

भारतीय मानक

वेल्डरों के लिये प्रशिक्षण — रीति संहिता

भाग 2 आक्सीईधन वेल्डिंग

( दूसरा पुनरीक्षण )

*Indian Standard*

TRAINING OF WELDERS – CODE OF PRACTICE

PART 2 OXYFUEL WELDING

( *Second Revision* )

ICS 25.160-10, 03.100.30

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**BUREAU OF INDIAN STANDARDS**

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## FOREWORD

This Indian Standard ( Second Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Welding General Sectional Committee had been approved by the Metallurgical Engineering Division Council.

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 was subsequently revised in 1966 simplifying the course and making it directly related to the actual requirement of the job.

In view of the experience gained and to cater the needs of the welding industry more effectively, the committee has decided to further revise this standard.

In this revision the committee decided to publish this standard in parts. This part covers the practices to be followed for the training of welders for oxyfuel welding. Additional parts of this standard, as proposed, are given under:

Part 1 Manual metal arc welding

Part 3 TIG welding

Part 4 MIG/MAG welding

Part 5 Mechanized welding

Part 1 'Manual metal arc welding' has been published.

# Indian Standard

## TRAINING OF WELDERS – CODE OF PRACTICE

### PART 2 OXYFUEL WELDING

### ( Second Revision )

#### 1 SCOPE

1.1 This code recommends minimum requirements for a course of instruction in gas welding and prescribes certain standard tests, comprising the initial qualification tests 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 this code are:

- a) to enable the trainees to acquire basic knowledge in theory as well as enough skill in practical welding to pass the qualification tests prescribed in this code.
- b) to coach the trainees in the fundamental techniques and safe practices in the use of different gas mixtures such as oxy-acetylene, oxy-propane, etc.

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.

1.3 The standard tests prescribed in this code consist of the following:

- a) *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.
- b) *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.

#### SECTION 1 GENERAL

#### 2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	Title
812 : 1957	Glossary of terms relating to welding and cutting of metals
813 : 1986	Scheme of symbols for welding ( <i>first revision</i> )
818 : 1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations ( <i>first revision</i> )
1278 : 1972	Filler rods and wires for gas welding ( <i>second revision</i> )

#### 3 TERMINOLOGY

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

#### 4 SYMBOLS

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 : 1986.

#### 5 MATERIALS

##### 5.1 Test Plates for Welding

Test plates shall consist of carbon and low alloy steel; cast iron; aluminium, copper, nickel, magnesium and their alloys.

##### 5.2 Consumables for Welding

Filler rods shall conform to IS 1278 : 1972 and corresponding fluxes.

##### 5.3 Gas Mixtures

Oxygen and acetylene are the principal gases used in gas welding. These are supplied generally in different coloured cylinders though in large workshops, piped oxygen and acetylene supplies are often used. Oxygen supports combustion of the fuel gases.

Acetylene supplies both the heat intensity and the atmosphere needed for welding. Hydrogen, natural gas, liquid petroleum gas, propane gas are used only to a limited extent in gas welding.

#### 5.4 Accessories

Aprons, gloves, hose protectors, hose clips, hoses, hose connectors and nuts, wire brush, goggles, spark lighter, cylinder trolley and other tools such as spanners and spindle keys.

### 6 SELECTION OF TRAINEES

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

- a) have minimum educational qualification equivalent to 10th standard;
- b) ability to understand the language of instruction;
- c) no physical or mental disability that precludes safe operation of welding equipment or interferes with full performances of duties of industry; and
- d) the minimum age requirements prescribed in the State and Central Labour laws applicable in the state in which the instruction is conducted.

### 7 LENGTH OF COURSE AND HOURS OF INSTRUCTION

It is recommended that theoretical instructions are given to the trainees for a minimum period of 40 h and practical training for preparation of test plates for welding, use of gas cylinders, and torches, cutting of plates, etc. for 3 h daily minimum for at least 15 working days.

## SECTION 2 EQUIPMENT AND FACILITIES FOR THE TRAINING ESTABLISHMENT

### 8 EQUIPMENTS ACCESSORIES AND CONSUMABLES

#### 8.1 Welding Booths

Each welding booth shall have an area with sufficient clear floor space to allow adequate freedom of movements for the trainee and the instructor. Internally each booth shall be so constructed, lighted and ventilated, as to provide complete protection to the trainee. Suitable positioning jigs shall be provided to facilitate the positional welding.

#### 8.2 Oxy-Acetylene Welding Outfits

One set of oxy-acetylene welding outfits of standard quality shall be provided to each group of trainees consisting of not more than four trainees in each group.

8.3 Adequate quantity of gas mixture, filler rods and fluxes besides parent plates shall be made available to the trainees.

#### 8.4 Testing Apparatus

The training establishment shall possess apparatus suitable for preparing and testing the test specimens

or shall have facilities for having these test specimen prepared and tested elsewhere.

8.5 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 Annex A.

### 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 Section 3. A recommended form of trainee progress chart is given in Annex B.

### 10 REFERENCE MATERIALS

#### 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 Annex C.

#### 10.2 Welding Publications

The training establishment shall make 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 possess the qualification prescribed under 11.2.2. In addition, each instructor shall have the ability to present effective demonstrations and explanation of those portions of the course which he is to teach.

#### 11.2 Qualification 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 and in welding technology with basic educational qualification;
- b) A practical knowledge of the physical properties of the metals and the welding process;

- c) Familiarity with the instructions in welding practices covered in Section 3; and
- d) Familiarity with the instructions 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 subject on which he gives instructions.

### 11.3 Duties of Instructors

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:
  - i) Preparing the trainee for new instruction;
  - ii) Using appropriate methods for presenting the new instruction (demonstration, illustration, explanation, discussion, etc);
  - iii) Providing proper supervision and criticism as the trainee applies his new knowledge and skill; and
  - iv) Supervising the check 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, care, control and conservation of materials and equipment, shop cleanliness and orderliness.

## SECTION 3 COURSE OF INSTRUCTIONS

### 12 GENERAL COURSE OF INSTRUCTION

**12.1** The instruction shall consist of welding practice and lectures in theory. The practical and theoretical training should be suitably interspersed and related to one another. The training shall start with instructions in safety precautions protection of person, protection and care of the equipment. This instruction coming at the very commencement of the course will reduce the risk of disablement of the trainees from such causes as back fire, blindness, etc, and help in preventing explosion to the cylinders 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 by regular welding

equipment. A list of recommended safety rules is given in Annex D and should be used in this instruction.

**12.1.2** For detailed instructions for safety and health requirements in gas welding and cutting operations reference should be made to IS 818 : 1968.

### 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 thickness as appropriate for each individual exercise. The plate shall be reasonably free from scales rust, paint and other defects which adversely affect welding.

**13.1.1** In this 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 satisfaction of the instructor before being allowed to advance to the next exercise.

**13.1.2** 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 tested welds and point out to the trainee any defects that may be in evidence and the reason for such defects or failure of the joint. The techniques of testing shall be as prescribed for the assessment tests ( see 15 ).

**13.1.3** It is recommended that the size of specimens indicated in the various illustrations be maintained wherever possible.

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

### 13.2 Exercises

#### 13.2.1 *Lighting the Torch and Flame Adjustment*

These exercises shall be designed to instruct the trainee to:

- a) readily open and close the different gas cylinders;
- b) light the torch; and
- c) adjust the flame-oxidizing, reducing and neutral flame.

#### 13.2.2 *Running Beads*

These exercises shall include practice of running beads using both right ward, that is, back hand and left ward, that is, forehand techniques of gas welding. Gradually the trainee shall learn to weld in different position. Initially filler rods shall not be used. When the trainees shall be confident in running beads, they shall use filler rods using proper flux. The art of which shall also be imparted during the practice of welding.

### 13.2.3 *Welding of Butt and Fillet Welds in Sheet Metal*

These exercises shall be designed to instruct the trainees in the technique of preparation of assemblies and also making the butt and fillet welds in various positions with or without the use of filler rods and fluxes. The trainees shall also learn the techniques for welding the short flanged edges butt joint ( melt through weld ) without the use of filler rods. The trainees shall be instructed to use different jigs used for welding to help maintain flatness and minimize distortion.

### 13.2.4 *Welding of Butt and Fillet Welds in Thick Plates*

These exercise shall be designed to instruct the trainees in the techniques of edge preparations and prepare test assemblies and also making fillet and butt welds in different positions using filler rods and fluxes. Use of different jigs and proper tacking to maintain flatness and minimize distortion shall also be taught to the trainees.

### 13.2.5 *Resurfacing for Repair Welds*

These exercises shall be designed to instruct the trainees in the technique of depositing of weld beads using repair welds. The trainees shall be instructed to clean the interpass welds property before depositing successive welds beads.

### 13.2.6 *Welding of Pipes and Tubes ( in Vertical Up and Flat Position )*

Exercises should be designed to instruct the trainees for butt welding of pipes and tubes in vertical up and flat positions. The trainees shall be instructed to weld with proper speed and manipulation so as to achieve complete root penetration.

## 13.3 Check Tests

13.3.1 Each trainee shall be required to make specimens on each exercise for check tests as stipulated in 13.2. Each specimen shall be inspected visually for appearance, size contour and defects, etc, till the trainee attains perfection in that exercise.

13.3.2 Check tests in jobs shall be made after sectioning the weld deposited plates, polishing the section and macro etching using 5 to 10 percent nitric acid in alcohol. Weld defects such as slag inclusions porosity, etc, should not be present in the weld beads.

## 14 PREPARATION OF TEST PIECES

14.1 Test welds shall be made on steel plates which shall be reasonably free from rust, oil, paint and other defects which may adversely affect welding.

### 14.2 Butt Weld Test Pieces

The test piece shall conform to the requirements of Fig. 1A for filler rod sizes of 2.5 mm and above and Fig. 1B for filler rod sizes 1.6 and 2.0 mm. The edges to be welded shall be prepared preferably by machining

or by smooth flame cutting. The plates shall be properly tack welded at regular intervals along the line of the weld with tacks about 25 mm. On thicker plates, the method usually adopted is to arrange the two plates so that they diverge from the point where welding commenced. This space may be maintained by the use of clamps and is particularly applicable to the longitudinal seams.

14.2.1 The plates shall be slightly pressed so that they are reasonably flat after welding. All beads shall be deposited with 4 mm filler rods including the sealing run. The weld shall be back chipped to a semicircular groove to a depth of 3 mm. After back-chipping, the sealing run shall be deposited.

### 14.3 Fillet Weld Test Pieces

The test pieces shall conform to the requirements of Fig. 2A for filler rod sizes of 2.5 mm and above and Fig. 2B for filler rod sizes 1.6 and 2.0 mm. The test pieces shall be properly tack welded at regular intervals along the line of the weld with tacks about 25 mm to minimize distortion. The test weld shall be deposited using 4 mm filler rods to deposit a weld of 6 mm leg length.

14.4 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 the following:

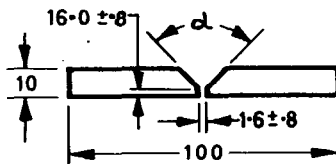
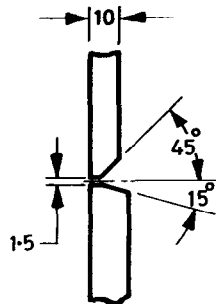
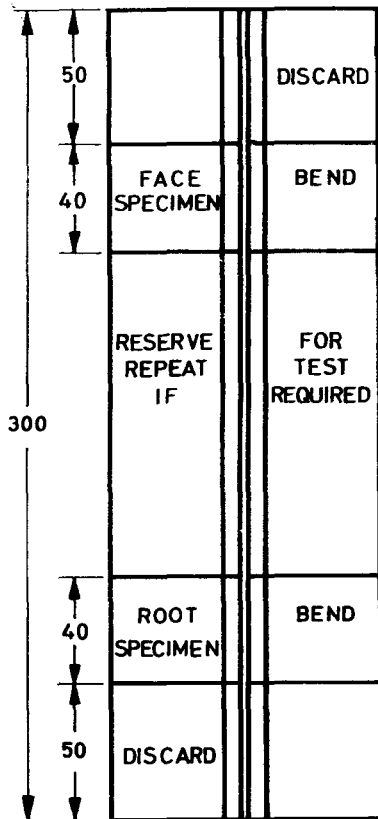
- a) The trainee,
- b) The position of welding, and
- c) The material.

## 15 ASSESSMENT

### 15.1 By Visual Examination

The test pieces shall be visually examined for the following:

- a) *Dimension of weld deposit* – The dimensions of the weld shall be checked. The finished weld shall be slightly over rather than under the specified size.
- b) *Shape of profile* – In butt welds, the surface shall be slightly convex. In fillet welds, the contour may vary from concave to convex according to the welding position and technique followed.
- c) *Uniformity of surface* – The height and spacing of ripples shall be uniform.
- d) *Degree of under cut* – The welded joint shall be free from under cuts, but slight intermittent occurrences may be disregarded provided that such undercut is not in the form of a sharp notch.
- e) *Freedom from other defects* – The surface of the weld shall be free from porosities, cavities and slag inclusions.

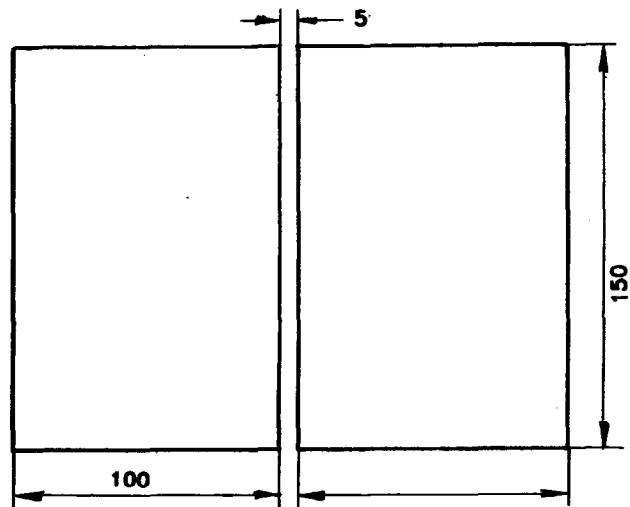


Position	$\alpha$
F	60° - 65°
H - V	60° - 65°
V (Up)	70° - 75°
V (Down)	70° - 75°
O	80° - 85°

Weld to be stopped and restricted with a fresh electrode within central 50 mm.

All dimensions in millimetres.

1A For Filler Rods of Sizes 2.5 mm and Above



1B For Filler Rods of Sizes 1.6 mm and 2.0 mm

FIG. 1 METHOD OF MAKING BUTT WELD TEST SPECIMEN FOR INITIAL QUALIFICATION TEST AND ANNUAL TEST

## 15.2 By Testing

### 15.2.1 Butt Welds

After visual assessment of the butt welded tests pieces, two bend specimens each 40 mm wide shall be cut from the test assembly. The upper and lower surfaces of the weld shall be made flush with the parent plates. Tool marks should be avoided as they lead to localization of stress and may cause premature failure. The sharp corners of the test specimens shall be rounded

to a radius not exceeding 1 mm. The specimens then shall 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 3. One test specimen shall be tested with the face of the weld in tension and the other with the root in tension. A good weld shall 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 shall not be regarded as cause for rejection.

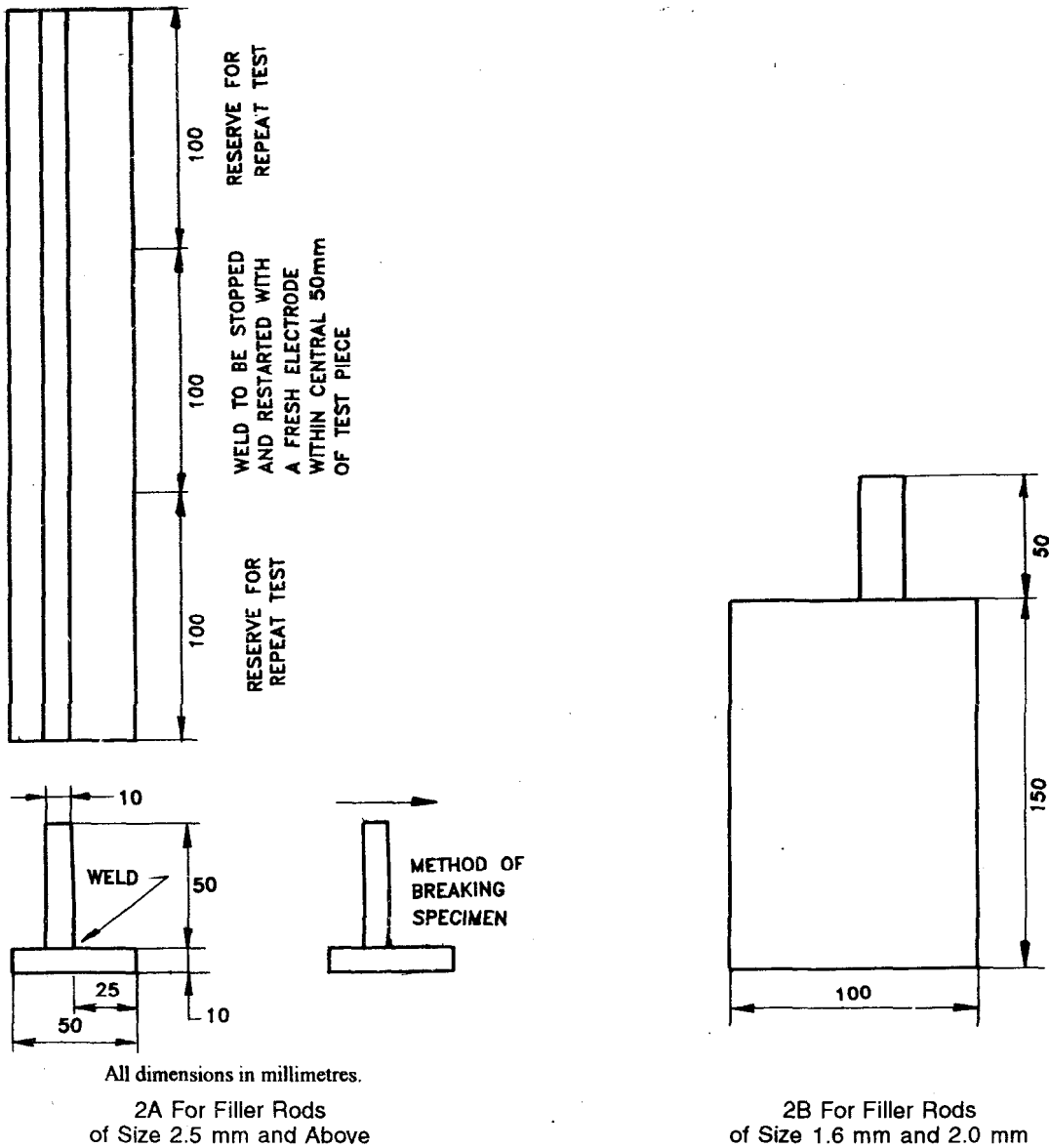


FIG. 2 METHOD OF MAKING FILLET WELD TEST SPECIMEN FOR INITIAL QUALIFICATION, ANNUAL AND PERIODIC CONTROL TEST

Prior to bending the edges of the test specimen shall be etched to reveal the weld, if this is not sufficiently discernible to ensure that the bending takes place at the centre line of the weld.

#### 15.2.2 Fillet Weld

After the visual assessment, the test assembly shall be cut into 3 equal portions and break open along the weld and the weld fracture examined. The weld fracture shall be examined, keeping in view of the following factors:

- Degree of fusion* – Fusion shall be completed over the whole area of the joint surfaces. The fracture shall be inspected for lack of fusion.

- 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 shall reach the corner.

The fracture shall have a clean uniform appearance and the weld metal shall be free from cavities and slag inclusions.

15.2.3 The butt welded pipes/tubes shall be sectioned and etched with suitable etching after grinding the welded areas. There should be reasonable penetration and absence of weld defects like under cut, porosity, etc.



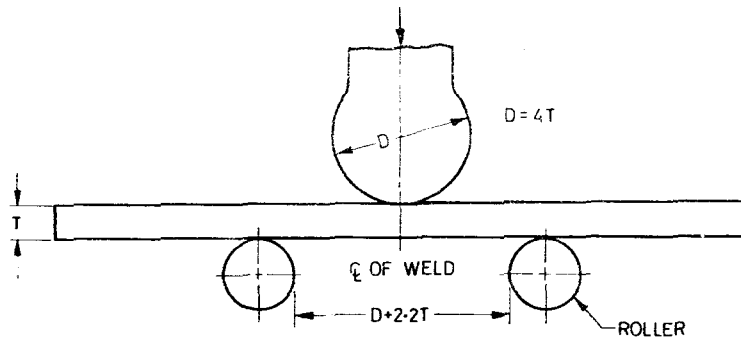


FIG. 3 METHOD OF CARRYING OUT BEND TEST

**ANNEX A**

( Clause 8.5 )

**ACCESSORIES AND EQUIPMENT RECOMMENDED FOR TRAINING ESTABLISHMENT FOR WELDERS****A-1 SHOP MACHINES AND ACCESSORY EQUIPMENT**

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 specimen;
- c) Two-ended pedestal grinder with 25 cm x 3 cm ( or larger ) coarse wheels and wheel dresser;
- d) Heavy power hacksaw ( preferably 25 mm 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 tonnes or larger capacity;
- j) Fire extinguishers, chemical type;
- k) Fire buckets with water;
- m) Sand bags of fire protection;
- n) Scrap box 90 cm x 60 cm x 30 cm;
- p) Chartboard for progress chart, instructional charts and notices;
- q) Small platform scales for weighing electrodes, etc;
- 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, film strips and slides have been found to be of assistance.

**A-2 SMALL TOOLS AND ACCESSORIES**

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 );

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- k) Small steel wedges;
- m) Medium coarse files for rounding edges of test specimen; and
- n) Soapstone marking crayon.

**A-3 REQUIREMENTS FOR EACH TRAINEE WHILE WELDING**

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 clamps ( 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.

**A-4 EQUIPMENT FOR TRAINEE OBSERVERS AND INSTRUCTORS WHILE OBSERVING**

While welding each instructor and trainee shall be supplied with the following equipment:

- a) Helmet or hand shield with suitable coloured filter glass and clear cover glass, and
- b) Weld gauges ( *see* ISI Handbook of Manual Metal Arc Welding for Welders ).

**ANNEX B**

( *Clause 9.2* )

**RECOMMENDED FORM OF TRAINEE PROGRESS CHART**

Sl No.

Name.....

Address.....

Local Address.....

Employer's Name and Address.....

Course 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**

**Lighting the Torch and Flame Adjustment**

Date

Day

Opening/closing of gas cylinders

Lighting the torch

Adjusting the flame

Status of progress

**Lesson 2**  
**Running Beads**

	Date	Day
Right ward/back hand ( flat position, without filler rod )		
Left ward/forhand ( flat position, without filler rod )		
Running of bead with filler rod ( flat position )		
Running of bead ( in different positions with filler rods )		
Status of progress		

**Lesson 3**  
**Butt and Fillet Weld in Sheet Metal**

	Date	Day
Fillet weld in different positions, without filler rod		
Butt weld in different positions, with filler rod		
Fillet weld in different positions, with filler rod		
Butt weld in different positions, with filler rod		
Short flanged edged butt joint		
Making check test specimen No. 1		
Making check test specimen No. 2		
Status of progress		

**Lesson 4**  
**Butt and Fillet Welds in Thick Plate**

	Date	Day
Butt and fillet welds in thick plate		
Edge preparation		
Fillet weld in different position using filler rods		
Butt weld in different position using filler rods		
Making check test specimen		
Status of progress		

**Lesson 5**  
**Repair of Welding/Joining**

	Date	Day
Depositing of weld beads in minimum of two beads of worn-out surfaces		
Status of progress		

**Lesson 6**  
**Pipes and Tubes**

	Date	Day
Butt welding of pipes/tubes in flat and vertical up position		
Status of progress		

## ANNEX C

### ( Clause 10.1 )

#### RECOMMENDED SYLLABUS FOR THE TRAINING COURSE

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
First Week	<p><b>Theory</b></p> <p>a) <i>Safety in Welding</i></p> <p>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:</p> <ol style="list-style-type: none"> <li>i) Protection of person, that is, proper shoes, clothing, hand shield, helmet or goggles with the right shade of filter, adequate ventilation.</li> <li>ii) Protection of property, that is, safeguarding combustible material, protection from hot slag, flying sparks and flame, availability of fire protection equipment etc.</li> <li>iii) Protection and care of equipment, that is, storage and handling of oxygen and acetylene cylinders ( or acetylene generators where low pressure system is used ), operation of pressure regulators, handling of blowpipe, care of hose and equipment, etc.</li> <li>iv) Safety rules recommended in IS 818 : 1957.</li> </ol> <p>b) <i>Welding Process</i></p> <p>Instruction in this subject shall be designed to acquaint the trainee with the principal welding process in common use, with particular emphasis on gas welding.</p> <p><b>Practice</b></p> <ol style="list-style-type: none"> <li>a) Lighting the torch and flame adjustment.</li> <li>b) Running beads</li> </ol> <p>Film shows, discussions, etc.</p>		7
			30
Second Week	<p><b>Theory</b></p> <p>a) <i>Gases</i></p> <p>The elementary knowledge about the various gases used in gas welding.</p> <p>b) <i>Welding and Gas Cutting Equipment</i></p> <p>Instruction in this subject shall be designed to give the trainee an idea of the characteristics of gas welding equipments. Fittings and dismantling of manual gas cutting equipment, flame adjustment and care of equipment should also be covered.</p> <p><b>Practice</b></p> <ol style="list-style-type: none"> <li>a) Butt and fillet welds in sheet metal</li> <li>b) Fillet welds in sheet metal</li> </ol> <p>Film shows, discussions, etc.</p>		7
			30
Third Week	<p><b>Theory</b></p> <p>a) <i>Elementary Welding Metallurgy</i></p> <p>Instruction in this subject shall be designed to give the trainee an</p>		7

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) *Elementary Blue Print Reading*

Instruction in this subject shall be designed to give the trainees an elementary knowledge of factors involved in reading simple blue prints in order to assist him in comprehending common welding terms and symbols used.

**Practice**

30

Butt and fillet welds in thick plates.

Film shows, discussions, etc.

Fourth  
Week

**Theory**

7

*Welding Procedures, Terms and Symbols*

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 gas welding and the standard symbols used for detailing weld sizes and showing welds on drawings shall be explained.

**Practice**

30

Resurfacing

Film shows, discussions, etc.

Fifth  
Week

**Theory**

7

a) *Quality of Welds*

Instruction in this subject shall be designed to familiarize the trainees with the characteristics of good welds and causes of defective welds. The topic for discussion shall include (i) soundness, (ii) fusion, (iii) penetration, and (iv) weld contours and dimensions.

b) *Inspection and Testing of Welds*

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 of a discussion of the trainees welds before and after testing. The following points in particular should be covered:

- i) Visual inspection and use of weld gauges;
- ii) Bend, tensile impact and pressure tests; and
- iii) Non-destructive methods such as radiographic and magnetic particle inspection.

**Practice**

30

Welding of pipes and tubes

Film shows, discussions, etc.

Sixth  
Week

**Theory**

7

Same as fifth week — Further lectures

<i>Period</i>	<i>Details of Course</i>	<i>Position</i>	<i>Hours of Instruction</i>
	<b>Practice</b>		30
	Same as fifth week.		
	Film shows, discussions, etc.		
Seventh Week	<b>Theory</b>		7
	a) <i>Characteristics of Filler Rods</i>		
	instruction in this shall be designed to familiarize the trainee with the different types of electrodes used in gas 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.		
	<b>Practice</b>		30
	Revision		
	Film shows, discussions, etc.		

## ANNEX D

( 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 or 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 studs, 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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