i>
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**Sub-section 3A**

Butt	Flat
Fillet	Flat
Fillet	Horizontal/Vertical

**Sub-section 3B**

Fillet	Vertical Up
Butt	Vertical Up
Butt	Horizontal/Vertical

**Sub-section 3C**

Fillet	Overhead
Butt	Overhead

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## APPENDIX B

(Clause 8.2)

### RECOMMENDED DESIGN OF POSITIONING EQUIPMENT

#### B-1. INTRODUCTION

**B-1.1** The positioning equipment is designed to hold and position plates while the trainee is busy in performing welding exercises and tests. The purpose of such equipment is to provide a convenient method for holding any kind of joint (butt joint, lap joint, tee joint or corner joint) so that it may be welded in the flat, horizontal, vertical or overhead position.

**B-1.2** This appendix describes the general features of the positioning device and illustrates its application.

**B-1.3** Separate equipment should be provided for each welding booth.

#### B-2. DESCRIPTION OF EQUIPMENT

**B-2.1** The complete positioning equipment, including all jigs and fixtures, is illustrated with details in Fig. 17.

#### B-3. ILLUSTRATIONS OF USE OF EQUIPMENT

**B-3.1** The use of positioning equipment has been illustrated by photographic of qualification test assemblies being prepared in each of the four positions of welding. Corresponding sketches of these test plates show the orientation of plates and welds for each position.

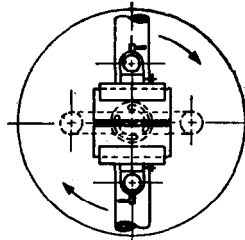
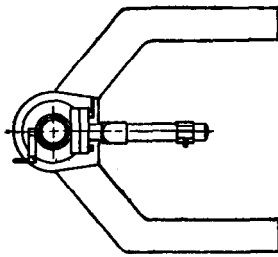
**B-3.2 Butt Welds** — Fig. 18A to 18D illustrate the orientation of plates for butt welding in the flat, horizontal-vertical, vertical and overhead positions while Fig. 19A to 19D show the butt welding being deposited in the corresponding positions.

**B-3.3 Fillet Welds** — The orientation of plates for fillet welding in the flat, horizontal-vertical, vertical and overhead positions is illustrated in Fig. 20A to 20D.

#### B-4. ADVANTAGES OF POSITIONING EQUIPMENT

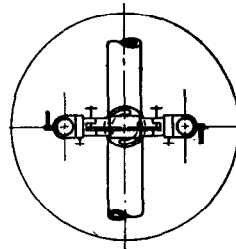
**B-4.1** Some of the advantages of using this type of positioning equipment, over the other makeshift facilities commonly employed, are given in **B-4.1.1** to **B-4.1.5**.

**B-4.1.1** The equipment increases actual welding time by (a) eliminating the use of C clamps; (b) facilitating rapid clamping of plates in jigs and adjustment of the jigs to any desired angle; (c) holding test plates rigid while they are being chipped and cleaned of slag; (d) permitting easy

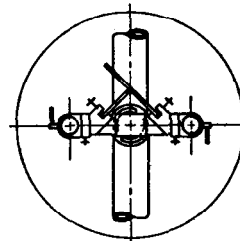


SET UP FOR HORIZONTAL VERTICAL WELDING

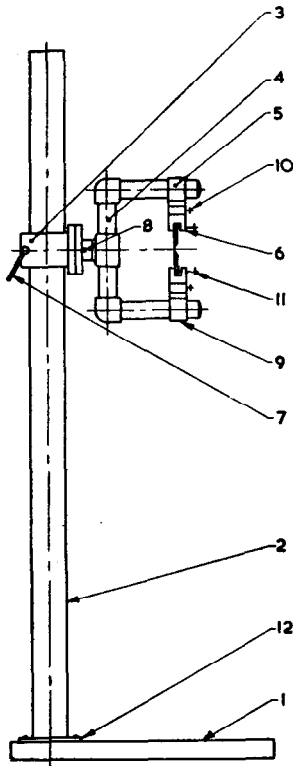
For Vertical Welding Shown Dotted Line Through 90° in The Direction Shown



SET UP FOR FLAT AND OVERHEAD WELDING



SET UP FOR "T" AND "L" JOINTS WELDING



- |                              |                         |                                    |
|------------------------------|-------------------------|------------------------------------|
| 1 Base                       | 5 Holder bracket        | 9 Holder bracket clamp             |
| 2 Column                     | 6 Straight plate holder | 10 Holder positioning clamp        |
| 3 Main column bracket        | 7 Main bracket clamp    | 11 Plate holding brackets          |
| 4 Galvanized iron pipe frame | 8 Disc clamp            | 12 Column fixed to base with bolts |

FIG. 17 ILLUSTRATION OF RECOMMENDED DESIGN OF POSITIONING EQUIPMENT

removal and replacement of test plates between passes when necessary; and (e) readily permitting the setting and holding of plates at proper root opening.

**B-4.1.2** The equipment illustrated permits welding on plates of any length up to 180 cm in the vertical position, and would hold plate of any thickness up to 16 mm. Special holding jigs may be made to take in plate of any desired thickness.

**B-4.1.3** The equipment permits holding the work in any position and at any desired level from the floor to over 180 cm above, thereby accustoming the trainee to some of the positions and angles at which he might be required to work on the job.

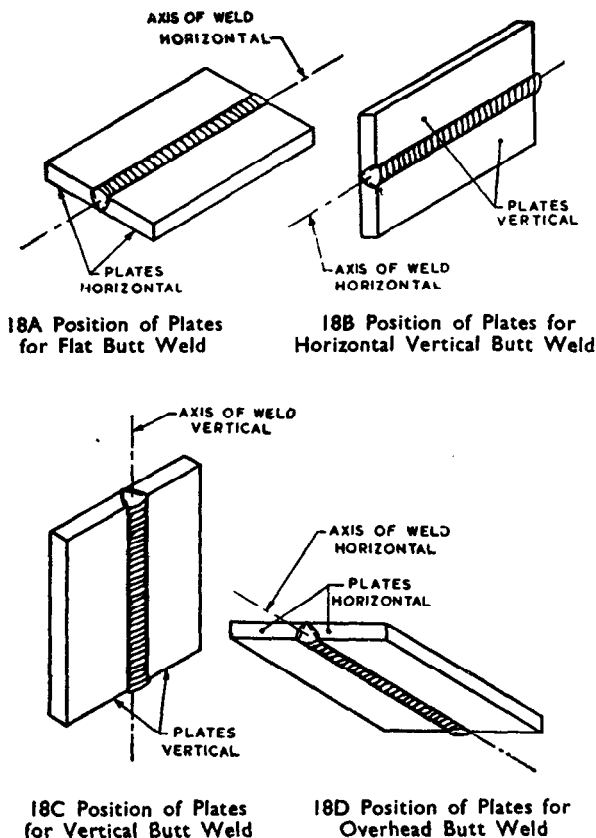
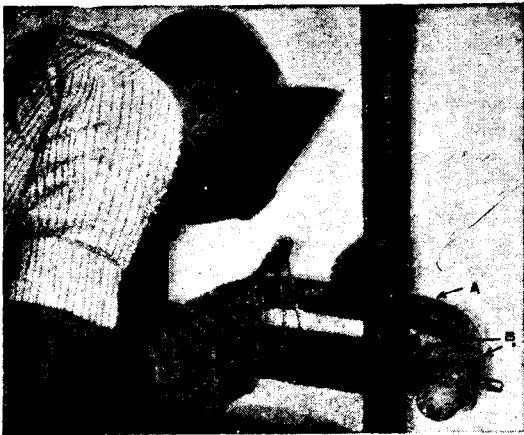


FIG. 18 POSITIONS OF PLATES FOR BUTT WELDS



19A Flat Position



19B Horizontal-Vertical Position



19C Vertical Position



19D Overhead Position

FIG. 19 POSITIONS OF PLATES FOR BUTT WELDS

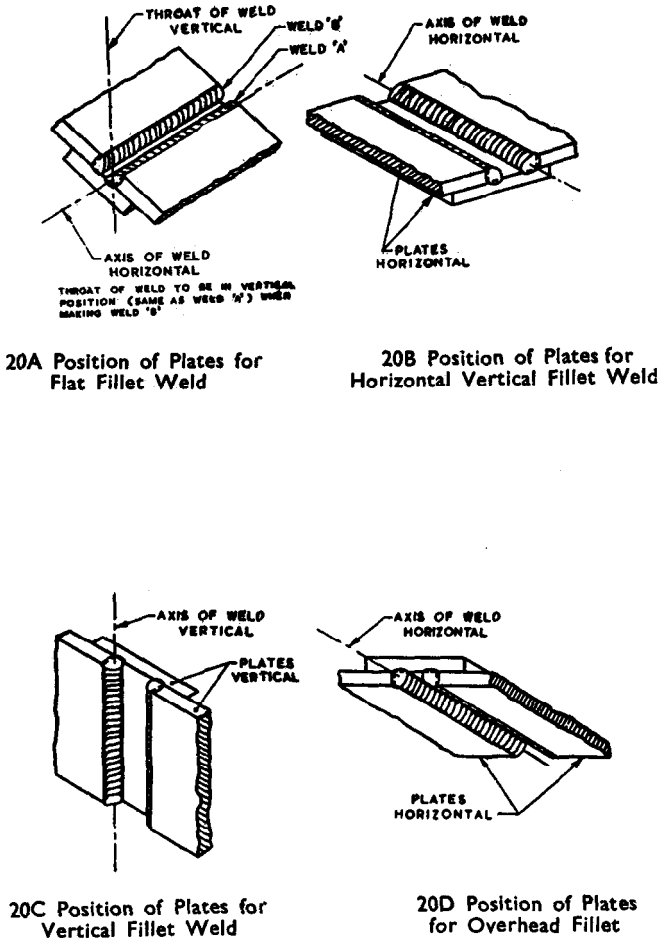


FIG. 20 POSITION OF PLATES FOR FILLET WELDS

**B-4.1.4** The equipment displaces table and stool from welding booth. (A tool tray, if desired, may be made as part of the equipment, as shown in Fig. 17.)

**B-4.1.5** The equipment may be readily constructed in most of the machine shops and welding shops.



## APPENDIX C

(Clause 8.7)

### ACCESSORIES AND EQUIPMENT RECOMMENDED FOR TRAINING ESTABLISHMENT FOR WELDERS

#### C-1. SHOP MACHINES AND ACCESSORY EQUIPMENT

**C-1.1** The training establishment shall be provided with the following shop and accessory equipment:

- a) Heavy work bench with machinist's or blacksmith's vice weighing 30 kg or more;
- b) Gas cutting torch (manual or machine type) or plate shear for preparing plates for welding and for cutting test specimens;
- c) Two-ended pedestal grinder with  $25 \times 3$  cm (or larger) coarse wheels and wheel dresser;
- d) Heavy power hacksaw (preferably with 25 cm width capacity) or horizontal metal band saw;
- e) Portable or flexible shaft grinder;
- f) Equipment for machining test specimens;
- g) Guided-bend test device with hydraulic jack of 8 tonnes or larger capacity;
- h) Break or rupture device with hydraulic jack of 8 metric tons or larger capacity;
- j) Fire extinguishers, chemical type;
- k) Fire buckets with water;
- m) Sand bags for fire protection;
- n) Scrap box  $90 \times 60 \times 30$  cm;
- p) Chartboard for progress chart, instructional charts and notices;
- q) Small platform scales for weighing out electrodes;
- r) First aid kit;
- s) Provisions for sterilizing welding helmets;
- t) Anvil 45 kg or heavier;
- u) Display board for sample specimens of welding exercises; and
- v) Hot metal quenching tank.

**NOTE** — Facilities for showing motion pictures, filmstrips and slides have been found to be of assistance.

## **C-2. SMALL TOOLS AND ACCESSORIES**

**C-2.1** While welding, each trainee shall be supplied with the following equipment:

- a) Sledge hammer for rupturing check test specimens,
- b) Ball peen hammer,
- c) C-clamps,
- d) Cold chisels,
- e) Centre punches,
- f) Scribes,
- g) Metal rules,
- h) Try squares,
- j) Sets of metal marking steel stamps (letters and figures of 5 mm height),
- k) Small steel wedges,
- m) Medium coarse files for rounding edges of test specimens, and
- n) Soapstone marking crayon.

## **C-3. REQUIREMENTS FOR EACH TRAINEE WHILE WELDING**

**C-3.1** While welding, each trainee shall be supplied with the following equipment:

- a) Helmet or hand shield with suitable coloured filter lens and clear cover glass,
- b) Welding and cutting torches,
- c) Ground clamp (where necessary leather gloves, or gauntlets),
- d) Safety goggles for use while chipping and cleaning welds and for flash protection,
- e) Wire scratch brush,
- f) Slag-chipping hammer, and
- g) Pair of short pick-up tongs or heavy gas pipe pliers.

## **C-4. EQUIPMENT FOR TRAINEE OBSERVERS AND INSTRUCTORS WHILE OBSERVING**

**C-4.1** While welding, each instructor and trainee shall be supplied with the following equipment:

- a) Helmet or hand shield with suitable coloured filter lens and clear cover glass, and
- b) Weld gauges.

**APPENDIX D**

(Clause 9.2)

**RECOMMENDED FORM OF TRAINEE PROGRESS CHART**

Sl No.

Name.....

Address.....

Local Address.....

Employer's Name &amp; Address.....

.....

**\*Courses required:**

1. Butt Welds in Flat Position and Fillet Welds in Flat and Horizontal-Vertical Position,
2. Butt and Fillet Welds in Vertical Position and Butt Welds in Horizontal-Vertical Position, and
3. Butt Welds and Fillet Welds in Overhead Position

Special remarks, if any.....

Terms of payment — Cash/Credit/Free

Date in.....Date out.....Total Period (weeks).....

LESSON 1 BUTT WELDS IN FLAT POSITION AND FILLET WELDS IN FLAT AND HORIZONTAL- VERTICAL POSITION	Dates					Days	Total No. of hours of actual welding practice	Estimated time observing weld and test specimens
Striking the arc and bead welding								
Striking the arc								
Running beads (flat position)								
Bead welds weaving techni- que (flat position)								
Status of progress								

\* These courses correspond to Sub-sections 3A, 3B, and 3C of Section 3.

LESSON 1 BUTT WELDS IN FLAT POSITION AND FILLET WELDS IN FLAT AND HORIZONTAL- VERTICAL POSITION	Dates	Days	Total No. of hours of actual welding practice	Estimated time observing weld and test specimens
--	-------	------	--	---

## Welding of butt joints and fillet joints in flat position

Corner weld									
Single-run fillet weld									
Multi-run fillet weld									
Butt weld ( <i>see</i> Fig. 8A)									
Butt weld ( <i>see</i> Fig. 6)									
Making check test specimen No. 1									
Making check test specimen No. 2									

Status of progress

## Welding of fillet joints in the horizontal-vertical position

Single-run fillet weld									
Multi-run fillet weld									
Making check test specimen No. 3									
Making check test specimen No. 4									

Status of progress

LESSON 2 BUTT AND FILLET WELD IN VERTICAL POSITION AND BUTT WELDS IN HORIZON- TAL-VERTICAL POSITION	Dates				Days	Total No. of hours of actual welding practice	Estimated time observing weld and test specimens
Welding in vertical position							
Bead welds and reinforcing pad in horizontal-vertical position							
Butt welds (see Fig. 10)							
Butt welds (see Fig. 14)							
Making check test specimen No. 5							
Making check test specimen No. 6							
Status of progress							
Welding in horizontal-vertical position for butt welds							
Bead welds-vertical up and vertical down							
Single-run fillet welds— vertical up							
Multi-run fillet welds— vertical up							
Butt welds							
Corner welds—down direc- tion							
Making check test specimen No. 7							
Status of progress							

LESSON 3 WELDING IN OVER- HEAD POSITION	Dates						Days	Total No. of hours of actual welding practice	Estimated time observing weld and test specimens
Bead welds in overhead position									
Single-run fillet weld									
Multi-run fillet weld									
Butt weld									
Making check test specimen No. 8									
Making check test specimen No. 9									
Status of progress									

**APPENDIX E**

(Clause 10.1)

**RECOMMENDED SYLLABUS FOR TRAINING COURSE****E-1. BUTT WELDS IN FLAT POSITION AND FILLET WELDS IN FLAT AND HORIZONTAL-VERTICAL POSITION (See 13)**PERIOD — Theory — 50 hours, *Min*Actual Welding Practice — 75 hours, *Min*

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
1st Week	<i>Theory</i>		7

a) *Safety in Welding*

The instruction course shall be so designed as to make the trainee aware of the necessity for observing safety precautions under the following three general headings:

- 1) Protection of person, that is, proper shoes, clothing, hand shield, helmet or goggles with the right shade of filter, adequate ventilation, avoidance of electric shock, etc.
- 2) Protection of property, that is, safeguarding combustible material, protection from hot slag, flying sparks and flame, availability of fire protection equipment, etc.
- 3) Protection and care of equipment, that is, proper cable connections, avoidance of grounding electrode holder, shutting off equipment when not in use, storage and handling of oxygen and acetylene cylinders (or acetylene generators where low pressure system

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
	is used), operation of pressure regulators, handling of blow-pipe, care of hose and equipment, etc.		
	Safety rules recommended in Appendix F and the detailed instruction given in IS : 818-1957*.		
	b) <i>Welding Processes</i> Instruction in this subject shall be designed to acquaint the trainee with the principal welding processes in common use, with particular emphasis on manual arc welding.		
	<i>Practice</i> Elementary gas cutting Bead welds Running beads	Flat Flat	30*
	<i>Film shows, discussion, etc.</i>		3
2nd Week	<i>Theory</i>		7
	a) <i>Elementary Electricity</i> The elements of electricity should be explained in a simple manner to the trainees to assist them in properly appreciating the lecture that follows on electric welding equipment.		
	b) <i>Welding and Gas Cutting Equipment</i> Instruction in this subject shall be designed to give the trainee an idea of the characteristics of arc welding plant of different types, their principal features, method of connecting up, current setting		

\*Code of practice for safety and health requirements in electric and gas welding and cutting operations.



<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
	and minor adjustments. Fitting and dismantling of manual gas cutting equipment, flame adjustment and care of equipment should also be covered.		
	<i>Practice</i>		30*
	Reinforcing pad	Flat	
	Fillet welds	Flat	
	<i>Film shows, discussion, etc.</i>		2
3rd Week	<i>Theory</i>		8
	a) <i>Elementary Welding Metallurgy</i>		
	Instruction in this subject shall be designed to give the trainee an elementary knowledge of the thermal and metallurgical factors involved in the welding of steel. The welding characteristics of high tensile and alloy steels, cast iron and non-ferrous metals should also be explained in a simple manner.		
	b) <i>Elementary Blue Print Reading</i>		
	Instruction in this subject shall be designed to give the trainee an elementary knowledge of factors involved in reading simple blue prints in order to assist him in comprehending common welding terms and symbols used.		
	<i>Practice</i>		30*
	Corner welds	Flat	
	<i>Film shows, discussion, etc.</i>		3

\*It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 percent at the welding point having practice in welding, the rest of the time being spent in the preparation of plates, testing of specimens, witnessing demonstration, etc.

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
4th Week	<i>Theory</i>		7
	a) <i>Welding Procedures, Terms and Symbols</i> Instruction in this subject shall include plate edge preparation, types of joints, use of jigs, fixtures and manipulators, tacking and other aids to assembly, sequence of welding, residual stresses, control of distortion, pre-heating and post-heating. The more important terms relating to arc welding and the standard symbols used for detailing weld sizes and showing welds on drawings shall be explained.		
	<i>Practice</i> Butt weld — Single 'V'	Flat	30*
	<i>Film shows, discussion, etc.</i>		3
5th Week	<i>Theory</i>		7
	a) <i>Quality of Welds</i> Instruction in this subject shall be designed to familiarize the trainee with the characteristics of good welds and causes of defective welds. The topic for discussion shall include (1) soundness, (2) fusion, (3) penetration, and (4) weld contours and dimensions.		
	b) <i>Inspection and Testing of Welds</i> Under this heading should be covered the more common methods of weld inspection and testing (shop as well as field methods). Instruction in this subject is better given in the form		

\*It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 percent at the welding point having practice in welding, the rest of the time being spent in the preparation of plates, testing of specimens, witnessing demonstration, etc.

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
	of a discussion of the trainees' welds before and after testing. The following points in particular should be covered:		
	1) Visual inspection and use of weld gauges.		
	2) Bend, tensile, impact and pressure tests.		
	3) Non-destructive methods such as radiographic and magnetic particle inspection.		
	<i>Practice</i>		30*
	Butt weld — square edges	Flat	
	<i>Film shows, discussion, etc.</i>		3
6th Week	<i>Theory</i>		7
	Same as 5th week — Further lectures.		
	<i>Practice</i>		30*
	Fillet welds	Horizontal-vertical	
	<i>Film shows, discussion, etc.</i>		3
7th Week	<i>Theory</i>		7
	a) <i>Characteristics of Electrodes</i>		
	Instruction in this shall be designed to familiarize the trainee with the different types of electrodes used in metal arc welding.		
	b) <i>Estimating and Costing</i>		
	Factors affecting welding cost and the method of estimating materials requirements shall be explained in a simple manner.		
	<i>Practice</i>		30*
	Revision		
	<i>Film shows, discussion, etc.</i>		3

\*It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 percent at the welding point having practice in welding, the rest of the time being spent in the preparation of plates, testing of specimens, witnessing demonstration, etc.

**E-2. BUTT AND FILLET WELD IN VERTICAL POSITION AND  
BUTT WELDS IN HORIZONTAL-VERTICAL POSITIONS**  
(See 13)

PERIOD — Actual Welding Practice — 75 hours, *Min*

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
1st Week	<i>Practical</i> Bead welds Fillet welds	Vertical/up Vertical/up	37*
	<i>Film shows, discussion, etc.</i>		3
2nd Week	<i>Practical</i> Fillet welds Butt — Single 'V'	Vertical/up Vertical/up	37*
	<i>Film shows, discussion, etc.</i>		3
3rd Week	<i>Practical</i> Butt — Single 'V' (Further exercises) Corner weld Depositing bead	Vertical/up Vertical/ down Horizontal/ vertical	37*
	<i>Film shows, discussion, etc.</i>		3
4th Week	<i>Practical</i> Butt weld-bottom plate square top plate bevelled Butt weld-both plates bevelled	Horizontal/ vertical Horizontal/ vertical	37*
	<i>Film shows, discussion, etc.</i>		3
5th Week	<i>Practical</i> Revision		38*
	<i>Film shows, discussion, etc.</i>		2

\*It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 percent at the welding point having practice in welding, the rest of the time being spent in the preparation of plates, testing of specimens, witnessing demonstration, etc.

**E-3. WELDING IN OVERHEAD POSITION** (*See 13*)PERIOD — Actual Welding Practice — 50 hours, *Min*

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
1st Week	<i>Practical</i> Bead welds Fillet welds	Overhead Overhead	37*
	<i>Film shows, discussion, etc.</i>		3
2nd Week	<i>Practical</i> Fillet weld	Overhead	37*
	<i>Film shows, discussion, etc.</i>		3
3rd Week	<i>Practical</i> Butt weld — Single 'V'	Overhead	37*
	<i>Film shows, discussion, etc.</i>		3
4th Week	<i>Practical</i> Butt weld — Single 'V' (Further exercises) Revision	Overhead	37*
	<i>Film shows, discussion, etc.</i>		3

\*It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 percent at the welding point having practice in welding, the rest of the time being spent in the preparation of plates, testing of specimens, witnessing demonstration, etc.

## APPENDIX F

(Clause 12.1.1)

### RECOMMENDED SAFETY RULES

#### DO

- 1 Wear leather gloves, adequate clothing and heavy shoes, tightly laced.
- 2 Wear a helmet or use a shield when in the vicinity of welding flash arc.
- 3 Remove combustible materials from the vicinity of welding or gas cutting operations.
- 4 Get prompt first aid if burned or if your eyes have been injured by a flash or flying scale.
- 5 Wear safety goggles when chipping, grinding, peening or removing slag.
- 6 Keep booth and floor clean and clear of electrode stubs, scraps of metal and carelessly disposed tools.
- 7 Know how to use the fire extinguishers and memorize their location.
- 8 See that hose connections are tight and that cables do not become hot.
- 9 Make proper provision for venting exhaust gases when operating the tip of the torch in confined spaces.

#### DON'T

- 1 Look at a welding flash with the naked eye.
- 2 Use cracked or defective helmets or shields.
- 3 Hang a torch with its hose on regulators or cylinder valves.
- 4 Pick up hot objects.
- 5 Use electrode holders with defective jaws.
- 6 Leave the electrode holder on the table or in contact with a grounded metallic surface. Replace it on the support provided for that purpose.
- 7 Weld on closed containers or on containers that have held combustible materials. Secure permission from the instructor before welding on *any* container.
- 8 Weld in the vicinity of flammable or combustible materials.

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- 9 Weld on galvanized metal without permission from the instructor.  
(Special care should be taken to provide adequate ventilation.)
- 10 Weld in confined spaces without adequate ventilation.
- 11 Attempt to repair equipment.
- 12 Strike an arc on a compressed gas cylinder.

**NOTE** — For detailed instructions for safety and health requirements in electrode and gas welding and cutting operations, reference should be made to IS : 818-1957\*.

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\*Code of practice for safety and health requirements in electric and gas welding and cutting operations.

## BUREAU OF INDIAN STANDARDS

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37 29 25

117/418 B, Sarvodaya Nagar, KANPUR 208005

21 68 76

Seth Bhawan, 2nd Floor, Behind Leela Cinema, Naval Kishore Road,  
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23 89 23

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52 51 71

Patliputra Industrial Estate, PATNA 800013

26 23 05

Institution of Engineers (India) Building 1332 Shivaji Nagar, PUNE 411005

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27 10 85

†Sales Office is at Novelty Chambers, Grant Road, MUMBAI 400007

309 65 28

‡Sales Office is at 'F' Block, Unity Building, Narashimaraja Square,  
BANGALORE 560002

222 39 71