SLS 887 : 1990

SRI LANKA STANDARD
CODE OF PRACTICE FOR BASIC TRAINING AND TESTING OF MANUAL METAL ARC WELDER

SRI LANKA STANDARDS INSTITUTION

CONTENTS

~~Draft~~ Sri Lanka Standard

CODE OF PRACTICE FOR BASIC TRAINING AND TESTING OF MANUAL METAL ARC WELDERS

FOREWORD

This standard was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 90/11/29, after the draft, finalized by the Drafting Committee on Welding, had been approved by the Mechanical Engineering Divisional Committee.

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

a) to provide the trainee with a basic knowledge of welding theory,

b) to give the trainee a good understanding of the proper methods of manual 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 coach the trainee in the fundamental techniques and safe practices of manual metal arc welding.

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

In order to simplify the course of training and to make the course directly related to the actual requirements of the job, 14 on weld excercises is split into the following three sub-clauses:

14.1 – Butt welds in flat position and fillet welds in flat and horizontal position,

14.2 – Butt and fillet welds in vertical position and butt welds in horizontal position,

14.3 – Welding in overhead position

Welders who, will normally be required to weld only the types of joints in the positions described under 14.1, will have to undertake training specified in 14.1.
Welders who have to in addition, weld the types of joints in positions described in 14.2, will be required to be trained in positions specified in 14.2 also after they have completed the training specified in 14.1 satisfactorily. Welders who would be required to carry out welding work in all positions, will be required to be trained in positions specified in 14.1, 14.2 and 14.3 in that order.

The assistance derived from the publications of the International Organization for Standardization (ISO), and the Bureau of Indian Standards (BIS), in the preparation of this standard is gratefully acknowledged.

SECTION 1 : GENERAL

1 SCOPE

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

2 REFERENCES

ISO	630	Structural steels
ISO	2553	Welds - Symbolic representation on drawings
SLS	414	Covered electrodes for the manual metal arc welding of mild steel
SLS	727	Code of safety for welding
SLS	888	Definition of welding positions
SLS	....*	Glossary of terms in welding

3 DEFINITIONS

For the purpose of this code definitions given in SLS ..* shall apply.

* 'Glossary of terms in welding' (under preparation)

4 SYMBOLS

For the purpose of this code and unless otherwise defined in this code the symbols used shall have meanings assigned to them in ISO 2553.

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 Sri Lanka Government Labour Laws.

6 TRIAL PERIOD OF INSTRUCTION, DURATION OF COURSE AND HOURS OF INSTRUCTION

6.1 Trial period of instruction
In the begining of the course there shall be a trial or probationary period, not exceeding 30 hours, 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.

NOTE
The exact period should be obtermined by the training establishment.

6.2 Minimum duration for weld exercises
It is recommended that each trainee devotes a minimum of 75 hours for weld exercises specified in 14.1 and 14.2 each and 50 hours for exercises specified in 14.3 of this code to actual welding, This excludes the 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.

6.3 Duration of instruction in welding theory
It is recommended that each trainee devotes 50 hours to instruction in welding theory prescribed in Section 3 (also see Appendix A).

6.4 Duration 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.

7 CERTIFICATE OF QUALIFICATION

7.1 Upon completion of the course and fulfilment of the requirements prescribed in this code, the trainee shall be granted a certificate indicating that the trainee has passed the tests prescribed in this code. Further, these tests together with their results shall be listed on the certificate. Of 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 certificate.

7.2 The certificate 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, etc. A recommended form for this certificate is given in Appendix B.

SECTION 2: TRAINING ESTABLISHMENT

8 EQUIPMENT AND SHOP FACILITIES

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 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, 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). SLS 727 and all relevant statutary requirements shall be complied with.

8.2 Positioning jig
Suitable positioning jigs shall be provided to facilitate the execution of the welding exercises and tests prescribed in this code. A suggested design of such equipment is given in Appendix C.

8.3 Arc welding machines
The training establishment shall be equipped with at least 50 per cent as many arc welding machines or welding outlets as there are trainees in the shop class (see 6.2 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 continuous welding current rating of 300 A or more be available.

8.4 Materials for welding

There shall be an adequate supply of materials such as mild steel plates and electrodes for the exercises prescribed in this code.

8.4.1 Steel used as parent metal for testing according to provisions of this code shall conform to ISO 630.

8.4.2 Electrodes used for all tests, according to provisions of this code, shall be general purpose mild steel electrodes conforming to the requirements of SLS 414.

NOTE
Electrodes should be stored at controlled temperature and humidity according to manufacturer's instructions

8.5 Testing apparatus
The training establishment shall possess apparatus suitable for preparing and testing the test specimens as prescribed in this code or shall have facilities for having these test specimens prepared and tested elsewhere.

8.6 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. (also see SLS 727 for safety in welding and cutting). A list of accessories and equipment recommended for a training establishment is given in Appendix D.

9 SUPERVISION

9.1 Number of trainees per instructor
Each shop class should be restricted to not more than 8 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 prescribed in this code and the results of all tests prescribed in Section 4 of this code. A recommended form of trainee progress chart is given in Appendix E.

1Ø REFERENCE MATERIAL

1Ø.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 A .

1Ø.2 Welding publications
The training establishment shall have suitable reference material consisting of books, manuals, periodicals, codes, standards, etc. available for trainees use.

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 14) shall possess the following qualifications:

a) A minimum of three years' experience as a metal arc welder and one year in the capacity of a supervisor.

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 and testing of welds;

d) Familiarity with the topics in welding theory covered in Section 3 of this code; 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 instructors shall be charged with the responsibility of giving instruction in welding practice and welding theory, as prescribed in Section 3 of this code. 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 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,
i) care, control and conservation of materials and equipment, and
ii) shop cleanliness and orderliness.

d) Keeping attendance records and recording trainees' progress.

SECTION 3 : COURSE OF INSTRUCTION

12 GENERAL

The instruction shall consist of welding practice and lectures in theory (see Appendix A for specimen syllabus). The practical and theoretical training should be suitably interspersed and related to one another. The training shall start with instruction in safety precautions, protection of persons 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 The instruction in safety shall be given before the trainees are permitted to use any welding equipment. A list of recommended safety rules is given in Appendix F, and should be used in this instruction.

12.2 For detailed instructions for safety and health requirements in electric and gas welding and cutting operations reference should be made to SLS 727.

13 INSTRUCTION IN WELDING PRACTICE

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 code. The steel used for weld exercises shall be reasonabley 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 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.

13.2 In the list of suggested welding exercises 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.

13.3 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 evidance and the reason for such defect or failure of the joint. The techniques of testing shall be as prescribed for the check tests.

13.4 It is recommended that the work pieces be set up and tack welded before welding.

13.5 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.

14 WELD EXERCISES

14.1 Butt-welds in flat position and fillet welds in flat and horizontal position

14.1.1 Group A exercises : Striking arc and flat position bead welding : These exercises 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 as follows :

TABLE 1- Details of welding exercises in Group A

Type of weld and procedure	Weld position	Joint preparation
Striking arc Tapping method and scratch method (see Fig.1)	flat	-
Running bead Use 3.15 mm, 4 mm, 5 mm and 6.3 mm electrodes. Deposit continuous beads with craters properly filled. Re-strike arc without excessive deposits. Make long continuous beads in all directions. (see Fig. 2 and Fig. 3B)	flat	
Bead welds Different weaving techniques in all directions; that is, left to right, right to left towards and away from the operator. Use 3.15 mm 4 mm and 6.3 mm electrodes	flat	-

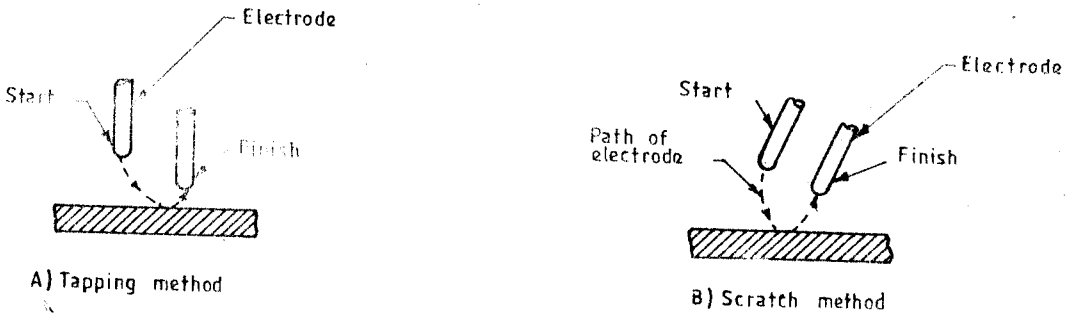


FIGURE 1 - Striking the arc

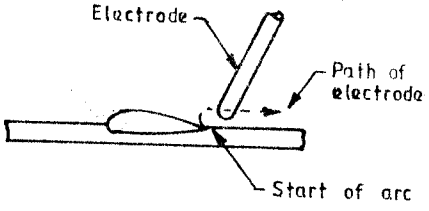


FIGURE 2 – Re-striking the arc

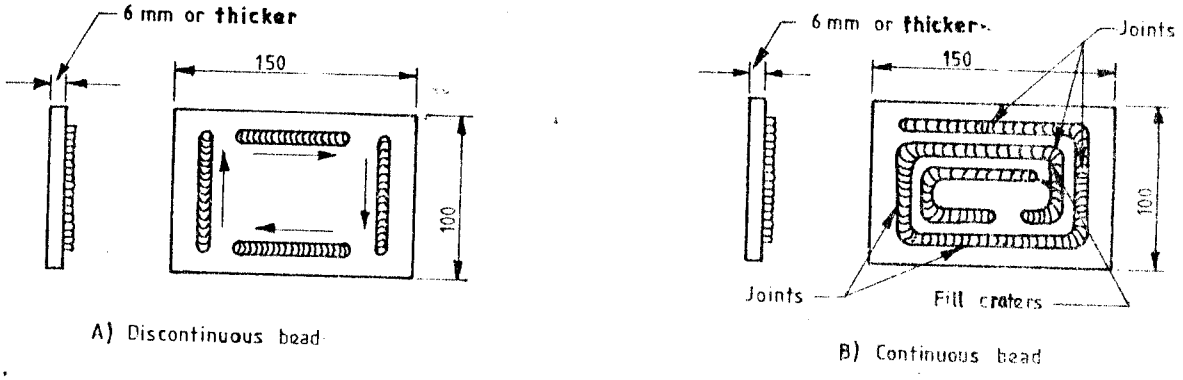


FIGURE 3 – Bead technique

All dimensions in millimetres

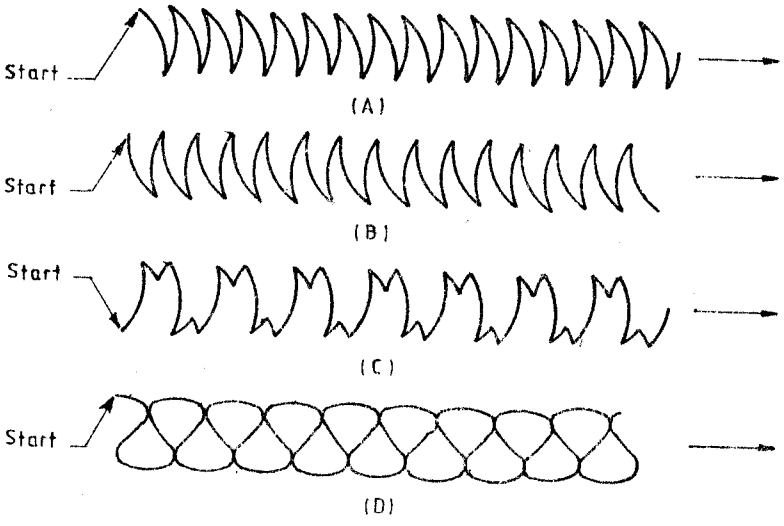
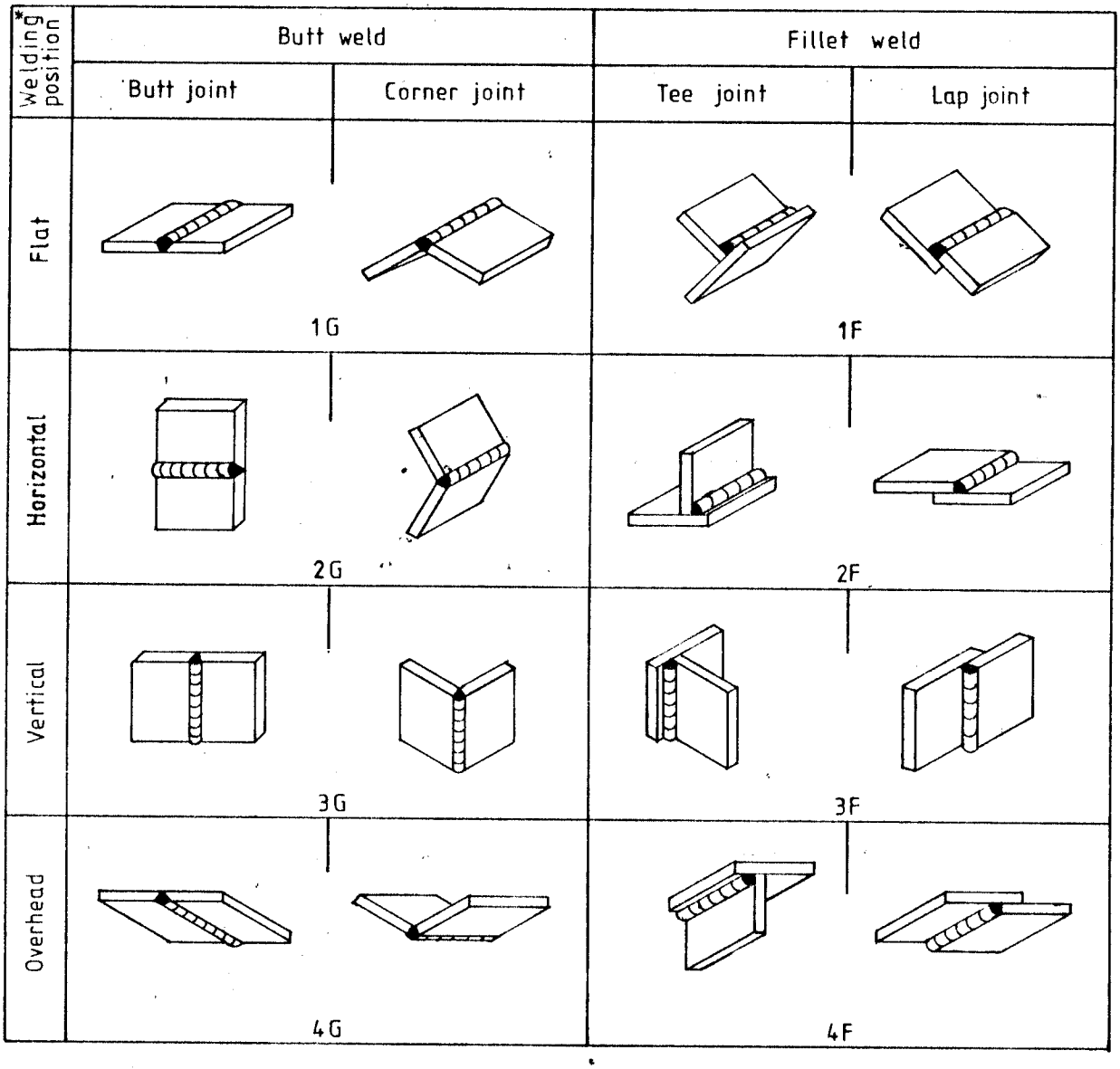


FIGURE 4 – Weaving technique



* NOTE :
See SLS-888 'Specification for the definition of welding positions'

FIGURE 5 - Illustration of welding positions

14.1.1.1 Check tests on Group A exercises
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 of uniform appearance and width in all directions without excessive deposits using different weaving techniques(see Fig.**4**).

14.1.2 Group B exercises : Butt joints and fillet joints in flat position

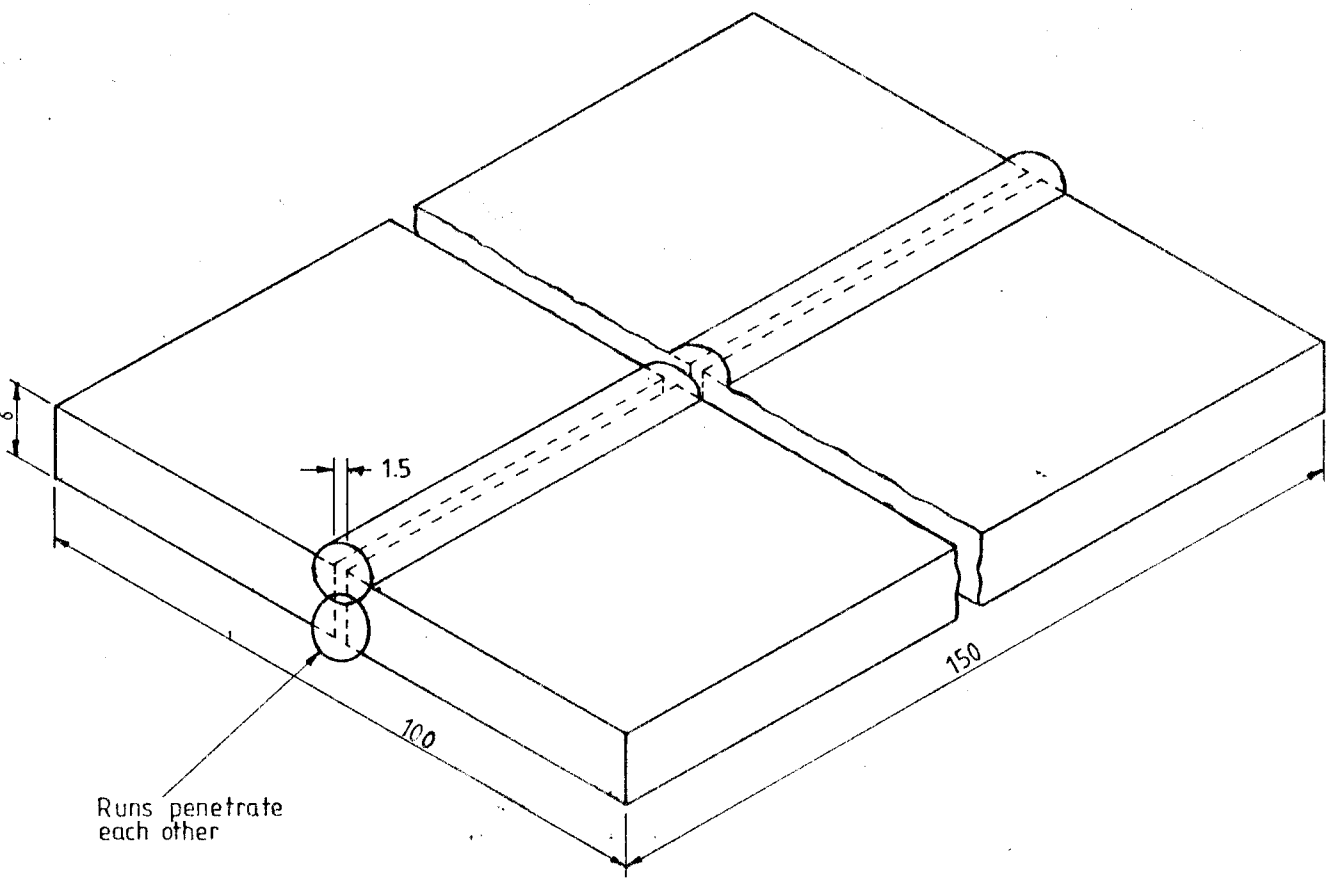
These exercises should be designed to instruct the trainee in the technique of making corner, fillet and butt welds in the flat position as follows :

TABLE 2 - Details of welding exercises in Group B

Type of weld and procedure	Weld position (see Fig 5)	Joint preparation
Corner joint First run with 4 mm electrode and second run with 5 mm electrode using weaving technique.	1 G	see Fig. **8B**
Single-run fillet Weld with 4 mm electrode to obtain a 6 mm fillet	1 F	see Fig. 7
Multi-run fillet First run with 4 mm electrode and second run with 6.3 mm electrode to obtain a 10 mm fillet.	1 F	see Fig 7
Butt joint First run with 3.15 mm electrode and second and third runs with 4 mm and 5 mm electrodes respectively.	1 G	single V see Fig.**8A**
Multi-run butt joint One run on each side using a 5 mm electrode	1 G	see Fig.6

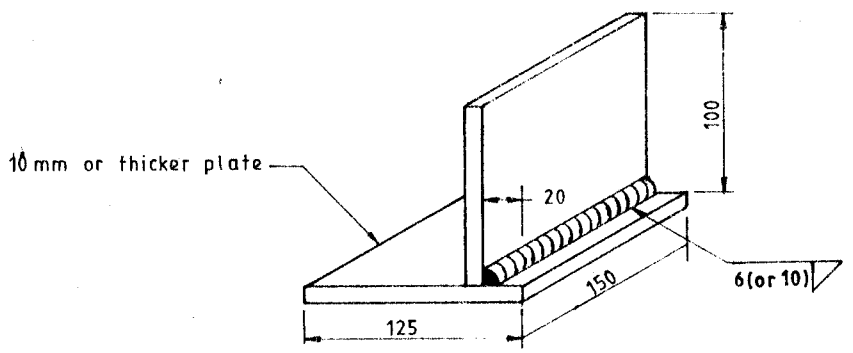
14.1.2.1 Check tests on Group B exercises

The trainee shall make two specimen welds conforming to the requirements in Table 2A.

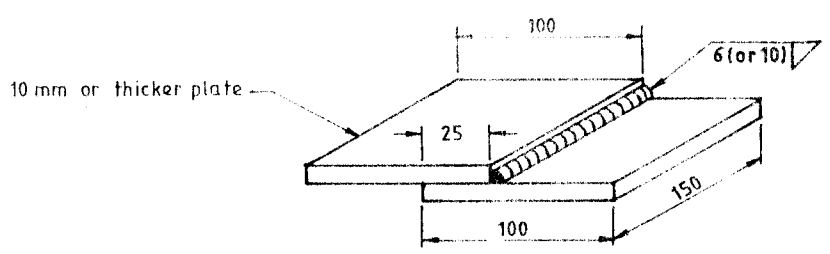


All dimensions in millimetres

FIGURE 6 – Butt weld (square edge)



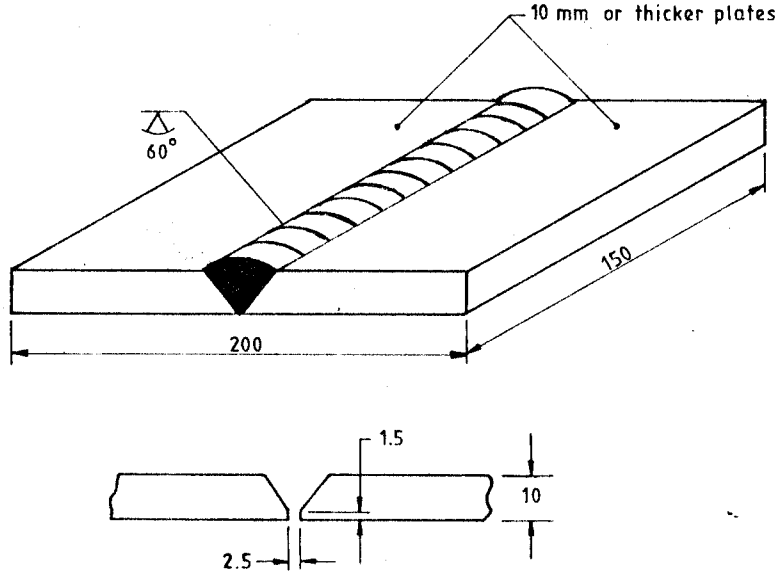
(A)



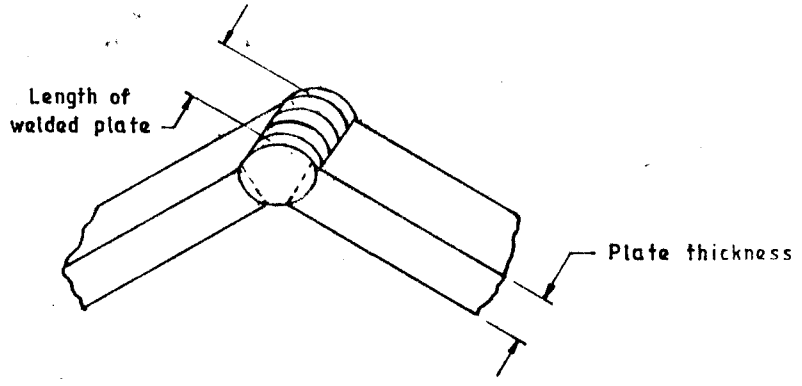
(B)

All dimensions in millimetres

FIGURE 7 – Forms of joint for fillet weld specimen



A) Single V-butt joint



B) Details of corner joint

All dimensions in millimetres

FIGURE 8 - Forms of joint for butt weld specimen

TABLE 2A - Details of check test on Group B exercises

Type of weld and procedure	Weld position (see Fig.5)	Joint preparation
Specimen 1 Weld in a single run with a 5 mm electrode	1 F	see Fig. 7
Specimen 2 Weld in multi-runs with a 3.15 mm electrode for the root run and a 5 mm electrode for the succeeding runs	1 G	see Fig. 8A

14.1.2.1 a) Each weld shall be inspected visually, checked for size and contour with a suitable weld gauge and then ruptured for internal examination (see Fig.9). Each weld shall be asseessed on the basis of provisions lunder 15.

14.1.3 Group C exercises : Fillet joints in the horizontal position

These exercises shall be designed to instruct the trainee in making fillet welds in the horizontal position using 3.15 mm or larger electrodes. The following exercises shall be included in this group :

TABLE 3 - Details of weld exercises in Group C

Type of weld and procedure	Weld position (see Fig.5)	Joint preparation
Single-run fillet Use 4 mm and 5 mm electrodes to deposit a 6 mm fillet	2 F	see Fig. 7
Multi-run fillet Use 4 mm electrode to deposit 10 mm fillet in three runs	2 F	see Fig. 7

14.1.3.1 Check tests on Group C exercises

The trainee shall make two specimen welds conforming to requirements in Table 3 A.

TABLE 3 A - Details of check tests on Group C exercises

Type of weld and procedure	Weld position (see Fig.5)	Joint preparation
Specimen 3 Weld in a single run with a 4 mm electrode	2 F	see Fig. 7
Specimen 4 Weld in a single run with a 5 mm electrode	2 F	see Fig. 7

14.1.3.1 a) Each weld shall be inspected visually, 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 under 15.

14.2 Butt and fillet welds in vertical position and butt welds in horizontal position

14.2.1 Group D exercises : Welding in vertical position.

These exercises shall be designed to instruct the trainee in making bead, fillet and butt welds in the vertical position. For the exercises requiring welding in the vertical down direction electrodes suitable only for this purpose shall be selected. The exercises given in Table 4 shall be included in this group.

TABLE 4 - Details of weld exercises in Group D

Type of weld and procedure	Weld position	Joint preparation
Bead weld : vertical up and down Practice bead welds both up and down using 3.15 mm, 4 mm and 5 mm electrodes.	see Fig. 3	see Fig. 3
Single-run fillet welds : vertical up Obtain 6.3 mm fillet with 4mm electrode	3F (see Fig 5)	see Fig.7
Multi-run fillet welds : vertical up Obtain 10 mm fillet using 4mm electrode for first run and 5 mm electrode for the second run	3 F (see Fig. 5)	See Fig 7
Butt joints Make the joint with three runs using 3.15 mm electrode for the first run and 4 mm electrodes for the second and third runs	3 G (see Fig. 5)	single vee see Fig. 8A
Corner joint Weld vertical down with 3.15 mm and 4 mm electrodes	3 G (see Fig. 5)	see Fig 8B

14.2.1.1 Check tests on Group D exercises

The trainee shall make two specimen welds conforming to the requirements in Table 4A

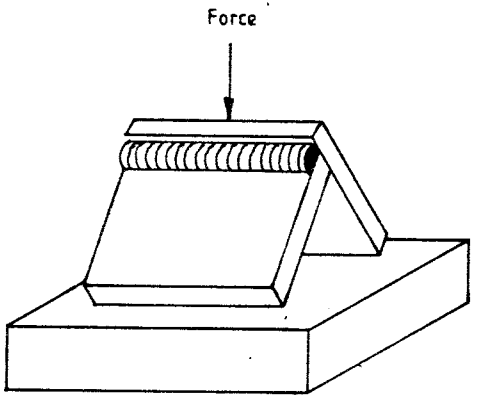
TABLE 4 A - Details of check tests on Group D exercises

Type of weld and procedure	Weld position (see Fig.5)	Joint preparation
Specimen 5 Weld in a single run with a 4 mm electrode. After visual inspection and gauging weld shall be increased making additional runs to form 10 mm fillet.	2 F	see Fig. 7
Specimen 6 Weld in multi-runs. Use 3.15 mm electrode for the rirst run and 4 mm electrodes for the subsequent runs.	2 F	single vee (see fig.8A)

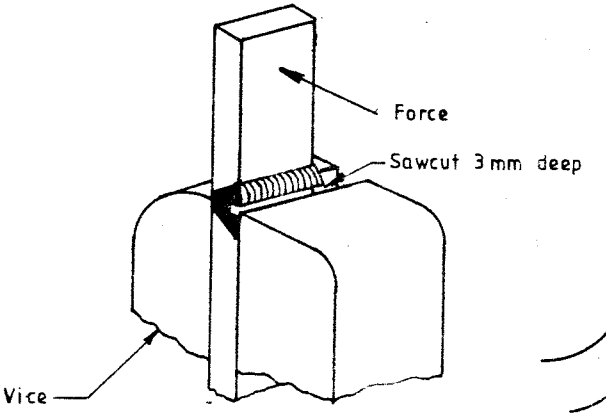
14.2.1.1 a) Eech weld shall be inspected visually, checked for size and contour with a suitable weld gauge and then ruptured for internal examination (see Fig. 9). Each weld shall be assessed on the basis of provisions under **15.**

14.2.2 Group E exercises : **Welding butt joints in horizontal position.**

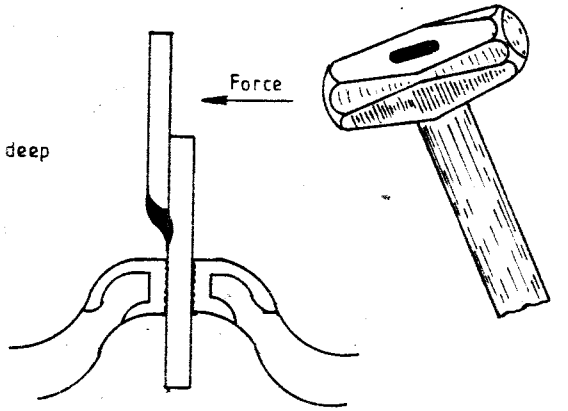
These exercises shall be designed to instruct the trainee in making bead welds and butt joints in horizontal position. The exercises given in Table 5 shall be included in this group.



A) For form of joint illustrated in Fig. 7A

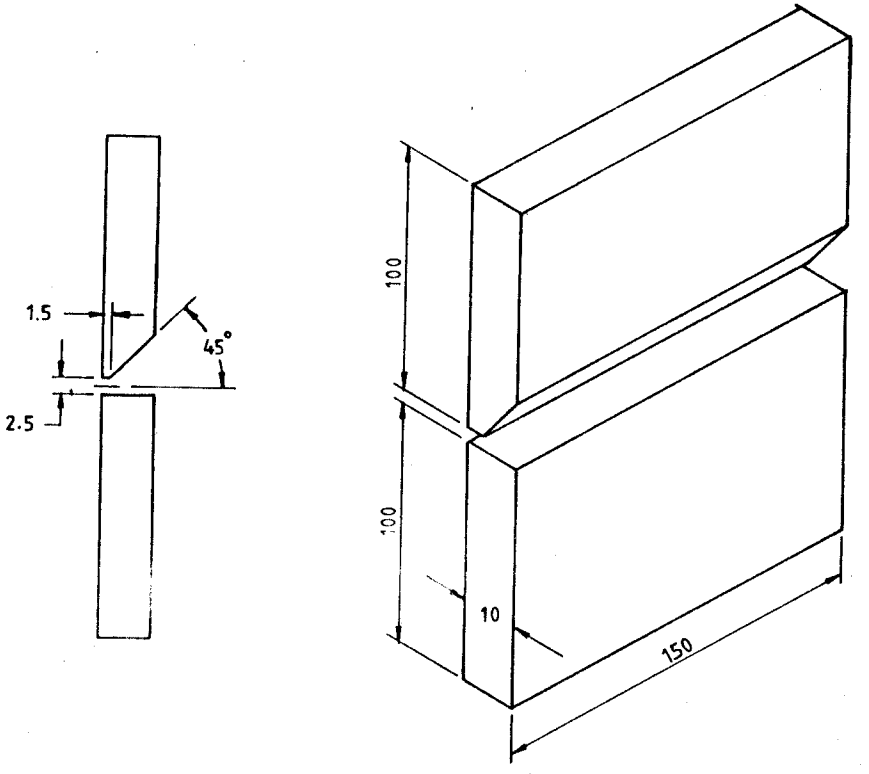


B) For form of joint illustrated in Fig. 8



C) For form of joint illustrated in Fig. 7B

FIGURE 9 - Method of rupturing check test specimens



All dimensions in millimetres

FIGURE 10 – Joint preparation for butt welds

TABLE 5 - Details of weld exercises in Group E

Type of weld and procedure	Weld position	Joint preparation
Bead weld and reinforcing pad Practice deposition of beads using 3.15 mm and 4 mm electrodes	horizontal	see Fig. 3
Butt joints Build up weld with approximately 4 straight beads without weaving. Use 3.15 mm electrode for first run and 4 mm electrode for subsequent runs	2 G	one plate grooved (see Fig.10)
Butt joints Build up weld with approximately five beads without weaving. Make first run with 3.15 mm electrode and subsequent runs with 4 mm electrodes	2 G	double-vee (see Fig. 14 A)

14.2.2.1 Check tests on Group E exercises
The trainee shall make one specimen weld conforming to the requirements in Table 5A.

TABLE 5 A - Details of check tests on Group E exercises

Type of weld and procedure	Weld position	Joint preparation
Specimen 7 Make weld in multi-run with 3.15 mm electrode for the first run and 4 mm electrode for the subsequent runs.	2 G (see Fig.5)	one plate vee grooved (see Fig. 10)

14.2.2.1 a) Each weld shall be inspected visually, 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 under 15.

14.3 Welding in overhead position

14.3.1 Group F exercises - Welding in overhead position

These exercises shall be designed to instruct the trainee in making bead, fillet and butt welds in the overhead position. Th exercises given in Table 6 shall be included in this group.

TABLE 6 - Details of weld exercises in Group F

Type of weld and procedure	Weld position	Joint preparation
Bead welds Practise striking arc and depositing beads with 3.15 mm and 4 mm electrodes	(see Fig. 3)	-
Fillet welds (single-run) Make 5 mm fillet weld with a 4 mm electrode.	4 F (see Fig. 5)	see Fig. 7
Multi-run fillet weld Make 10 mm fillet weld in three runs using 4 mm electrode.	4 F (see Fig. 5)	see Fig. 7
Butt welds Weld the joint in three layers using weaving technique for the last two runs. First two layers with 3.15 mm electrode and the final layer with 4 mm electrode.	4 G (see Fig. 5)	double V (see Fig. 8A)

14.3.1.1 Check tests on Group F exercises

The trainee shall make two specimen welds conforming to the requirements in Table 6A.

TABLE 6 A - Details of check tests on Group F exercises

Type of weld and procedure	Weld position (see Fig. 5)	Joint preparation
Specimen 8 Weld in a single-run with a 4 mm electrode. After visual inspection and gauging increase the size of weld by one or more additional runs.	4 F	see Fig. 7
Specimen 9 Weld in multi-run using 3.15 mm electrode for first run and 4 mm electrodes for subsequent runs	4 G	see Fig.8

14.3.1.1 (a) Each weld shall be inspected visually, 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 provisions under **15.**

15 ASSESSMENT OF CHECK TEST WELDS

There shall be two types of inspection of welds for the assesement of quality. One is inspection before fracture and the other is inspection after fracture. In each inspection the following parameters pertaining to the quality shall be assessed.

15.1 Inspection before fracture

15.1.1 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.

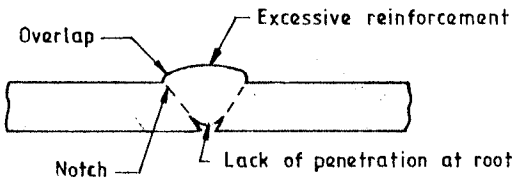
In butt welds the surface should be slightly convex. Typical profile views for butt welds have been illustrated in Fig. **11.**

In fillet welds the contour may vary from concave to convex. Typical profile views for normal fillet welds have been illustrated in Fig. 12.

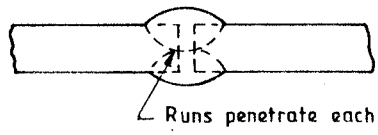
NOTE

The profile of the weld is affected by the type of filler material or electrodes used, the position of joint and the welding technique.

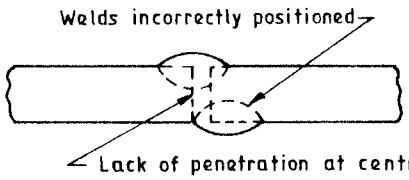
A) Desirable profile in V-Butt



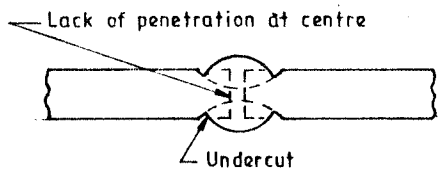
B) Undesirable profile in V-Butt



C) Desirable profile in unprepared Butt, weld each side

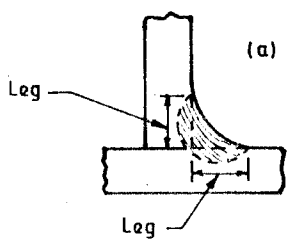


D) Undesirable profile in unprepared butt

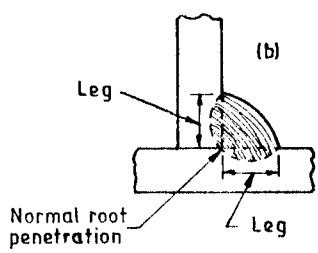


E) Undesirable profile in unprepared butt

FIGURE 11 – Typical profiles in butt welds

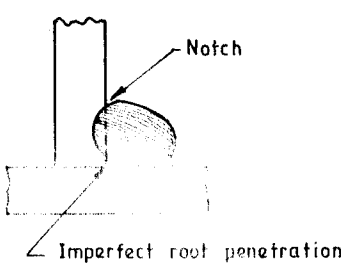


Concave, equal leg lengths

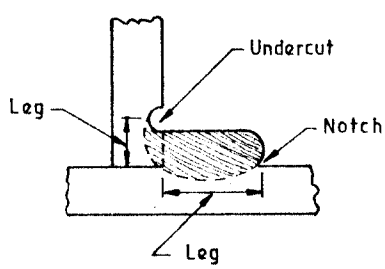


Convex, equal leg lengths

A) Desirable profiles



B) Undesirable profile
Too convex
No root penetration
Notch effect at sides of weld



C) Undesirable profile
Undercut
Notch effect due to overlap at lower toe
Unequal leg lengths

FIGURE 12 - Typical profiles in fillet welds

15.1.2 Uniformity of surface
Uniformity of height and spacing of the 'ripples' shall be maintained.

15.1.3 Degree of undercut
The welded joint should be reasonably free from undercut, but slight intermittent occurrences may be disregarded, provided that such undercuts are not in the form of a sharp notch.

15.1.4 Surface cavities and trapped slag
The weld shall be free from surface cavities and trapped slag.

NOTE
Surface cavities in a weld deposit may be caused by lack of fusion, gas bubbles or trapped slag. The presence of these defects may be considered attributable to the quality of workmanship provided suitable material are used.

15.1.5 Disposition of multiple runs
Where multiple straight beads are deposited particularly in horizontal position 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.

NOTE
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.

15.1.6 Penetration bead in butt welds
Where a penetration bead is required, it should penetrate to the underside of the plate and should be reasonably uniform in width and appearance (see Fig. 13).

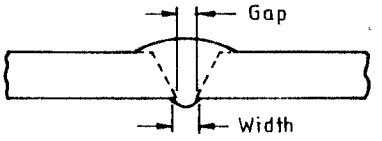
15.2 Inspection of weld fracture

15.2.1 Degree of fusion
Fusion should be completed over the whole area of the joint surfaces between weld metal and parent metal or between layers of weld metal.

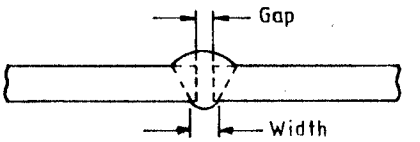
NOTE
Lack of fusion between weld metal and parent metal is indicated by the retention of the original form and surface markings of the parent metal between layers of weld metal it will appear as lines between the layers.

15.2.2 Degree of root penetration for butt and fillet welds
The first run in V-butt welds should normally penetrate right through to the underside of the plates, producing a penetration bead of the size required. In normal fillet welds the weld metal should reach the corner (see Fig. 11 and 12).

NOTE
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.

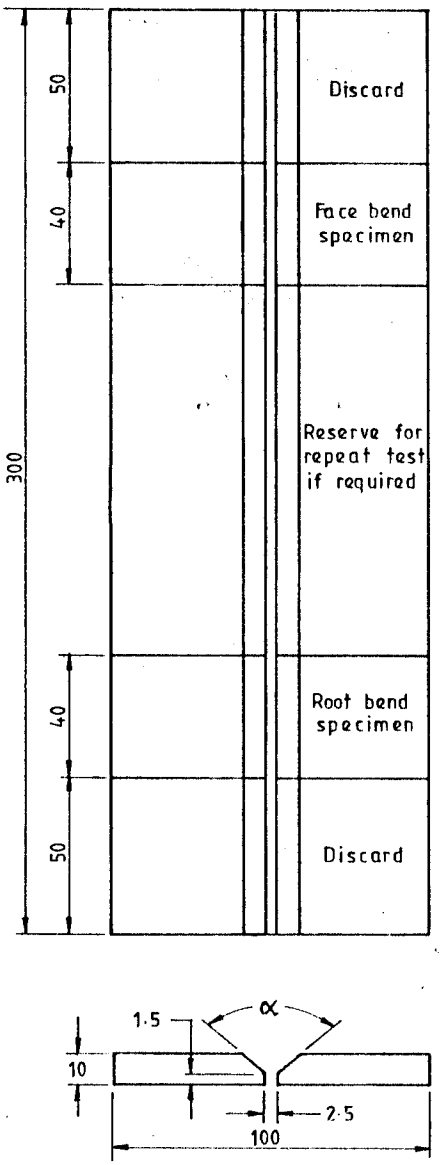


A) Single Vee joints



B) Square butt, 1·6 mm to 6·5 mm one run where no backing is deposited

FIGURE 13 – Typical shapes of penetration beads in butt welds

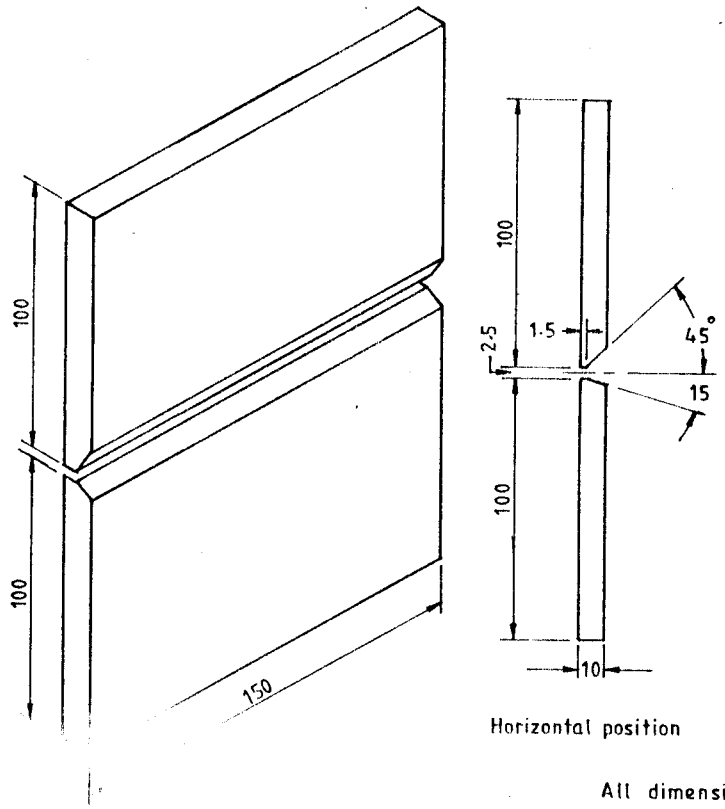


Position	α
Flat	60° – 65°
Horizontal	60° – 65°
Vertical (up)	70° – 75°
Vertical (down)	70° – 75°
Overhead	80° – 85°

Note – Weld to be stopped and re-started with a fresh electrode around the middle portion of the test specimen

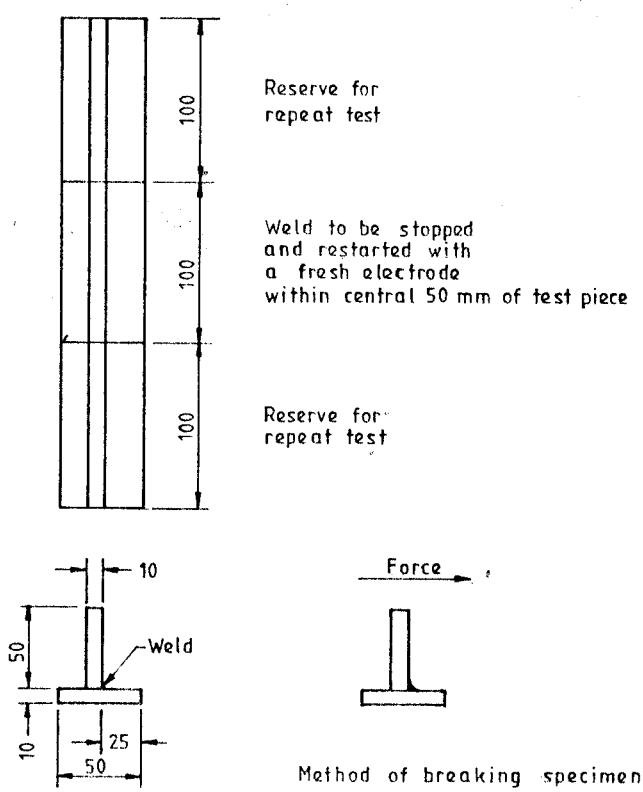
All dimensions in millimetres

FIGURE 14 – Method of making butt weld bend test specimen for initial qualification test and annual test (see Fig. 14A for horizontal position)



All dimensions in millimetres

FIGURE 14A – Length of specimen for horizontal position



All dimensions in millimetres

FIGURE 15 – Method of making fillet weld break test specimen for initial qualification, annual and periodic control tests

15.2.3 Non-metallic (slag) inclusions and gas cavities
The weld metal shall be free from non-metallic inclusions and gas cavities.

NOTES

1 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.

2 Inferior quality of weld metal may be caused by incorrect welding technique. In metal arc welding the defects may generally be due to the excessive arc length or speed of welding 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

16 GENERAL

16.1 The tests shall be of the following three types:

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

16.2 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.

17 INITIAL QUALIFICATION TEST

17.1 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-clause or sub-clauses of 14 for which he intends to qualify.

17.1.1 A trainee shall not be allowed to take the initial qualification test for training specified under 14.2 unless he has a valid initial qualification test certificate for training specified under 14.1. He shall not be allowed to take the initial qualification test for training specified under 14.3 unless he possesses an initial qualification test certificate for training specified under 14.2.

17.2 Preparation of test pieces

17.2.1 General
The steel for test pieces shall be reasonably free from scale, rust, oil, paint and other defects which adversely affect welding.

17.2.2 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 of the single-V type. 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 21), 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.

17.2.3 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 tlhe test piece. When the trainee is to be tested only for welding in the horizontal position (see 19), the welds shall be deposited using 5 mm filler rods.

17.3 Marking of test pieces

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

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

17.4 Assessment

17.4.1 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 under-cut, but slight intermittent occurrences may be disregarded provided that such undercut is not in the form of a sharp notch.

e) Freedom from surface cavities and trapped slag : The surface of the weld shall be free from porosity, cavities and trapped slag.

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.

17.4.2 By testing

17.4.2.1 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). Any excess penetration and reinforcement 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 stresses 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 root of the weld in tension. A good weld should show no opening 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 suffciently discernible to ensure that the bending takes place on the centre line of the weld.

17.4.2.2 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).

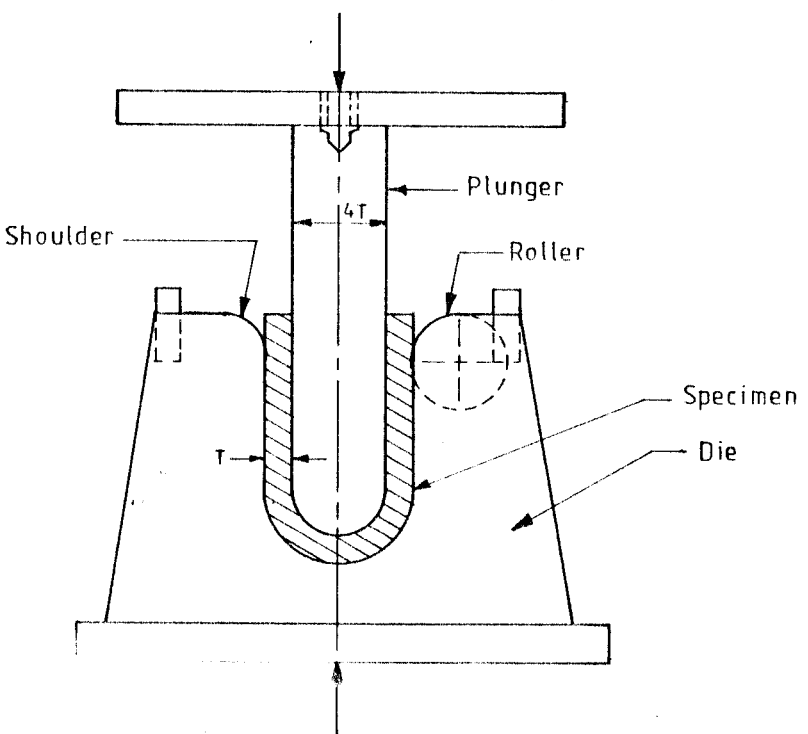


FIGURE 16 – Method of carrying out bend test

c) Appearance of fracture : The fracture shall have a clean uniform appearance and the weld metal should be free from cavities and slag inclusions.

17.5 Re-test for initial qualification test

17.5.1 In case a trainee fails to meet the requirements of one or more tests mentioned under 17.2 to 17.4, 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.

17.6 Validity of initial qualification test certificate

17.6.1 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 19 are passed.

18 ANNUAL TESTS

18.1 General
The annual tests to be taken by a welder and the results of which are to be entered on his 'certificate of qualification' (see 7) shall comprise a butt weld bend test and fillet weld break test as specified under 18.2 and 18.3 respectively. Details of test pieces and preparation are given below.

18.2 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 17.2.2 and 17.4.2.1 for the initial qualification test.

18.3 Fillet weld break test
The preparation of test piece and testing procedure for the fillet weld break test shall be the same as those prescribed under 17.2.3 and 17.4.2.2 for the initial qualification test.

19 PERIODIC CONTROL TEST

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 same 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 17.2.3 and 17.4.2.2 for the initial qualification test.

20 RE-TESTS FOR ANNUAL TEST AND PERIODIC CONTROL TEST

20.1 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 allowed to practise for a further period and then resubmitted to the annual test.

20.2 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 allowed to practise for a further period and then resubmitted to the annual test.

20.3 The welder shall not be permitted to re-start on important work until he has passed the annual test.

21 POSITION FOR TEST WELDS

21.1 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 7.

21.2 The entries made in the certificate of qualification (see 7) shall have a reference to the welding positions for which the tests have been conducted and passed.

TABLE 7 - Minimum requirements of test welds
(see 21.1)

Sub-clause	Type of joint	Welding position
14.1	Butt weld	Flat
	Fillet weld	Flat
	Fillet weld	Horizontal
14.2	Fillet weld	Vertical up
	Butt weld	Vertical up
	Blutt weld	Horizontal
14.3	Fillet weld	Overhead
	Butt weld	Overhead

APPENDIX A
(see 10.1)

RECOMMENDED SYLLABUS FOR TRAINING COURSE

A.1 BUTT WELDS IN FLAT POSITION AND FILLET WELDS IN FLAT AND HORIZONTAL POSITION (See 14.1)

PERIOD -Theory - Minimum 50 hours
Actual welding Practice - Minimum 75 hours

Period	Details of Course	Position	Hours of Instruction
1st Week Theory	a) Safety in Welding The instruction course shall be so desinged 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 use of proper shoes, leather gloves, 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 is used), operation of pressure regulators, handling of blowpipe, care of hose and equipment, etc.		7

	Safety rules recommended in Appendix F and the detailed instruction given in SLS :727*		
	b) Welding Processes 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.		
	Practice		30**
	Elementary gas cutting	Flat	
	Bead welds	Flat	
	Running beads		
	Film shows, discussion, etc.		3
2nd Week Theory			7
	a) Elementary Electricity 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) Welding and Gas Cutting Equipment 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 and minor adjustments. Fitting and dismantling of manual gas cutting equipment, flame adjustment and care of equipment should also be covered.		

* Code of safety for welding and cutting

** It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 per cent 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.

	Practice	30*
	Reinforcing pad — Flat	
	Fillet welds — Flat	
	Film shows, discussion, etc.	2
3rd Week Theory		8

a) Elementary Welding Metallurgy
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) Elementary Engineering drawing Reading
Instruction in this subject shall be designed to give the trainee an elementary knowledge of factors involved in reading simple engineering drawing in order to assist him in comprehending common welding terms and symbols used.

	Practice	30*
	Corner welds — Flat	
	Film shows, discussion,etc.	3

* It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 per cent 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.

4th Week	Theory		7
	a) 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 arc welding and the standard symbols used for detailing welds on drawings shall be explained.		
	Practice		30*
	Butt weld-Single 'V'	Flat	
	Film shows, discussion, etc.		3
5th Week	Theory		7
	a) Quality of Welds 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.		

* It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 per cent 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.

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 :
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

Practice		30*
Butt weld-square edges	Flat	
Film shows, discussion, etc.		3

6th Week Theory 7
Same as 5th week - Further lectures

Practice		30*
Fillet welds	Horizontal	
Film shows, discussion, etc.		3

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

7th Week	Theory		7
	a) Characteristics of Electrodes Instruction in this shall be designed to familiarize the trainee with the different types of electrodes used in metal arc welding. Purpose of flux coating on electrodes, storage procedures, selection etc.		
	b) Estimating and Costing Factors affecting welding cost and the method of estimating materials requirements shall be explained in a simple manner.		
	Practice		30*
	Revision film shows, discussion,etc.		3

A.2 BUTT AND FILLET WELDS IN VERTICAL POSITION AND BUTT WELDS IN HORIZONTAL POSITION (see 14.2))

PERIOD - Actual Welding practice -Minimum 75 hours

Period	Details of Course	Position	Hours of Instruction
1st Week	Practical		37*
	Bead weld	Vertical/up	
	Fillet welds	Vertical/up	
	Film shows, discussion,etc.		3

* It has been found that of the total number of hours of training a trainee spends not more than 35 to 40 per cent 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.

2nd Week	Practical		37*
	Fillet welds	Vertical/up	
	Butt - single 'V'	Vertical/up	
	Film shows, dicussion, etc.		3
3rd Week	Practical		
	Butt - Single 'V' (Further exercises)	Vertical/up	
	Corner weld	Vertical/down	
	Depositing bead	Horizontal	
	Film shows, discussion, etc.		3
4th Week	Practical		37*
	Butt weld-bottom plate square top plate bevelled	Horizontal	
	Butt weld-both plates bevelled	Horizontal	
	Film shows, discussion, etc		3
5th Week	Practical		38*
	Revision		
	Film shows, discussion, etc.		2

A-3. WELDING IN OVERHEAD POSITION (see 14.3)

PERIOD- Actual welding practice - Minimum 50 hours

Period	Details of Course	Position	Hours of Instruction
1st Week	Practical		37*
	Bead welds	Overhead	
	Fillet welds	Overhead	
	Film shows, discusion, etc.		3

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

2nd Week	Practical		37*
	Fillet weld	Overhead	
	Film shows, discussion, etc.		3
3rd Week	Practical		37*
	Butt weld- single 'V'	Overhead	
	Film shows, discussion, etc.		3
4th Week	Practical		37*
	Butt weld-single'V' (Further exercises) Revision	Overhead	
	Film shows, discussion, etc.		3

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

APPENDIX B
(see 7)

RECOMMENDED TEST CERTIFICATE
(suggested information on page 1 of certificate)

CERTIFICATE FOR WELDER QUALIFICATION IN ACCORDANCE WITH SLS....

Name and address of Training Institution:

Certificate No:

Date of issue:

Name of trainee: Photograph

Identity Card No:

Signature of Trainee

Welding process : Manual Metal Arc Welding.

Parent Material & thickness:

Electrodes:

This is to certify that .....
(Full name of trainee)
whose signature and photograph are shown above, has completed a course of training in manual metal arc welding conforming to sections ..... of SLS .....'Code of practice
(specify)
for basic training and testing of manual metal arc welders'and has passed the test (s) specified in the said code of practice as indicated in the following pages and duly certified by signatures under official seals.

Validity: The certification implied in passing of the initial qualification tests is valid only when the holder is employed as a welder within six months of the passing of test. (also see 17.6 of this code)

(suggested information on page 2 of certificate)

Courses of training completed and the initial qualification tests passed

Clause 14.1 of SLS .....*

Period of training:

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

Type of weld	Position of Welding	Date of tests	Remarks
Butt	Flat	—	—
Fillet	Flat	—	—
Fillet	Horizontal	—	—

(Signature of Training Establishment Officer)
(Designation of Officer)
Date:..... (Official Seal of Training Establishment)

Clause 14.2 of SLS ....*

Period of training

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

Type of weld	Position of welding	Date of tests	Remarks
Fillet	Vertical Up	—	—
Butt	Vertical Up	—	—
Butt	Horizontal	—	—

(Signature of Training Establishment Officer)
(Designation of Officer)
Date:..... (Official Seal of Training Establishment)

Clause 14.3 of SLS ....*

Period of training

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

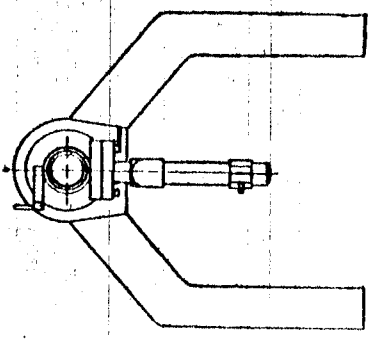
Type of weld	Position of welding	Date of tests	Remarks
Fillet	Overhead	—	—
Butt	Overhead	—	—

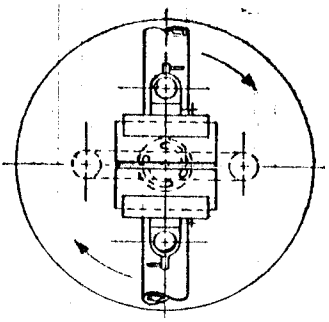
(Signature of Training Establishment Officer)
(Designation of Officer)
Date:..... (Official Seal of Training Establishment)

(suggested information on page 3 to 12 of certificate)

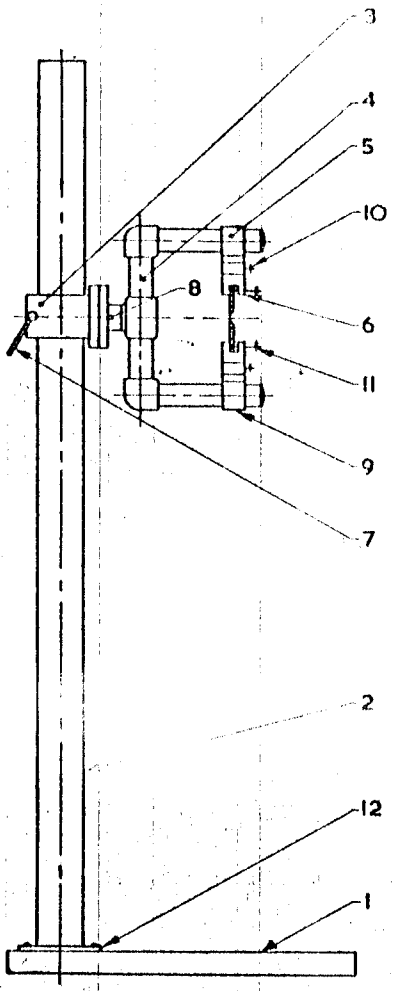
Record of annual tests

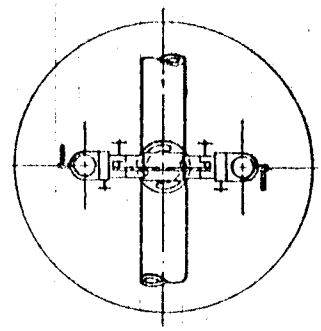
Type of weld	Position of Welding	Date of Test	Remarks	Signature of Officer with Designation and Official Seal
Clause 14.1				
Butt	Flat			
Fillet	Flat			
Fillet	Horizontal			
Clause 14.2				
Fillet	Vertical Up			
Butt	Vertical Up			
Butt	Horizontal			
Clause 14.3				
Fillet	Overhead			
Butt	Overhead			



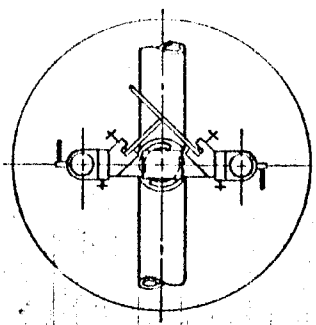


Set up for horizontal vertical welding





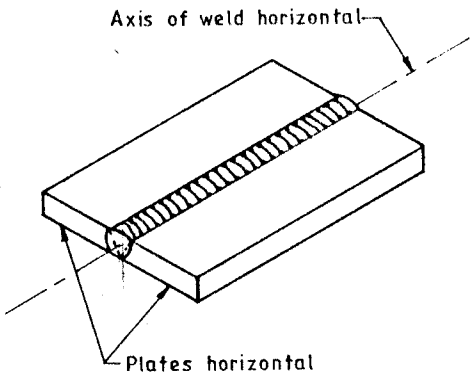
Set up for flat and overhead welding



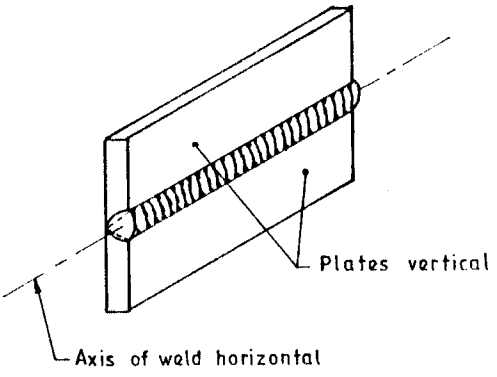
Set up for 'T' and 'L' joints welding

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

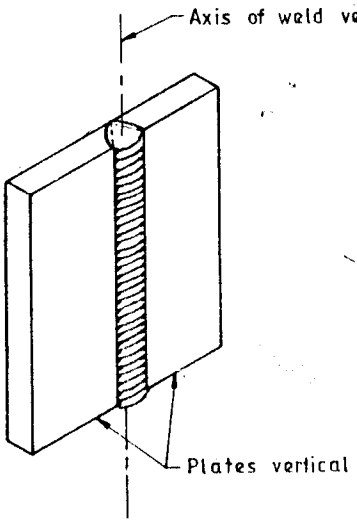
FIGURE 17 – Illustration of recommended design of positioning equipment



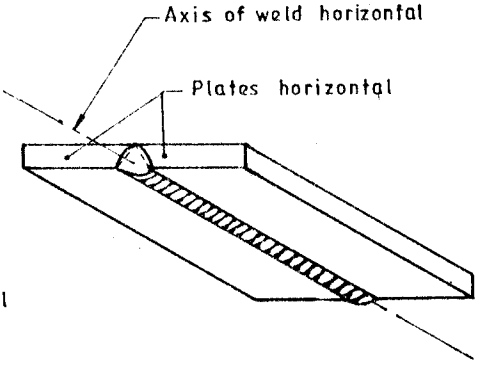
A) Position of plates for



B) Position of plates for horizontal vertical butt weld

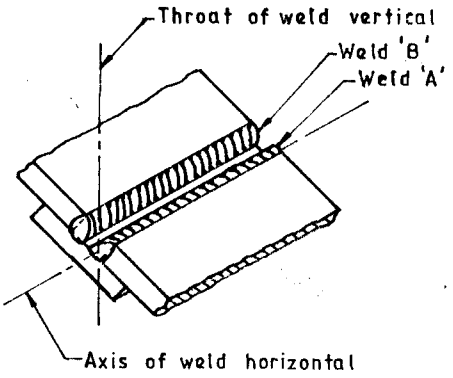


C) Position of plates for vertical butt weld



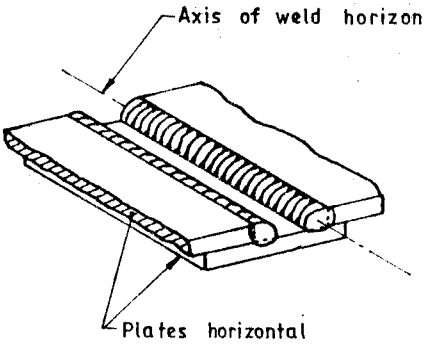
D) Position of plates for overhead butt weld

FIGURE 18 – Positions of plates for butt welds

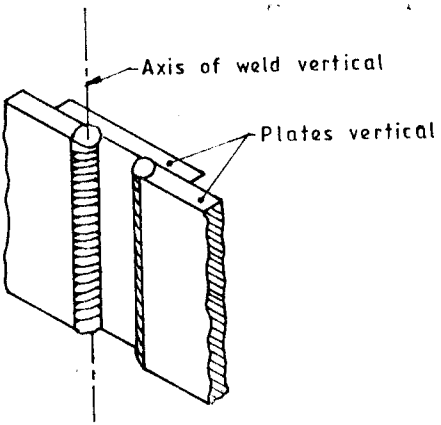


Throat of weld to be in vertical position (same as weld 'A') when making weld 'B'

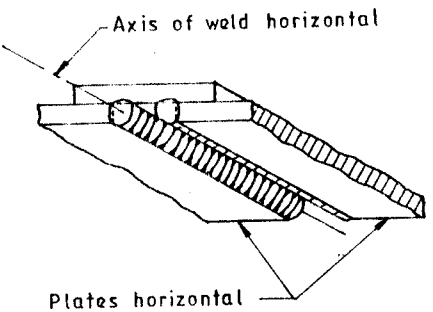
A) Position of plates for flat fillet weld



B) Position of plates for horizontal fillet weld



C) Position of plates for vertical fillet weld



D) Position of plates for overhead fillet

FIGURE 19 - Position of plates for fillet welds

APPENDIX C
(see 8.2)
RECOMMENDED DESIGN OF POSITIONING EQUIPMENT

C.1 INTRODUCTION

C.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.

C.1.2 This appendix describes the general features of the positioning device and illustrates its application.

C.1.3 Separate equipment should be provided for each welding booth.

C.2 DESCRIPTION OF EQUIPMENT

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

C.3 ILLUSTRATIONS OF USE OF EQUIPMENT

C.3.1 Butt welds
Fig. 19A to 19D illustrate the orientation of plates for butt welding in the flat, horizontal, vertical and overhead positions.

C.3.2 Fillet welds
The orientation of plates for fillet welding in the flat, horizontal, vertical and overhead positions is illustrated in Fig. 19A to 19D.

C.4 ADVANTAGES OF POSITIONING EQUIPMENT

C.4.1 Some of the advantages of using this type of positioning equipment, over the other makeshift commonly employed, are given in C.4.1.1 to C.4.1.3.

C.4.1.1 The equipment increases actual welding time available by a) eliminating the use of C clamps; b) facilitating rapid clamping of plates in jigs and adjustment of jigs to any desired angle; c) holding test plates rigid while they are being chipped and cleaned of slag; d) permitting easy removal and replacement of test plates between passes when necessary; and e) readily permitting the setting and holding of plates at proper root opening.

C.4.1.2 The equipment displaces table and stool from welding booth. (A tool tray, if desired, may be made as part of the equipment).

C.4.1.3 The equipment may be readily constructed in most of the machine shops and welding shops.

APPENDIX D
(see 8.6)
ACCESSORIES AND EQUIPMENT RECOMMENDED FOR TRAINING ESTABLISHMENT FOR WELDERS

D.1 SHOP MACHINES AND ACCESSORY EQUIPMENT

D.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) Two-ended pedestal grinder with 25 cm x 3 cm (or larger) coarse wheels and wheel dresser;

c) Heavy power hacksaw (preferably with 25 cm width capacity) or horizontal metal band saw;

d) Portable or flexible shaft grinder;

e) Equipment for machining test specimens;

f) Guided-bend test device with hydraulic jack of 8 metric tons or larger capacity;

g) Break or rupture device with hydraulic jack of 8 metric tons or larger capacity;

h) Small platform scales for weighing out electrodes;

j) Anvil 45 kg or heavier;

k) Scrap box 90 cm x 60 cm x 30 cm;

m) Hot metal quenching tank;

n) Chartboard for progress chart, instructional charts and notices;

p) Display board for sample specimens of welding exercises;

q) Gas cutting torch with accessories (manual or machine type or plate shear for preparing plates for welding and for cutting test specimens);

r) Provisions for sterilizing welding helmets;

s) Drying oven;

t) Fire extinguishers, chemical type;

u) Fire buckets with water;

v) Sand bags for fire protection; and

x) First aid kit;

NOTE
Facilities for showing motion pictures, filmstrips and slides are of assistance.

D.2 SMALL TOOLS AND ACCESSORIES

D.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) Center punches;
f) Scribers;
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.

D.3 REQUIREMENTS FOR EACH TRAINEE WHILE WELDING

D.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.

D.4 EQUIPMENT FOR TRAINEE OBSERVERS AND INSTRUCTORS WHILE OBSERVING

D.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 E
(see 9.2)
RECOMMENDED FORM OF TRAINEE PROGRESS CHART

Name .....

Address.....

Employer's Name & Address.....
.....

*Courses required:
1) Butt Welds in Flat Position and Fillet Welds in Flat and Horizontal Position,
2) Butt and Fillet Welds in Vertical Position and Butt Welds in Horizontal 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).....

* These courses correspond to those described under 14.1, 14.2 and 14.3.

LESSON 1 BUTT WELDS IN FLAT POSITION AND FILLET WELDS IN FLAT AND HORIZONTAL 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 technique (flat position)				
Status of progress				
			Welding of butt joints and fillet joints in flat position	
Corner weld				
Single-run fillet weld				
Multi-run fillet weld				
Butt weld (see Fig.8A)				
Butt weld (see Fig. 6)				
Making check test specimen No.1 (see 14.1.2.1)				
Making check test specimen No.2 (see 14.1.2.1)				
Status of progress				
			Welding of fillet joints in horizontal position	
Single-run fillet weld				
Multi-run fillet weld				
Making check test specimen No.3 (see 14.1.3.1)				
Making check test specimen No.4 (see 14.1.3.1)				
Status of progress				

LESSON 2 BUTT AND FILLET WELDS IN VERTICAL POSITION AND BUTT WELDS IN HORIZONTAL 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 position				
Butt weld (see Fig.1Ø)				
Butt weld (see Fig.14)				
Making check test specimen No.5 (see 14.2.1.1)				
Making check test specimen No.6 (see 14.2.1.1)				
Status of progress				
			Welding of butt joints in horizontal position	
Bead welds-vertical up and vertical down				
Single-run fillet welds-vertical up				
Multi-run fillet welds-vertical up				
Butt welds				
Corner welds-down direction				
Making check test speciman No.7 (see 14.2.2.1)				
Status of progress				

LESSON 3 BUTT AND FILLET WELDS 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 (see 14.3.1.1)				
Making check test specimen No.9 (see 14.3.1.1)				
Status of progress				

APPENDIX F
(see 12.1)

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 of 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.

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 on safety and health requirements in electrode and gas welding and cutting operations, reference should be made to SLS 727*.

* Code of safety for welding and cutting.

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