WELDER

NSQF LEVEL - 4

2nd Semester

TRADE PRACTICAL

SECTOR: Fabrication

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Welder, 2nd Semester Trade Practical NSQF Level - 4 in Fabrication Sector under Semester Pattern.** The NSQF Level - 4 Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

RAJESH AGGARWAL
Director General/ Addl.Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi (NSQF Level 4) under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

R. P. DHINGRA

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Practical)** for the trade of **Welder** under **Fabrication** sector.

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NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercies to be completed by the trainees during the Second Semester course of the Welder trade supplemented and supported by instructions/informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered.

The manual is divided into five modules. The distribution of time for the practical in the five modules are given below.

Module 1	Inspection and testing	25 Hrs
Module 2	Gas metal arc welding	250 Hrs
Module 3	Gas tungsten arc welding	140 Hrs
Module 4	Plasma arc cutting & Resistance welding	35 Hrs
Module 5	Repair and maintenance	75 Hrs
	Project work	50 Hrs
	Total	575 Hrs

The skill training in the computer lab is planned through a series of practical exercises centred around some practical project. However, there are few instance where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average traninee. However the development team accept that there if a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theorectical information for the Second Semester couse of the Welder Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theortical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade Theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

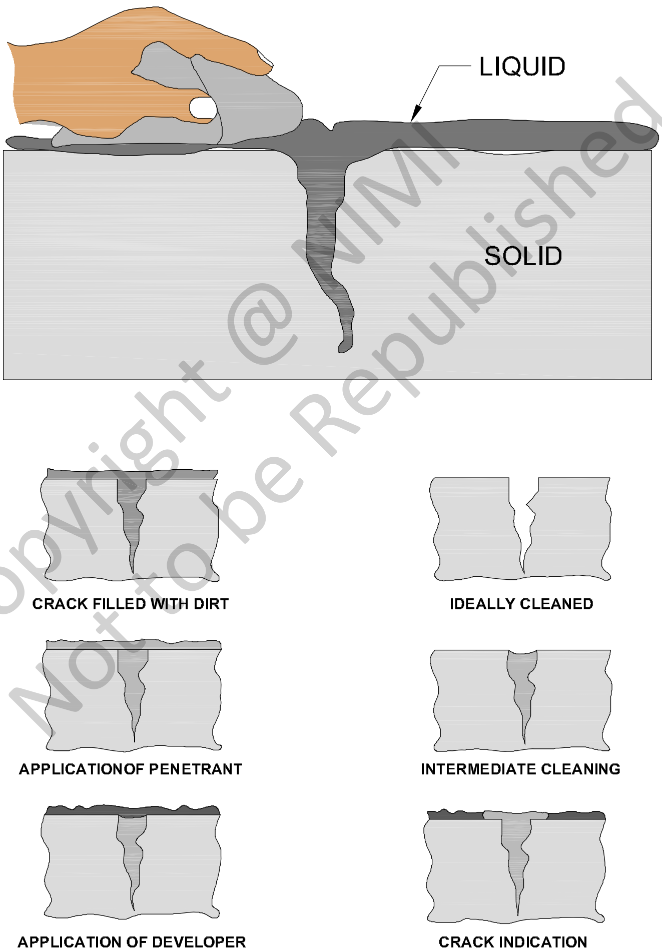
LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- Test welded joints by different methods of testing. [Different methods of testing- Dye penetration test, Magnetic particle test, Nick break test, Free bend test, Fillet fracture test].
- Set GMAW machine and perform welding in different types of joints on MS sheet/ plate by GMAW in various positions by dip mode of metal transfer. [Different types of joints Fillet (T-joint, lap, Corner), Butt (Square & V); various positions - IF, 2F, 3F, 4F, 1G, 2G, 3G].
- Set the GTAW machine and perform welding by GTAW in different types of joints on different metals in different position and check correctness of the weld [Different types of joints- Fillet (T-joint, lap, Corner), Butt (Square & V); different metals- Aluminium, Stainless Steel; different position- 1F & 1G].
- Perform Aluminium & MS pipe joint by GTAW in flat position.
- Set the Plasma Arc cutting machine and cut ferrous & non-ferrous metals.
- Set the resistance spot welding machine and join MS & SS sheet.
- Perform joining of different similar and dissimilar metals by brazing operation as per standard procedure [Different similar and dissimilar metals- Copper, MS, SS].
- Repair Cast Iron machine parts by selecting appropriate welding process [Appropriate welding process- OAW, SMAW].
- Hard facing of alloy steel components/ MS rod by using hard facing electrode.

Dye penetrant test

Objectives: At the end of this exercise you shall be able to
- **prepare the surface**
- **deposit penetrant**
- **develop the penetrant**
- **inspect the defect.**



1	WELDED MODEL		Fe 310 - W			I & T-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	DYE PENETRANT TEST				TOLERANCE ±1	TIME 05 Hrs
					WLN2162E1	

Dye penetrant inspection (DP)

This method is also known as Liquid Penetrant Inspection (LPI) Liquid Penetrant Inspection is a non destructive method of revealing discontinuities that are open to the surface of solid and essentially non-porous materials.

Indicators of a wide spectrum of flaw size can be found regardless of the configuration of the work piece and regardless of flaw orientiation. Liquid penetrant seep into various types of minute surface opening by capillary action. Because of this, the process is well suited to detect all types of surface cracks, laps porosity and shrinkage areas. In practice the liquid penetrant process is relatively simple to utilize and control. This method does not depend on ferromagnetism and the sensitivity is greater than that of magnetic particle inspection. Following steps have to be followed during the liquid penetrant inspection.

Surface preparation

All surfaces to be inspected must be throughtly cleaned and completely dried. Surface must be free from oil, grease, water or other contamination.

Materials used in penetrant inspection

1 Penetrant

There are two types of penetrant

1 fluorescent type

2 visible type

2 Emulsifiers

Emulsifiers are liquids used to remove excess penetrant. There are two types of emulsifiers

1 lipophilic (oil based)

2 hydrophilic (water based)

3 Developers

There are four forms of developers in common use

1 Dry powder

2 Water souble

3 Water suspendible

4 Non aqueous solvent suspendiable

Penetration

Penetrant is applied in a suitable manner so as to form a film of the penetrant over the surface. Application of penetrant may be by dipping the work pieces in the penetrant liquid or spraying, brushing, flowing the penetrant over the work piece. The film should rematin on the surface long enough to allow maximum penetration of the penetrant into the surface openings. The time allowed is called the dwell time/penetrant time.

Removal of excess penetrant

The excess penetrant is the penetrant that has not entered into discontinutiy and remain on the surface. This must be removed from the surface. The type of penetrant used determines removal method. Some penetrant can be simply wahed water. Other requires the use of emulsifies (lipophilic of excess penetrant from the surface is necessary for effective inspection. Over removal must be avoided. Removal of excess penetrant from the surface is necessary for effective inspection.

Development

After cleaning and drying the surface a thin layer developer is applied by suitable method (spraying / dipping etc) uniformly over the surface. Depending on the form of developing agent used, the work piece is dried accordingly. The developer forms a film over the surface. It acts as a blotter to assist the natural see page of the penetrant out of surface openings and to spread it at the edges to enhance the penetrant indication.

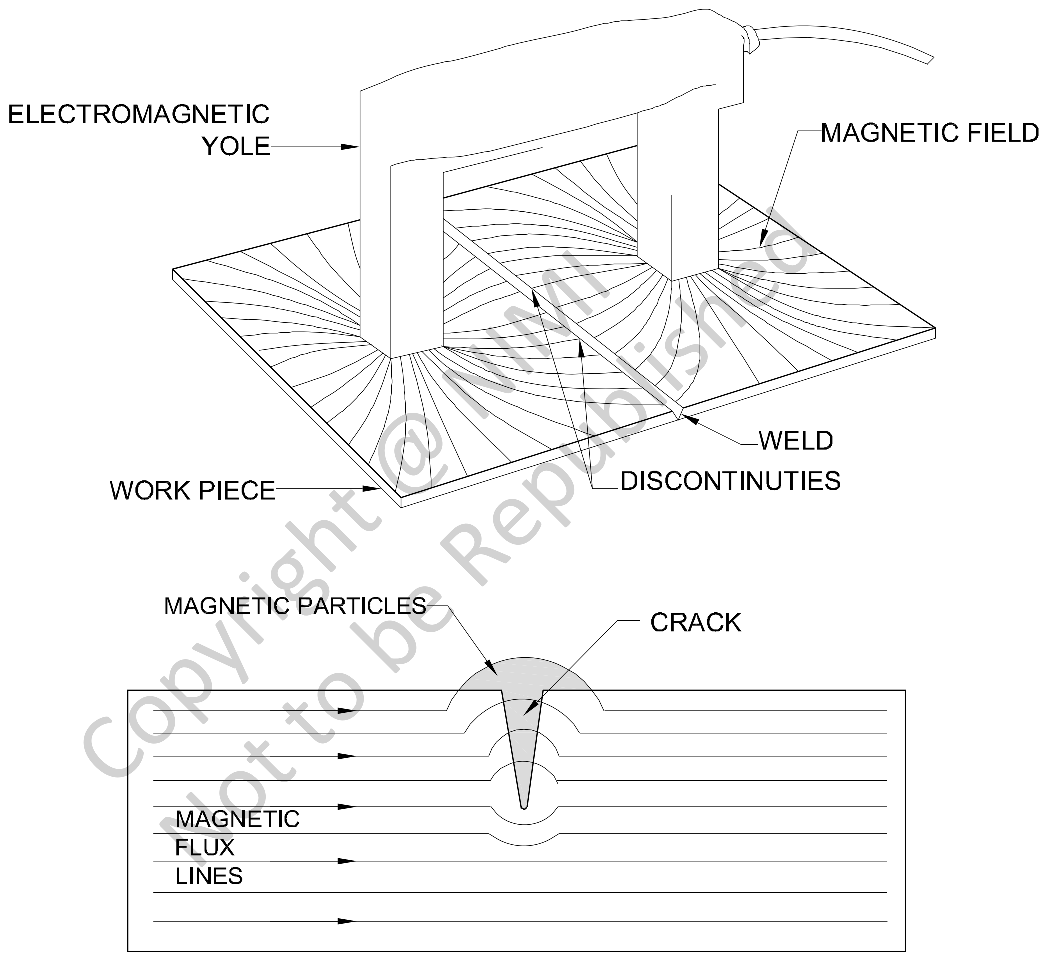
Inspection

After it is sufficiently developed the surface is visually examined for indication of penetrant bleed back from the surface openings. This examination must be performed in a suitable inspection environment. Visbile penetrant inspection is performed in good white light.

If fluorescent penetrant is used inspection is performed in a darkened area using ultraviolet light. Interpretation of the defect can be made by the method is that it is not well suited for rough and porous surfaces. surfaces.

Magnetic particle test

Objectives: At the end of this exercise you shall be able to
- **apply the magnetic particle on job**
- **use the equipment**
- **identify the defect.**



MAGNETIC PARTICLE INSPECTION

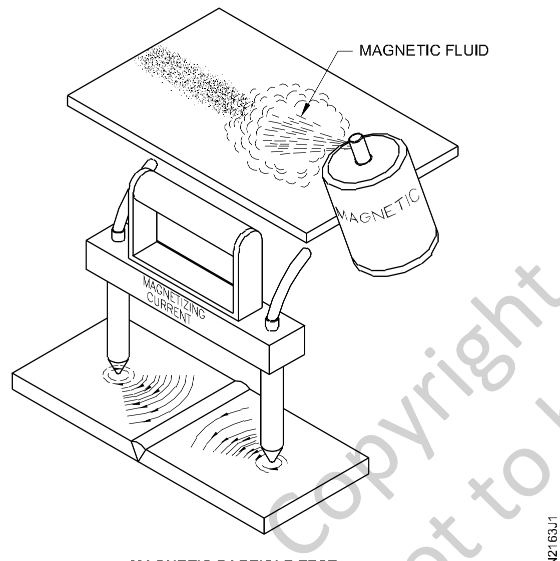
1	WELDED JOB		Fe 310 - W			I&T-03
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MAGNETIC PARTICLE TEST	TOLERANCE ±0.5	TIME 5 hrs
		WLN2163E1	

Magnetic particel inspection is a method of locating surface and subsurface discontinuties in ferromagnetic materials. It depends on the fact that when the material or part under test is magnetized, magnetic discontinuties that lie in a direction generally transverse to the direction of the magnetic field will cause a leakage field to be formed above the surface of the part.

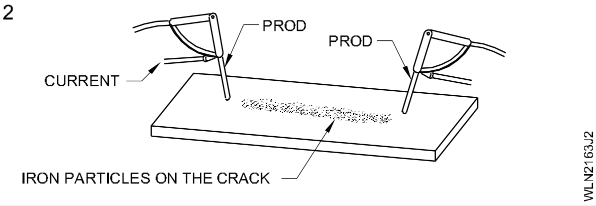
The presence of the this leakage field, and the presence of the discontinuity, is detected by the use of finely divided ferromagnetic particles applied over the surface. With some of the particles being gathered and held by the leakage field. Magnetically held collection of particles forms an outline of the discontinuity and generally indicates its location, size, shape, and many respects. The important difference with regard to magnetic particle inspection is that the fields produced by direct current. Generally penetrate the cross section of the part, while the fields produced by alternating current are confined to the metal at or near the surface of the part, a phenomenon known as the skin effect. Therefore, alternating current should not be used in searching for subsurface discontinuities.

Fig 1



MAGNETIC PARTICLE TEST

Fig 2



Method of generating magnetic fields

1 Yokes

There are tow basic types of yokes that are commonly used for magnetizing

Purposes: Permanent-magnet and electromagnetic yokes. Both are hand held and therefore quite mobile.

a Permanent-magnet yokes

b Electromagnetic yokes

2 Coils

Single-loop and multiple-loop coils are used for the longitudinal magnetization of components. Portable magnetizing coils are available that can be plugged into an electrical outlet. These coils can be used for the in-place inspection of shaft like parts in railroad shops, aircraft maintenance shops, and shops for automobile truck, and tractor repair. Transverse cracks in spindles and shafts are easily detected with such coils.

3 Central conductors

For many tubular or ring-shaped parts, it is advantageous to use a separate conductor to carry the magnetizing current rather than the part itself. Such conductors commonly referred to as a central conductor and ferromagnetic materials that are good conductors of electricity.

4 Prod method

For the inspection of large and massive parts too bulky to be put into a unit having clamping contact heads, magnetization is often done by using prod contacts to pass the current directly through the part or through a local portion of it. Prod contacts are used in the magnetic particle inspection of large castings and weldments.

Advantages: Prod contacts are widely used and have many advantages. Easy portability makes them convenient to use for the field inspection of large tanks and welded strucures. Sensitivity to defects lying wholly below the surface is greater with this method of magnetization than with any other, especially when half wave current is used in conjunction with dry powder and the continuous method of magnetization.

Limitations: Great care must be taken to avoid burning of the part under the contact points. Suitable magnetic fields exist only between and near the prod contact points. These points are seldom more than 12inch apart and usually much less; therefore, it is sometimes necessary to relocate the pods so that the entire surface of apart can be in inspected.

Types of magnetic particles

Magnetic particles are classified according to the medium used to carry the particles to the part. The two primary types of particle inspection are dry particles, and each type is available in various colors and as fluorescent particles.

Detectable discontinuties

Relevant indication (are produced by leakage field which are the result of discontinuity) which have dimension greater than 1/16” shall be considered.

a A linear indication is having a length greater than three times the width.

b A rounded indication is in circular or elliptical in shape with a length equal to or less than three times its width L<=3W.

The defect area shall be removed by clipping or grinding and subsequent repair by welding.

Specifications

ASTM - E 709 : Magnetic particle examination.

ASTM - SE 709 : Magnetic particle particle

MIL -I-6868 : Inspection [rocess magnetic particle

MIL-STD 271 E : Inspection requirements for metals.

Ultrasonic inspection is to conducted after the final heat treatment of the material to get better results. 6 dB method / DAC curve will help in judging significance of the defect. Discontinuities are usually compared to a reference standard. The reference standard may be of any reference block or set of blocks. A typical flat bottom hole block can also be used.

Lower range of testing frequencies are generally adopted to castings. It is very difficult to test porous grain structure castings ultrasonically, because of extreme scattering resulting from grain boundaries. Some alloys of brass stainless steel, Titanium and cast iron belongs to this category.

Lower range of testing frequencies are generally adopted to castings. It is very difficult to test porous grain structure castings ultrasonically, because of extreme scattering resulting from grain boundaries. Some alloys of brass stainless steel, Titanium and cast iron belongs to this category.

Typical in herient discontinuties found in casting

Cold shut: Occurs when molten metal is poured over already solidified metal.

Shrinkage: Are formed by the lack of molten metal to fill the space created by the solidification.

Blow holes: Are caused by gas which comes from the mould.

Porosity: Is caused by entrapped gas.

Inclusions: Inclusions of slag or sand will occur when the metal is not refined properly and mould is not well prepared.

Advantages

The magnetic particle method is a sensitve means locating small and shallow surface cracks in ferromagnetic materials. Indications may be produced at cracks that are large enough to be seen with the naked eye, but exceedingly wide cracks will not produce a particle pattern if the surface opening is too wide for the particles to bridge. Discontinuities that do not actually break through the surface also indicated in many cases by these methods, although certain limitations must be regonized and understood. If a discontinuity is fine, sharp, and closed to the surface, such as a long stringer or nonmetallic inclusion, a clear indication can be produced. If the discontinuity lies deeper, the indication will be less distinct.

Magnetic particle indications are produced directly on the surface of the part and constitute magnetic pictures of the actual discontinuity. There is no electrical circuitry or electronic read out to be calibrated or kept in proper operting condition. Skilled operator can sometimes make a reasonable estimate of crack depth with suitable powders and proper technique.

Limitations

There are certain limitations to magnetic particle inspection. The operator must be aware of thin coatings of paint and other nonmagnetic coverings, such as plating, which adversely affect the sensitivity of magnetic particle inspection.

1 The method can be used on ferromagnetic materials.

2 For best results, the magnetic field must be in a direction that will intercept the principle plane of the discontinuity; that is sometimes requires two or more sequential inspections with different magnetization.

3 Demanetization following inspection is often necessary

4 Post cleaning to remove remnants of the magnetic particles clinging to the surface may sometimes be required after testing and demagnetization

5 Exceedingly large currents are sometimes needed for very large parts.

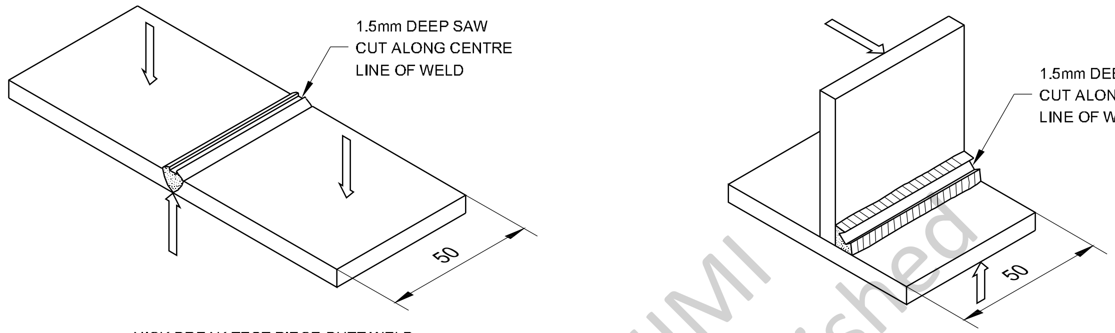
6 Although magnetic particle indications are easily seen, experience and skill are sometimes needed to judge their significance.

Magnetizing current

Direct current (DC), alternating current (AC) and half wave direct current (HWDC) are suitable for magnetizing parts for magnetic particle inspection. The strength, direction, and distribution of magnetic fields are greatly affected by the type of current used for magnetization.

Nick-break test

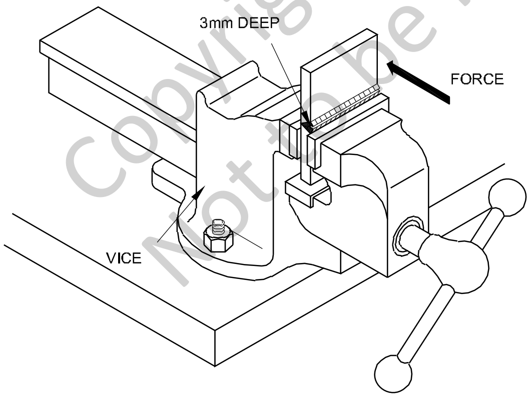
Objectives: At the end of this exercise you shall be able to
- **make saw cut on the weld bead**
- **apply the force on weld metal to break**
- **identify the internal defectes.**



NICK BREAK TEST PIECE-BUTT WELD

NICK BREAK TEST PIECE-FILLET WELD

Fig.1



FRACTURE TEST ON BUTT JOINT

Fig.2

2	WELDED JOBS		Fe 310 - W			I&T-04
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	NICK BREAK TEST				TOLERANCE ±0.5	TIME 5 Hrs
					WLN2164E1	

Job Sequence

1 Select welded Tee or butt joint

2 Make saw cut of about 1.5mm to 2mm depth along the centre line of the welddas per Fig.2.

3 Apply the force with hammer on the reverse of the joint as shown in the Figure 2.

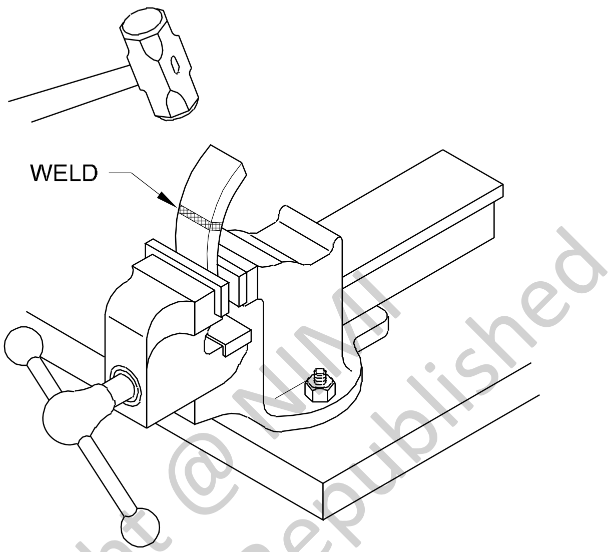
4 The joint will break along the saw cut & by observing the fractured surface.

5 Identify the various defects like slag inclusion, lack of fusion, lack of penetration etc.

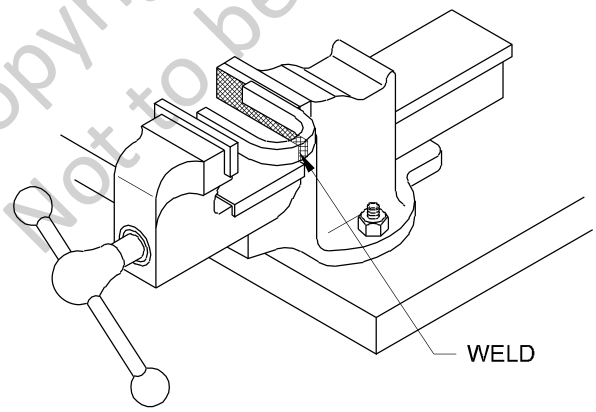
6 Rectify the reasons for the above defects.

Free bend test

Objectives: At the end of this exercise you shall be able to
- **fix the job in vice**
- **apply the force on job to bend**
- **use guided machine**
- **rectify the defects.**



THIS IS ONE WAY THE INITIAL BEND CAN BE MADE



FOR THE FINAL BEND, THE SPECIMEN MUST BE BENT IN A VISE

03	WELDED JOBS		Fe 310 - W			I&T-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

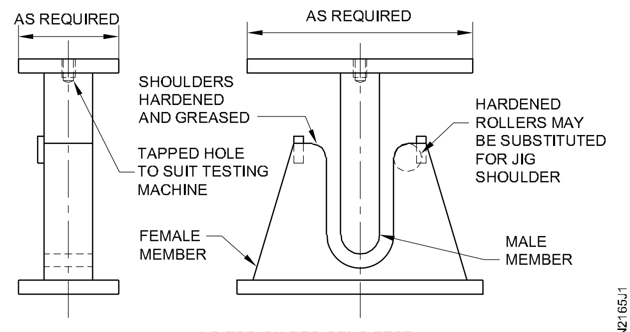
SCALE NTS	FREE BEND TEST WITH WELDED JOBS	TOLERANCE ±0.5	TIME 5 Hrs
		WLN2165E1	

Job Sequence

Free bend test: The welded joints are fixed on a vice and bent by applying forces by hammer/bending bar to determine the defect in the weld done by a trainee in a workshop. The workshop tests are usually used to break open the weld in a workshop using a vice and hammer for visual inspection.

Guided bend test: A guided bend test is one in which the specimen as in Fig 2 is bent to 180° through a bend testing jig as in Fig 1.

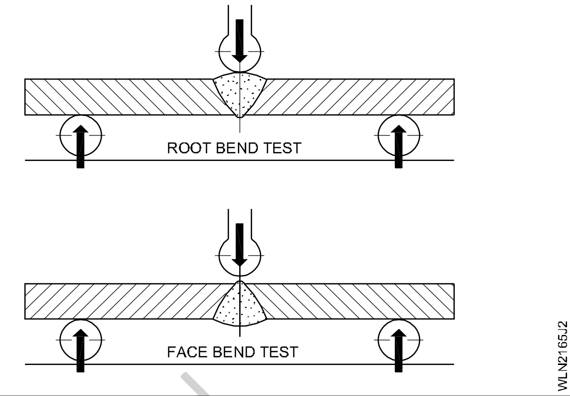
Fig 1



JIG FOR GUIDED BEND TEST

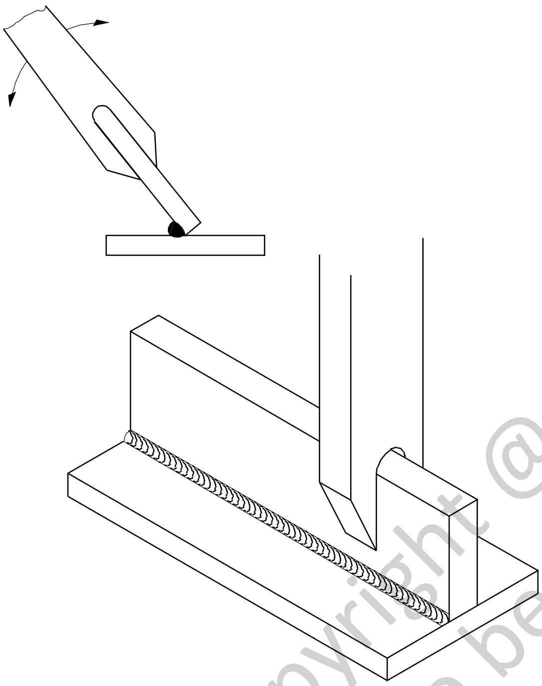
There are two types of specimens prepared for this-one for face bend and the other for root bend (Fig 2). This test measures the ductility of the weld faults quite accurately and it is very fast. A sample specimen can be tested on destruction to determine (a) the physical condition of the weld and thus check on the weld procedure and (b) the welder's capability.

Fig 2

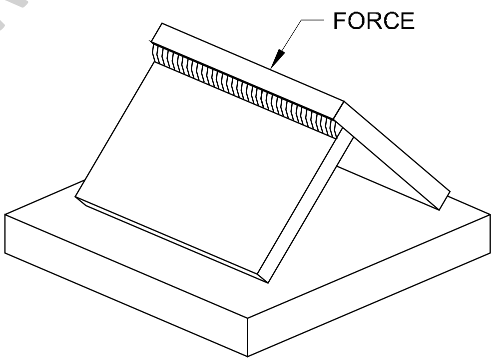


Fillet fracture test

Objectives: At the end of this exercise you shall be able to
- **fix the job in vice**
- **apply the force to fracture**
- **rectify the defects.**



FILLET FRACTURE TEST USING BENDING BAR



FILLET FRACTURE TEST USING HAMMER

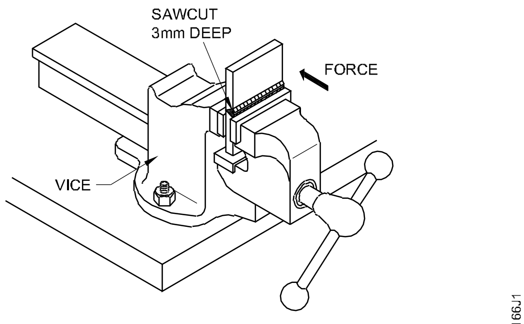
2	WELDED JOBS		Fe 310 - W			I&T-06
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET FRACTURE TEST ON WELDED JOBS				TOLERANCE ±0.5	TIME 5 Hrs
					WLN2166E1	

Job Sequence

1 Select job pieces of one side welded fillet tee, lap or but joint also.

2 Fix the jobs in bench vice as per Fig 1.

Fig 1



FRACTURE TEST ON BUTT JOINT

3 Use bending bar to bend or fracture the joint as per Fig1

4 Observing the fracutred surface

5 Select another welded job

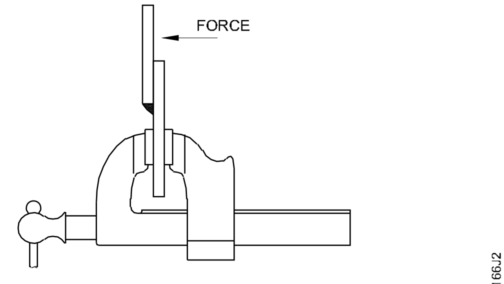
6 Apply the force on job.

Observing the fractured surface various defects like

- Lack of fusion
- Slag Inclusion
- Blow holes or porous weld

7 Rectify the defects.

Fig 2



FRACTURE TEST ON LAP FILLET

Examination of fractured weld

The fractured weld may exhibit and show the following internal defects in following figure

1 Lack of fusion

2 Incomplete penetration

3 Sleeg inclusion

4 Blow holes or porous weld.

Induction training

Objectives: At the end of this exercise you shall be able to
- **identify different types of arc welding machines and arc welding accessories**
- **connect the welding cables between the welding machine, electrode holder and the job**
- **fix the electrode in the electrode holder at the required angle**
- **start and operate the controls and stop arc welding machines safely and in sequence**
- **use the safety apparel, safety accessories and the hand tools required for arc welding**
- **set the welding current as per the size of electrode used**
- **strike and maintain the electric arc without freezing of the electrode.**

Switch on the starter.

Check and ensure the electrode holder and earth cable are without any loose connection or damage.

Loose cable connections cause spark, heat and unstable arc.

Connect tightly the earth cable to the welding table or work using the earth clamp and the electrode cable with the electrode holder.

Hang the electrode-holder on an insulated hook provided near the welding table whenever it is not in use.

Place portable screens around the welding table for the safety of others. (Fig 1)

Check that the welding accessories such as chipping hammer, carbon steel wire brush, tongs and chipping goggles are in working condition.

Keep ready safety apparels (such as leather apron, gloves, sleeves, leggings, jacket, shoes and cap) to ensure personal safety.

Operating the controls of arc welding machines.

Arc welding machines are used to get suitable current for welding purposes.

Connect the welding machine to the main supply as follows.

– Install the welding machine near the 3 phase main supply, keeping the mains supply cables as short as possible to avoid electrical power losses.

- Call a skilled electrician for permanent connections to the main supply since it carries dangerously high voltage.

Ensure that the main switch, fuses and power cables electrode holder, earth clamp and cable lugs are of the required ampere capacity.

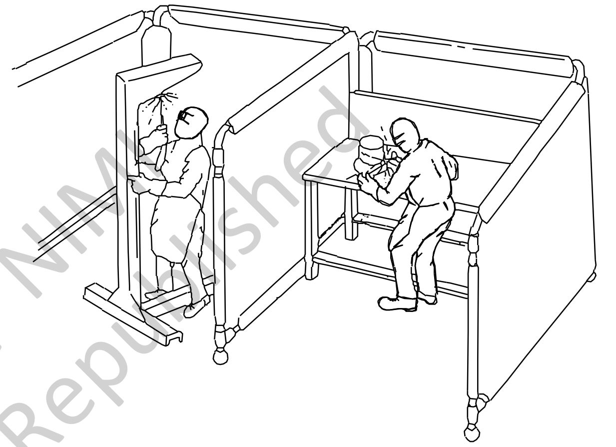
If the main supply connection is of the plug type, the welder can himself connect the main supply.

Check the proper operation of the main switch.

Check the proper operation of the on/off switch of the machine.

Check the proper operation of the current regulator of the welding machine and set the current at 110 ampere for a 3.15mm diameter electrode.

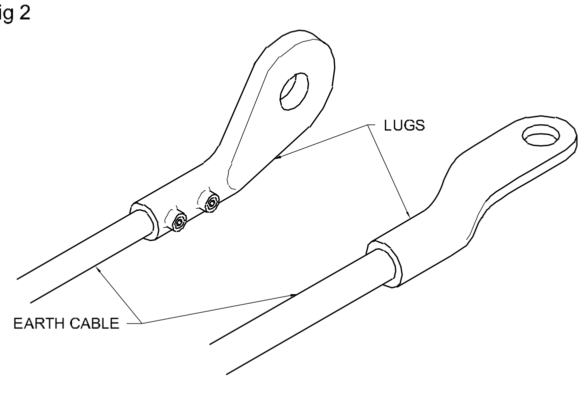
Fig 1



Check the operation of the polarity switch, if it is a DC welding generator or a rectifier.

Welding cables are used to carry the welding current from the welding machine to the electrode-holder and the job and suitable lugs are attached to the earth cable ends (Fig.2).

Fig 2

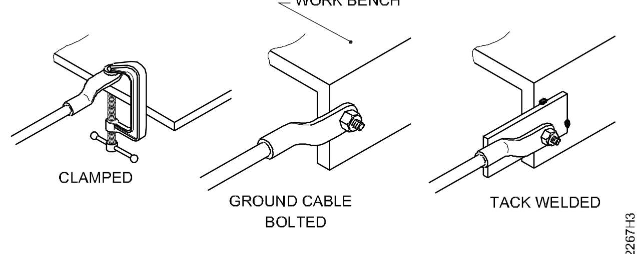


CABLE ATTACHMENTS

Connect one end of the earth cable to one of the output terminal of the machine tightly.

Connect the other end of the earth cable with the welding table or work tightly using the earth clamp as shown in Fig 2. Other methods are shown in Fig 3.

Fig 3



Connect one end of the electrode cable to the second terminal of the machine and the other end to the electrode holder.

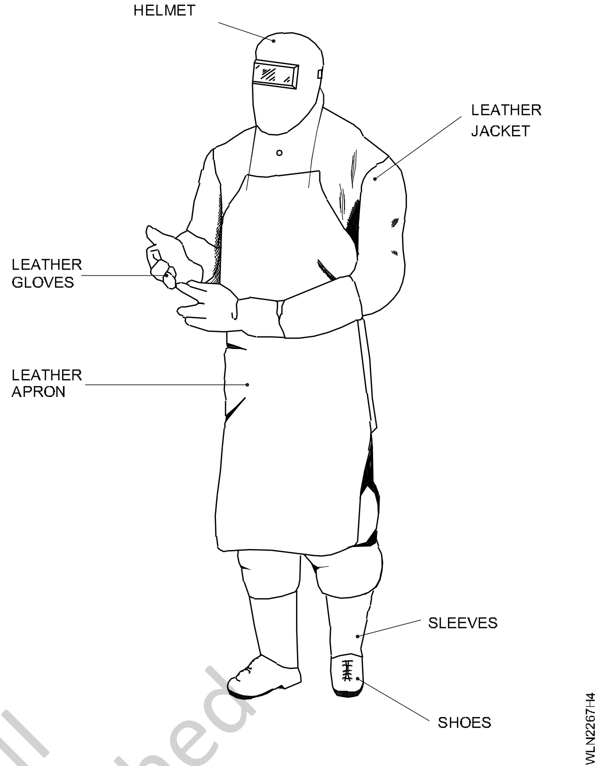
Improper cleaning makes poor electrical contacts and weak welds due to weld defects.

Set the workpiece on the welding table in a flat position.

Switch 'on' the input supply and start the welding machine.

Ensure safety apparels are worn. Fig 4

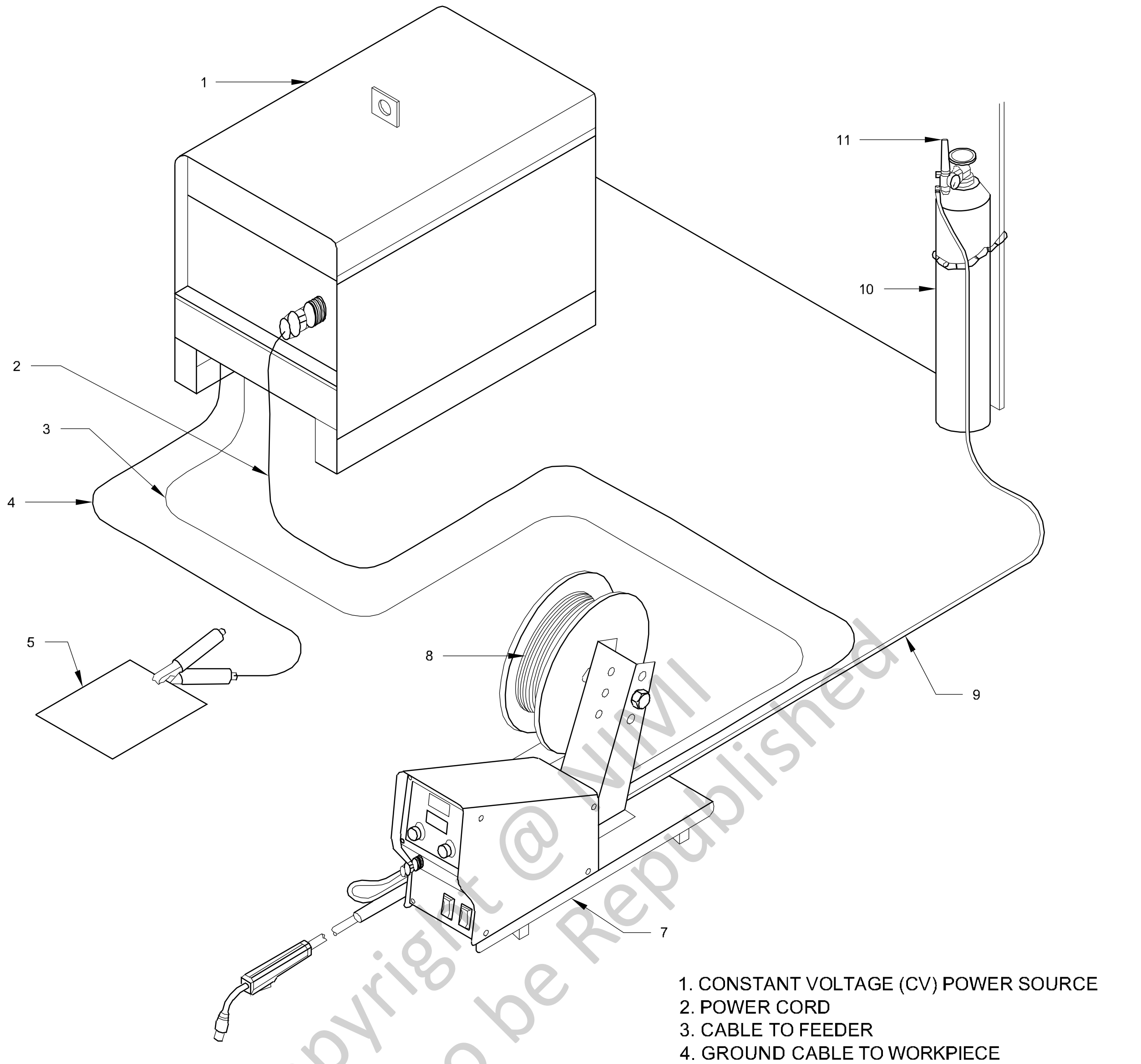
Fig 4



Basic equipment for a typical GMAW semiautomatic setup (Fig.2)

- Welding Power Source - provides welding power.
- Wire Feeders - controls supply of wire to welding gun.
- Supply of Electrode Wire.
- Welding Gun - delivers electrode wire and shielding gas to th weld puddle.
- Shielding Gas Cylinder - provides a supply of shielding gas to the arc.

Fig 5



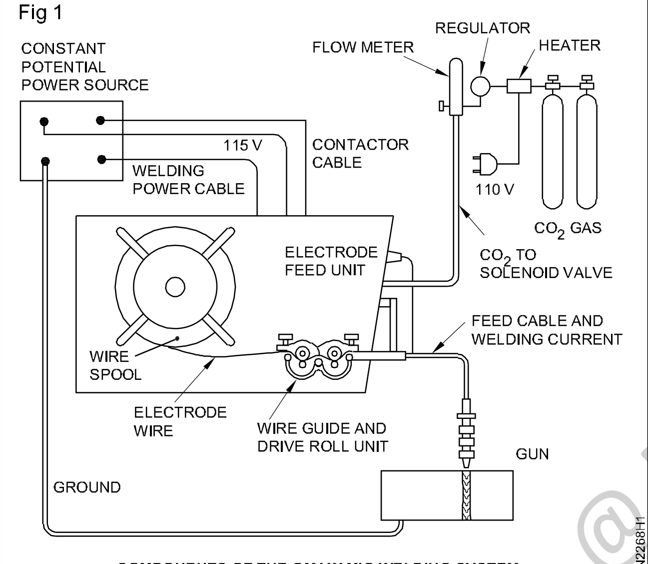
1. CONSTANT VOLTAGE (CV) POWER SOURCE
2. POWER CORD
3. CABLE TO FEEDER
4. GROUND CABLE TO WORKPIECE
5. WORKPIECE
6. WELDING TORCH
7. CONSTANT SPEED WIRE FEEDER
8. ELECTRODE WIRE
9. GAS HOSE
10. SHIELDING GAS CYLINDER
11. GAS REGULATOR WITH FLOW METER

Setting up of GMAW welding machine

Objectives: At the end of this exercise you shall be able to
- **identify the GMAW welding machine an accessories**
- **describe the welding techinies of GMAW.**

Setting up of the CO_2 machine: Fix the wire spool and take the wire through the guide tube, rollers, spiral and contact tip at the end of the torch/gun. (Fig 1)

Fig 1



COMPONENTS OF THE GMAW MIG WELDING SYSTEM

Draw the wire from the spool, pass it on through the inlet wire guide, driver rollers and outlet wire guide. (Fig 2 & 3).

Fig 2

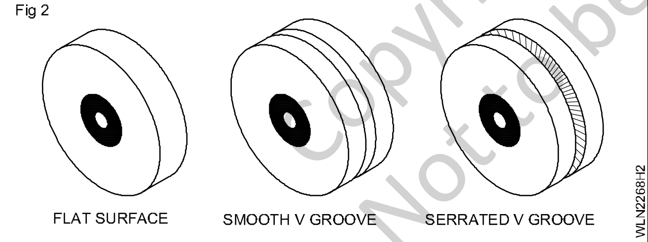
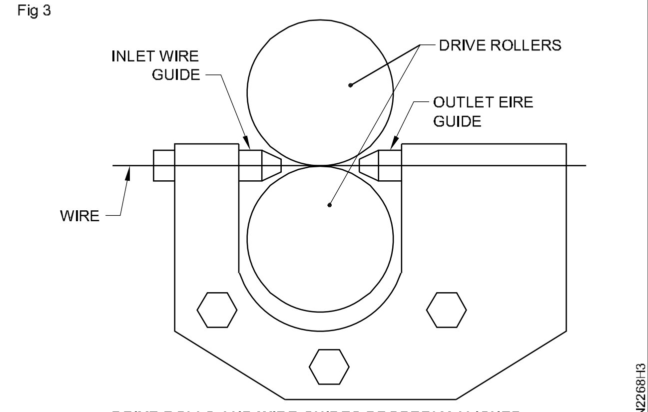


Fig 3

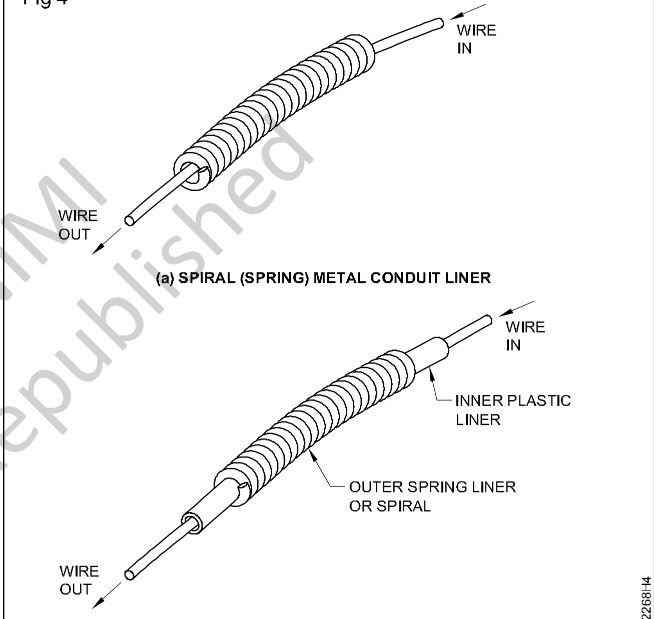


DRIVE ROLLS AND WIRE GUIDES PROPERLY ALIGNED

The roller should not be over tightned to avoid flattening and peeling of copper coating on the wire. The wire is further passed through the conduit liners with spring liners called spiral Fig.4 to the welding torch outlet through the contact tip. (Fig 5)

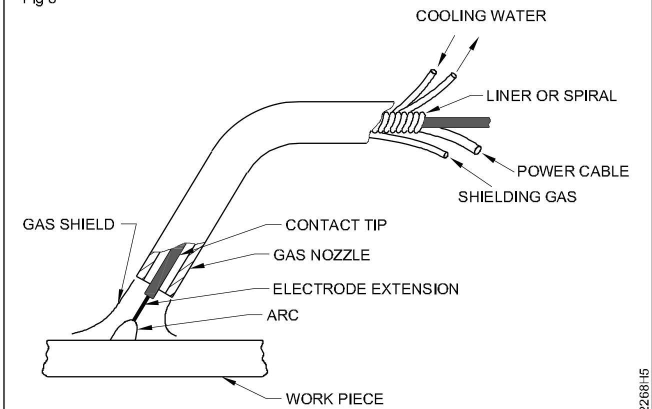
The wire should not develop any bends (or) kinks while inserting.

Fig 4



(b) METAL CONDUIT LINER WITH INNER LINER OF PLASTIC

Fig 5



PARTS OF A TYPICAL WELDING GUN

The contact tip should be removed to facilitate easy flow of the wire from the Spiral and put in position into the Torch later.

Start the welding machine after the machine is connected to the 3 phase supply mains.

Connect the welding torch to the positive terminal. The positive terminal influences deeper, wider weld penetration with a good ripple formation.

Connecting the heater, regulator and flow meter: The inlet end of the CO_2 gas heater is connected to the CO_2 cylinder. (Fig.1) The heater should be connected to either 110V supply from the welding machine (or) 230V supply from the mains.

This will help to avoid ice-forming (freezing) of the CO_2 gas at regulator and flow meter. Fix a two stage regulator using a flat spanner to the outlet end of the gas heater and ensure proper functioning of the dial gauges. Connect finally the Flow meter, Gas hose to the welding torch/gun. Set an outflow pressure for CO_2 gas to get a gas flow of 8 to 10 LPM as required for the Dip Transfer mode.

Ensure to avoid leakage at all connections so as to get correct pressure at the nozzle end. This could be checked by using soap-water solution. When used with correct gas flow rate a rapid cracking and hissing sound shall be heard. Too little flow results in porosity and too high flow rate creates turbulances and in turn contaminates weld.

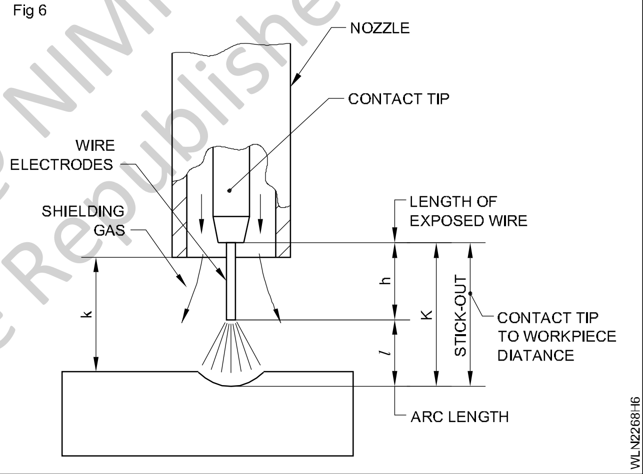
Setting up arc voltage, stickout and wire feed rate for dip transfer

Setting the current level by selecting proper wire feed rate: For this exercise of depositing straightline beads it is desirable to select a smaller diameter wire i.e. 0.8mm dia wire and dip transfer method. Accordingly a current range of 80-100A is to be set for the 0.8mm dia wire. The current to be set has a direct relationship with the wire feed rate in Co_2 welding/GMAW process. So the correct wire feed rate corresponding to the 80-100A current is set on the Electrode Feed unit of the machine.

Setting appropriate arc voltage for the corresponding current used: The Arc Voltage to be set depends on the filler wire diameter, the type of metal transfer and the current selected. The thumb rule to select arc voltage for DIP transfer mode in GMAW process is calculated by using an imperical formula i.e. Arc voltage = 14 + 0.05 (I) ±2 where I is the current selected for the diameter of the wire. This can be up further by +2 volts for globular and spray transfer mode and depending upon bead finish. For laying straight line beads on 10mm thick mild steel plate set an voltage of 23 to 24 volts using set voltage control knob of Co_2 welding machine. This set voltage will drop down and settle at 19-21 volts after arc initiation. The reduction in voltage from set to Arc voltage is due to length of the cable and other factors. The welder should select 19 to 21 volts, strike the arc without changing the current; The right arc voltage is selected by Trial and Error method to get a uniform bead profile.

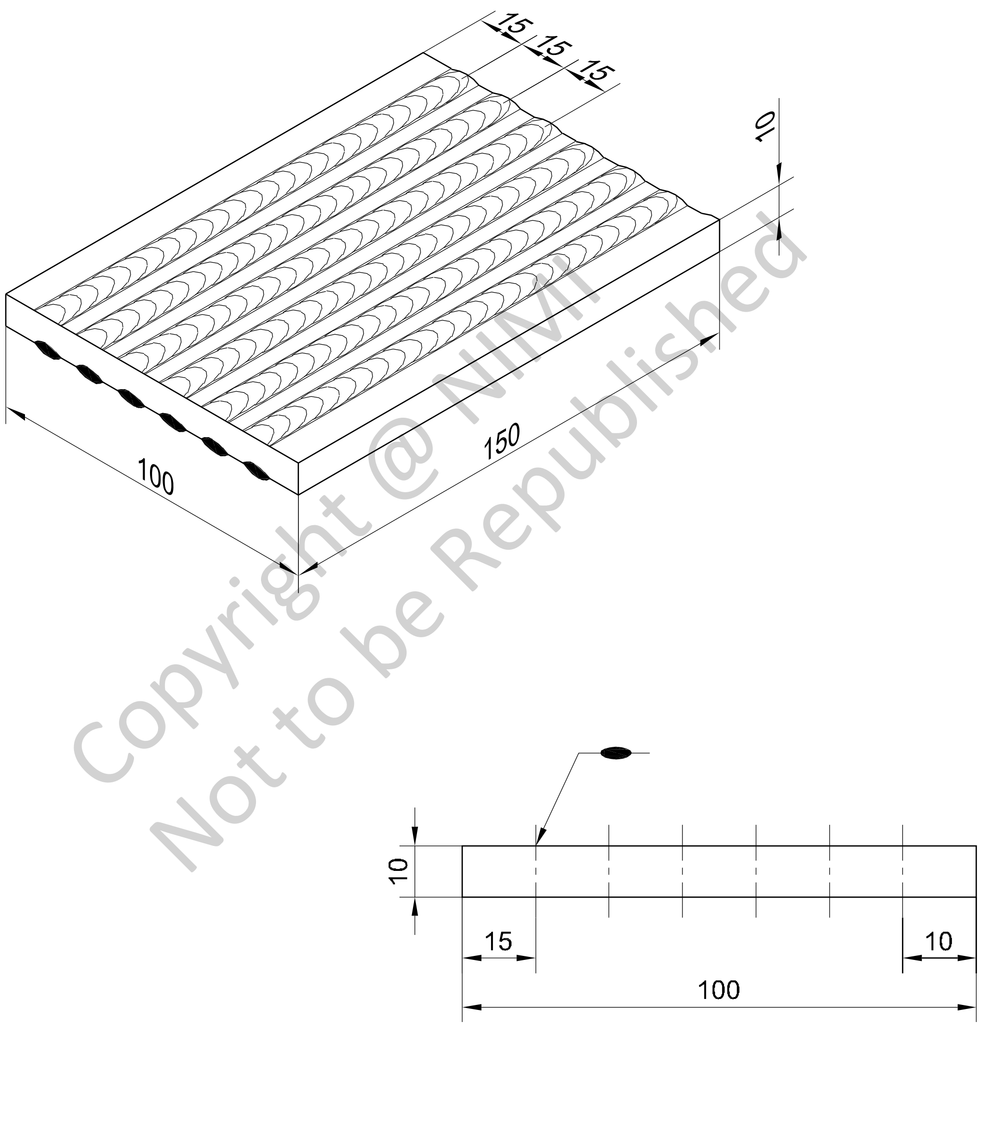
Setting the stick-out: This is the distance between the end of the contact tip and the outer tip of the electrode till it touches the base metal [refer (k) in the Fig.6. The stickout recommended is 5 to 10 mm for Dip Transfer. If the stickout is too short then excessive spatters will get deposited at the end of the nozzle which in turn restricts the shielding gas flow and may cause porosity. If the stickout is too large, arc voltage will shoot up, current diminishes, the arc will tend to become weaker and the metal deposition will become irregular.

Fig 6



Depositing straight line beads on MS plate 10mm in flat position by GMAW

Objectives: At the end of this exercise you shall be able to
- **set up the GMAW machine and set welding parameters.**
- **strike and maintain the electric arc without freezing of the electrode wire with the job**
- **deposit uniform straight bead in flat position without weld defects.**
- **inspect weld bead for finish and weld defects.**



1	100 ISF 10 - 150		Fe 310			GMAW-01
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.69

SCALE NTS	DEPOSING STRAIGHT LINE BEADS ON M.S.PLATE IN FLAT POSITION BY GMAW	TOLERANCE ±1	TIME 10h
		CODE NO. WLN2269E1	

Job Sequence

1 Prepare the job to size as per drawing.

2 Clean the job surface with carbon steel wire brush.

3 Mark parallel lines on the job surface as per drawing and punch the lines.

4 Set the workpiece (job) on the work table in Flat position.

5 Fix the 0.8mm diameter wire spool in position, lock it up and pull the wire through the guide tube, rollers, spiral and contact tip of the torch.

6 Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.

7 Connect the CO_2 gas heater to the electrical supply 5-10 minutes before starting of the weld.

8 Set the arc voltage at 19-21 volt as required for Dip Transfer mode.

9 Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute).

10 Set the wire feed rate so as to get 90-100 amp by striking the arc on a scrap plate.

11 Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.

12 Wear the protective clothing as required.

13 Switch over to weld mode as indicated in the machine.

14 Strike the arc, maintain a filler wire stick out of 8-10mm from the end of the contact tip to the job as required for dip transfer mode.

15 Deposit the bead on punched lines of the job from one end to other.

16 Remove spatters with chipping hammer and clean the joint using carbon steel wire brush.

17 Self inspect the weld bead for finish and defects.

Skill Sequence

Preparation and setting of the job: Prepare a M.S plate piece of size 150 x 100 x 10mm thick.

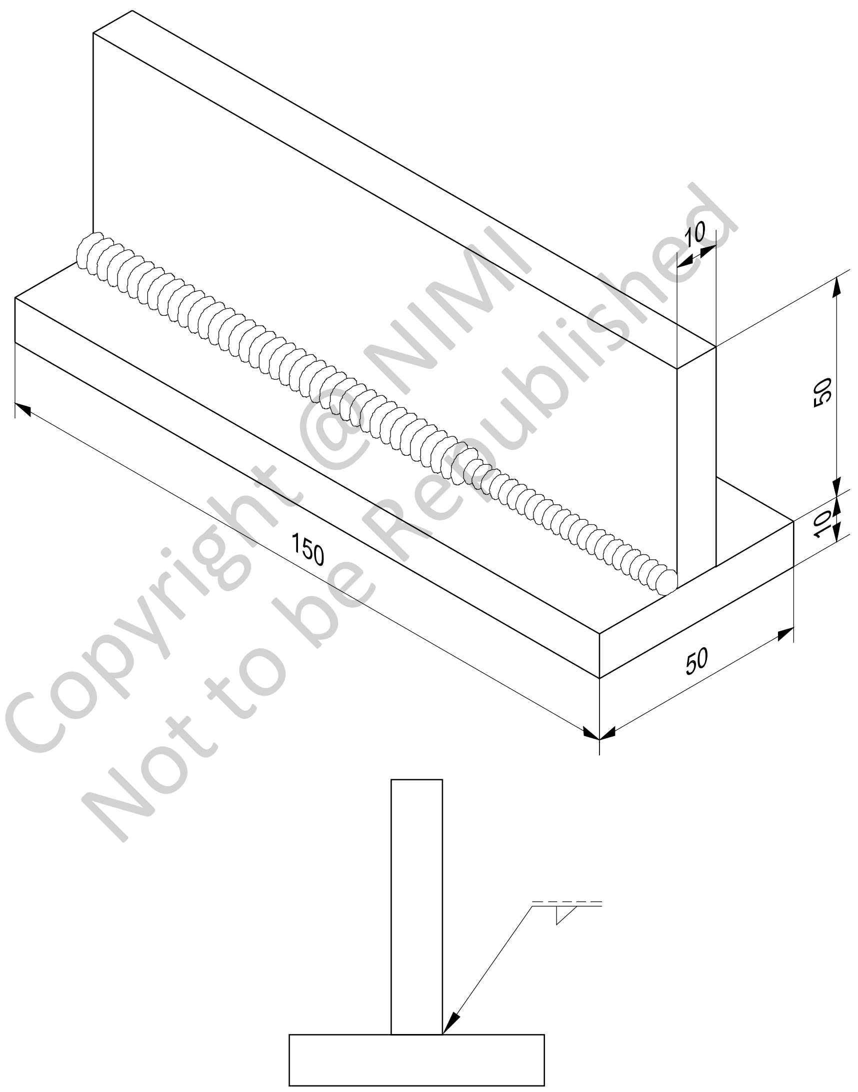
Mark striaght lines with punch marks spaced at 15mm.

Set the job on the welding table in a Flat position as done in earlier exercises.

Fillet weld Tee joint on MS plate 10mm thick in flat position by dip transfer 1F

Objectives: At the end of this exercise you shall be able to

- **set and tack plate pieces in alignment as tee joint and by keeping distortion allowance**
- **set the tee joint in flat position for welding**
- **deposit root run in tee joint of proper size and penetration**
- **deposit final covering run in the tee joint of proper leg size**
- **clean the weldment and inspect surface defects on the fillet weld.**



2	50 ISF 10 - 150		Fe 310 - W			GMAW-2
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.70

SCALE NTS	**FILLET WELD TEE JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION BY DIP TRANSFER**	TOLERANCE ±1	TIME 09 Hrs
		WLN2270E1	

Job Sequence

1 Cut the plates by gas cutting as per drawing.

2 Grind the gas cut edges to square.

3 Use plain goggles while grinding and welding googles while gas cutting.

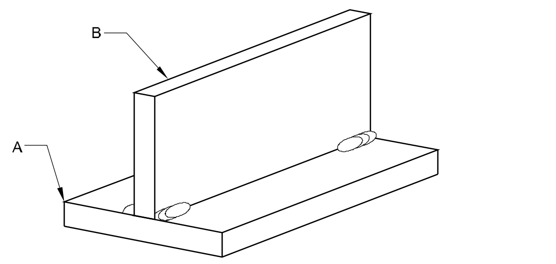
4 Deburr and clean the surface of the wire brush and filing.

5 Set the plate B on the plate A in the form of tee as per drawing.

6 Wear protective clothing's.

7 Tack weld(min. 10mm length) on both ends of the tee joint as shnown in the Fig 1.

Fig 1



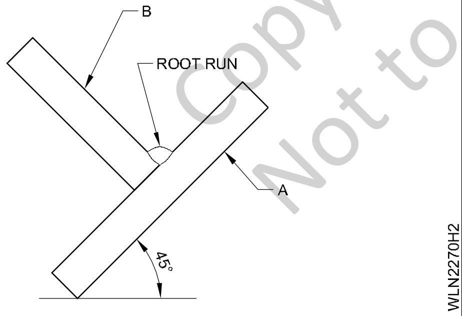
SETTING AND TACKING A TEE JOINT

8 Keep the tack welded job in the channel at 45 degree from the horizontal plane so that the welding can be done in flat/down hand postion

9 Connect the torch to positive terminal of the machine

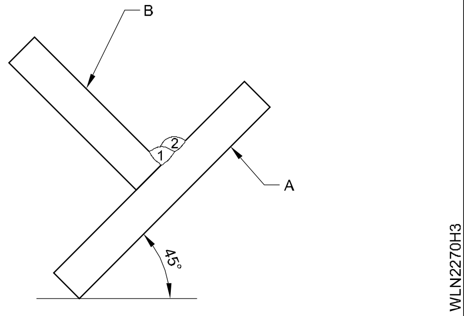
10 Weld the root run of the joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique Fig 2

Fig 2



11 Set 90 to 100 amps current/ corresponding wire feed rate 19 to 20 Arc and deposit the root run

Fig 3



12 Ensure proper root penetration and even fusion of plate A and B with suitable welding gun / torch angle and Arc travel speed.

13 Clean the root run using steel wire brush.

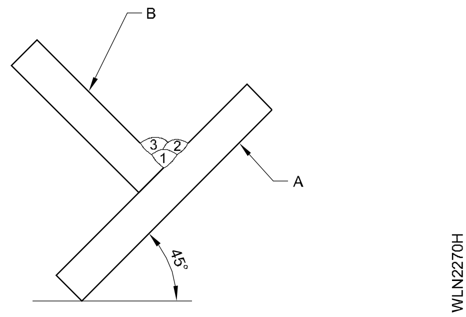
14 Deposit the 2nd run using stringer bead as shown in Fig 3 covering the bottom plate A and 2/3 of the width of the root run. Adopt the same welding parameters under techniques used for the root run.

15 Ensure the undercut in bottom plate is avoided and a leg length of plate thickness 10mm is obtained.

16 Clean the second run by wire brush

17 Deposit the third run similar to second run except that the deposit covers the vertical plate B, the root run and the second run Fig 4

Fig 4



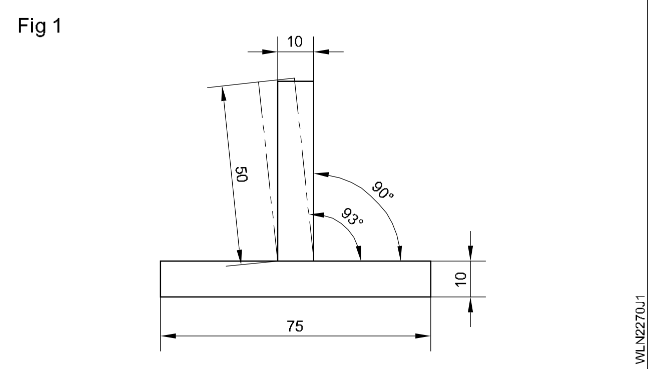
18 Ensure under cut on the vertical plate is avoided and a leg length of 10mm is obtained

19 Clean the welded joint by wire brush

20 Use tongs while handling the hot job.

Skill Sequence

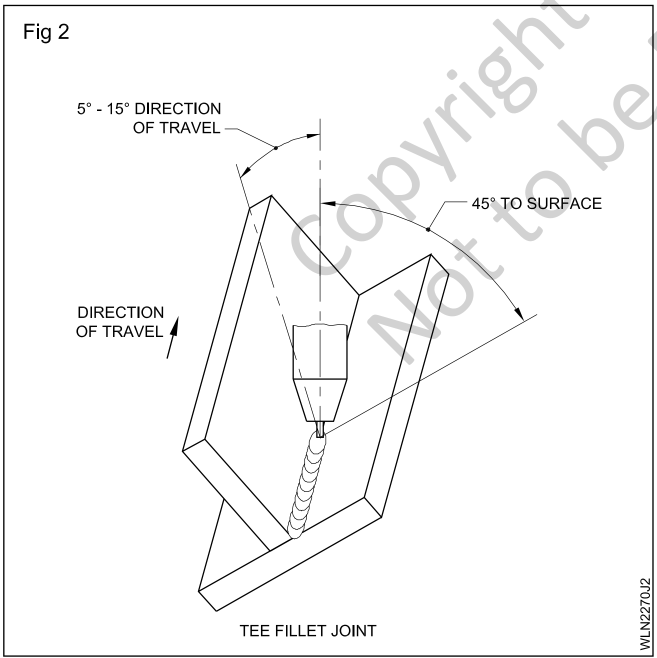
While tack welding plates A and B for the Tee joint I, the angle between them is to be kept initially as shown in Fig. 1(i.e a distortion allowance of 1º per run) so as to control the angular distortion which ultimately settles to 90º after welding.



For the lap fillet joints no distortion allowance is recommended.

Also for joint IV no distortion allowance is required as the vertical plate B is rigidly held by the weld bead at joint I.

For depositing the root run for the Tee Joint I hold the torch perpendicular to the joint and move the torch at a steady rate from left to right side (backhand technique) of the joint. The gun should be held between 5-15 degrees forward from the vertical line to the metal surface and 45º to the surface Fig 2.

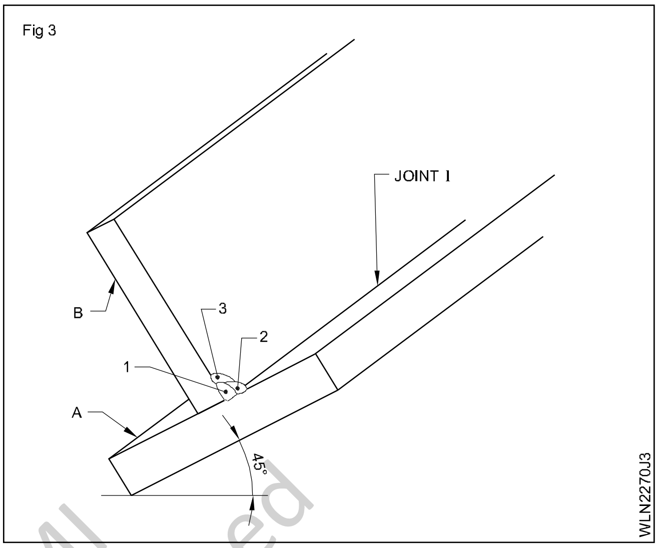


Since GMA welding process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

For welding the joints in flat (downhand) position it is convenient to use the channel to position the joints. This will permit the tack welded job to be kept at 45º angle with the horizontal plane.

Uniform travel speed will ensure even weld reinforcement, bead height and ripple formation, smooth joining of the weld bead with the base metal at the toes. fill the crater properly.

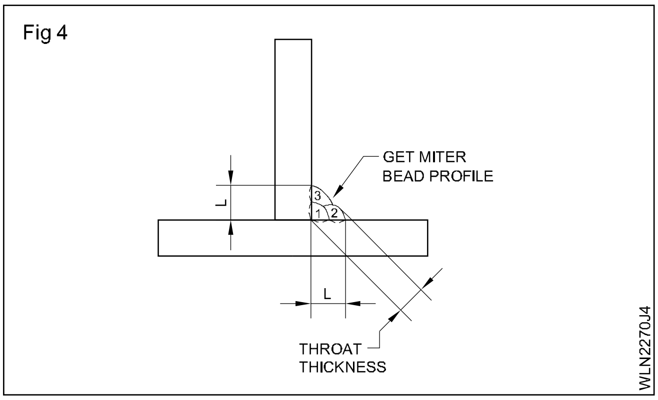
The bead placement for the 2nd and 3rd stringer bead are made as shown in the Fig 3. This is done to ensure that a



leg length (L) of 10mm is obtained. Ensure that the concavity between the beads 2 and 3 is kept to the minimum. This will ensure to obtain the required throat thickness (Fig 4).

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.

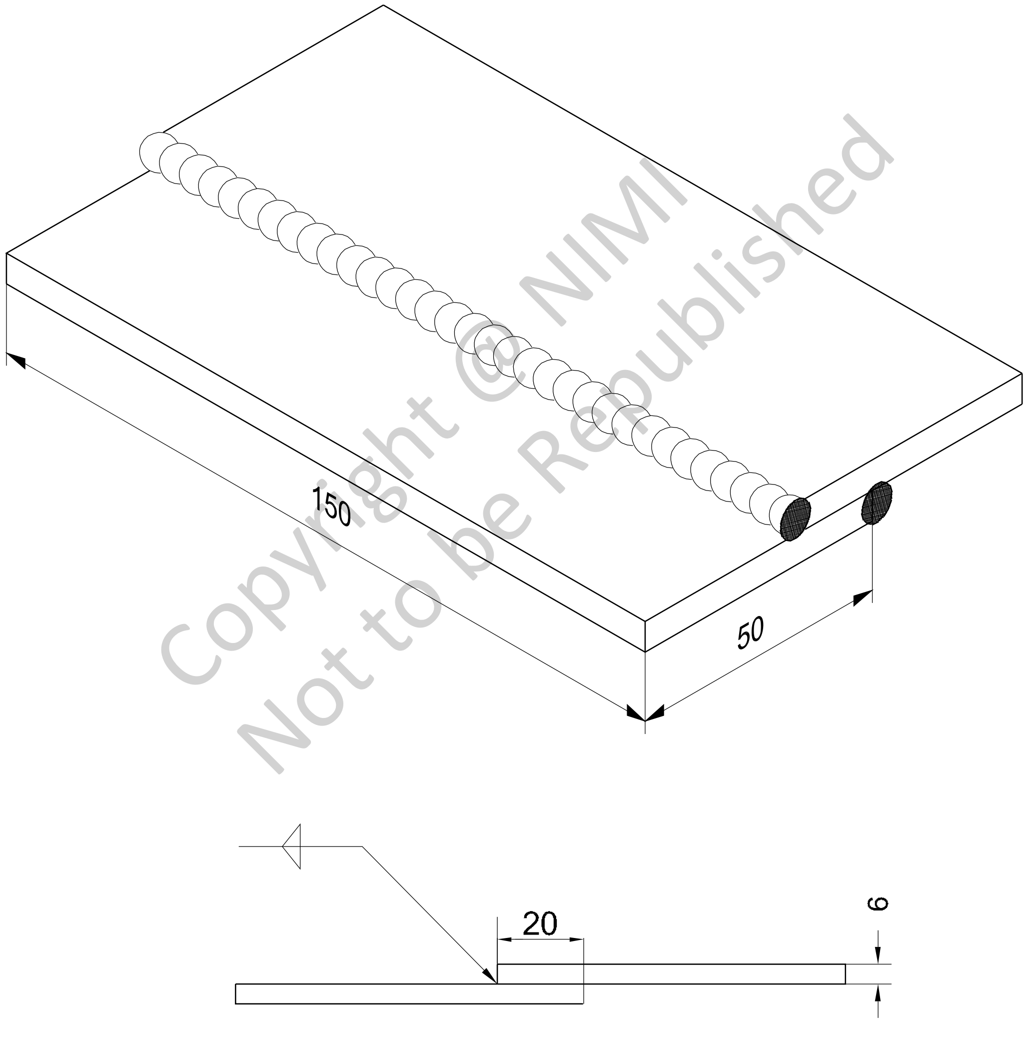
Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilished arc and the Co_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.



Clean each bead after deposition and the complete the job using carbon steel wire brush.

Fillet weld - Lap joint on MS sheet 3mm thick in flat position by dip transfer 1F

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as lap joint as per drawing**
- **set the lap joint in flat position for welding**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface deffects on the weld and bead appearance.**



2	ISST 50 x 3 - 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 71

SCALE NTS	LAP JOINT ON M.S.PLATE BY GMAW IN FLAT POSITION	TOLERANCE ±1	TIME 08 Hrs
		WLN2271E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

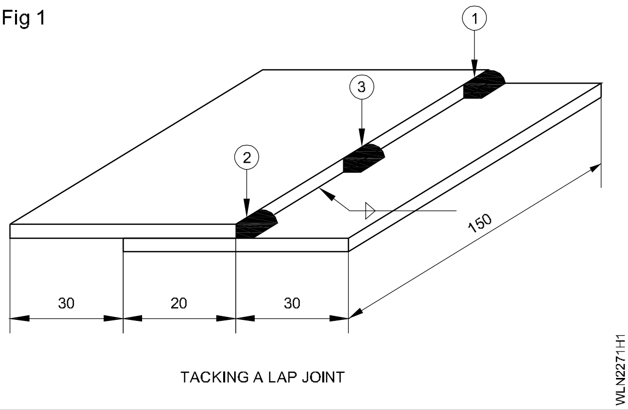
3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of lap as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

Fig 1



TACKING A LAP JOINT

7 Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the lap joint as dhown in Fig 1.

9 Keep the tack welded jib in the channel at 45 degree from the horizontal plane so that the welding can be done in flat / down hand position.

10 Weld the lap joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut

13 Ensure the edges of the plate is not melted off due to excessive weaving

14 Ensure there is no undercut at the other toe of the lap weld on plate

15 Clean the bead by wire brush

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

For the lap fillet joints no distortion allowance is recommended

Since the GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

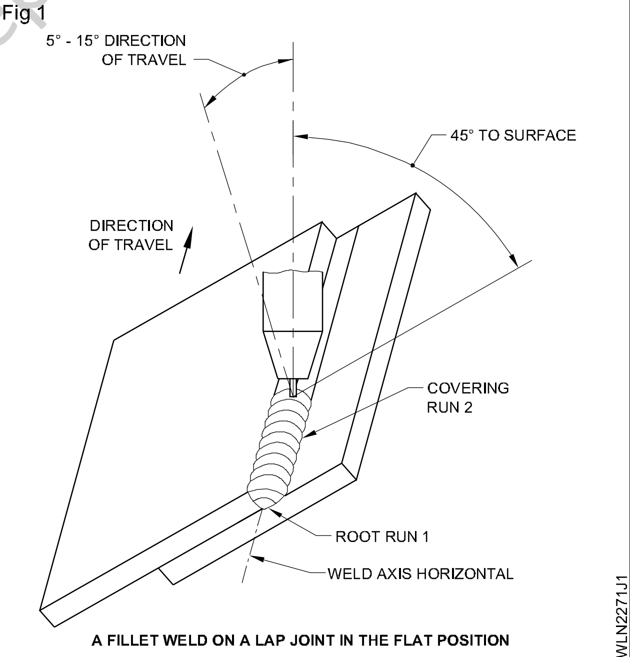
For welding the joints in flat position it is convenient to use the channel to position the joints. This weld permits the tack welded job to be kept at 45^0 angle with the horizontal plane.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig.1.

The torch movement at the edge of the top plate of the Lap joint should be so controlled that the edge is not melted off. Also the torch has to be paused when reaching the bottom toe of the weld for a short period so that the undercut, if developed, at toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

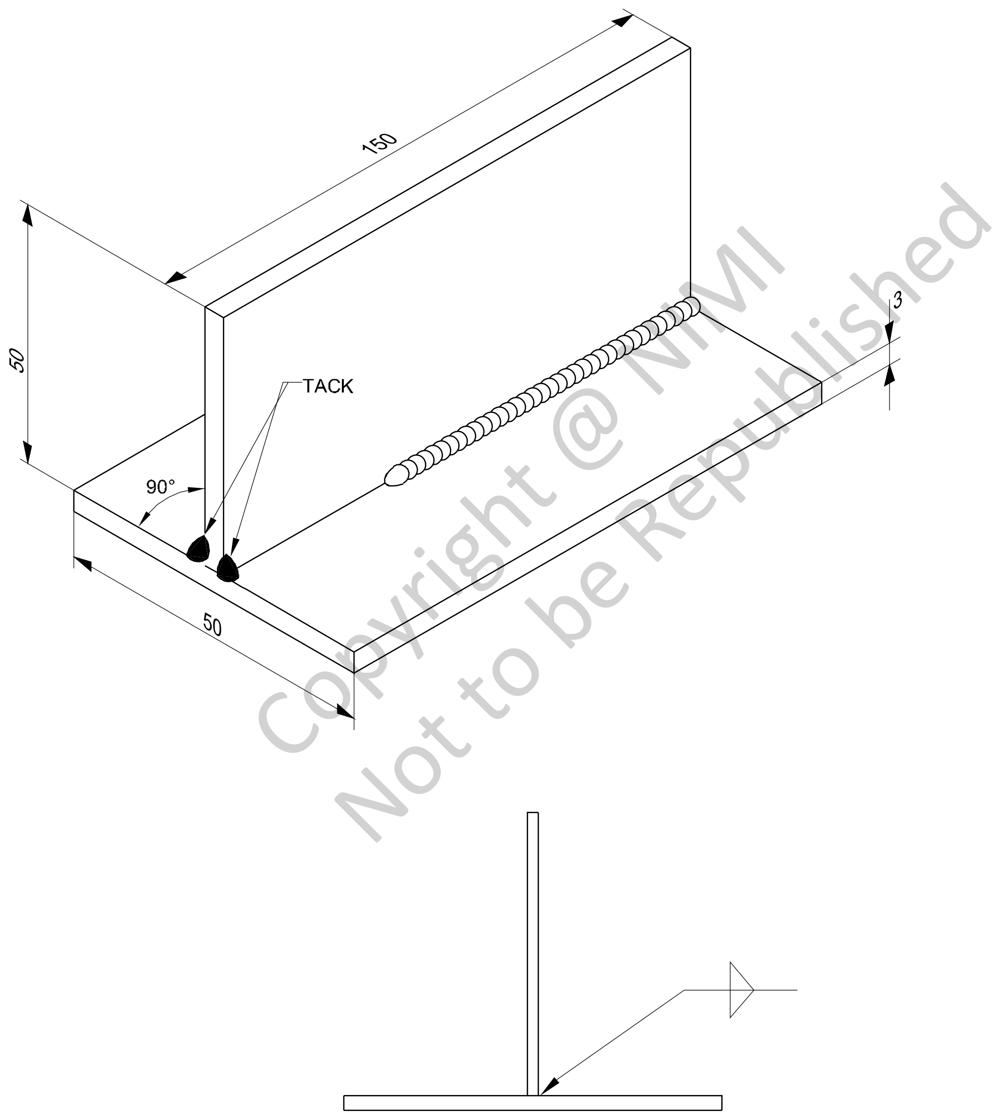
Fig 1



A FILLET WELD ON A LAP JOINT IN THE FLAT POSITION

Fillet weld - 'T' joint on M.S sheet 3mm thick in flat position by dip transfer IF

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as 'T' joint as per drawing**
- **set the 'T' joint in flat position for welding**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the weld and bead appearance.**



2	ISST 50 x 3 - 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 72

SCALE NTS	FILLET WELD TEE JOINT M.S. SHEET 3mm THICK IN FLAT POSITION BY DIP TRANSFER	TOLERANCE ±0.5	TIME 08 Hrs
		WLN2272E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of Tee as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

7 Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the Tee joint as dhown in Fig 1.

9 Keep the tack welded job in the channel at 45 degree from the horizontal plane so that the welding can be done in flat / down hand position.

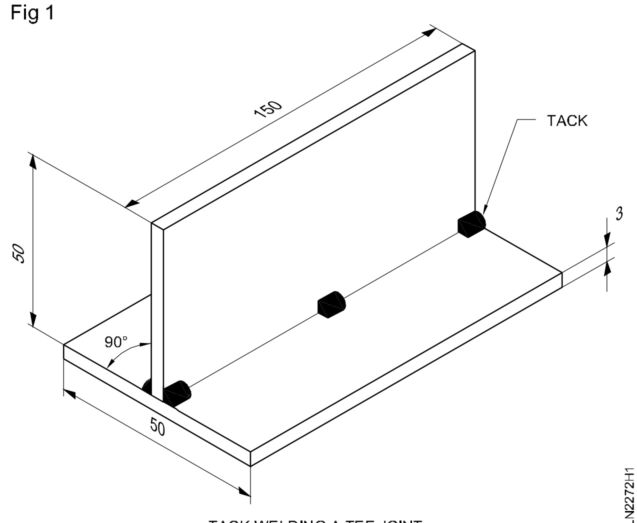
10 Weld the Tee joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut.

13 Ensure the edges of the plate is not melted off due to excessive weaving.

Fig 1



TACK WELDING A TEE JOINT

14 Ensure there is no undercut at the other toe of the lap weld on plate

15 Clean the bead by wire brush

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

For the lap fillet joints no distortion allowance is recommended.

Since the GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

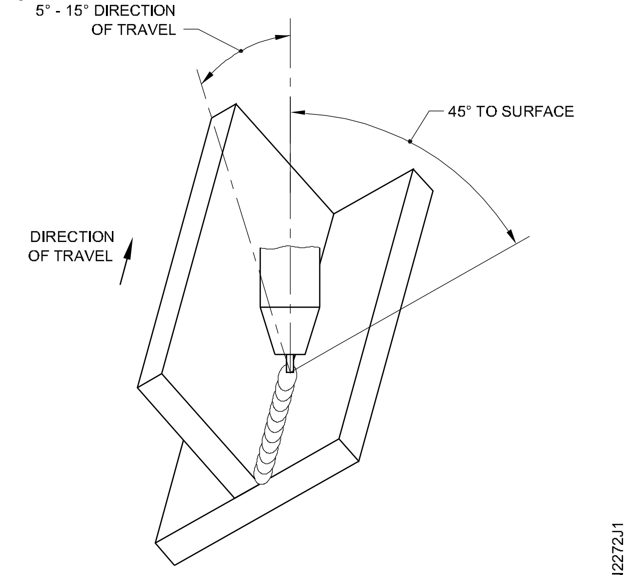
For welding the joints in flat position it is convenient to use the channel to position the joints. This weld permits the tack welded job to be kept at 45^0 angle with the horizontal plane.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig 1.

The torch movement at the edge of the top plate of the Lap joint should be so controlled that the edge is not melted off. Also the torch has to be paused when reaching the bottom toe of the weld for a short period so that the undercut, if developed, at toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

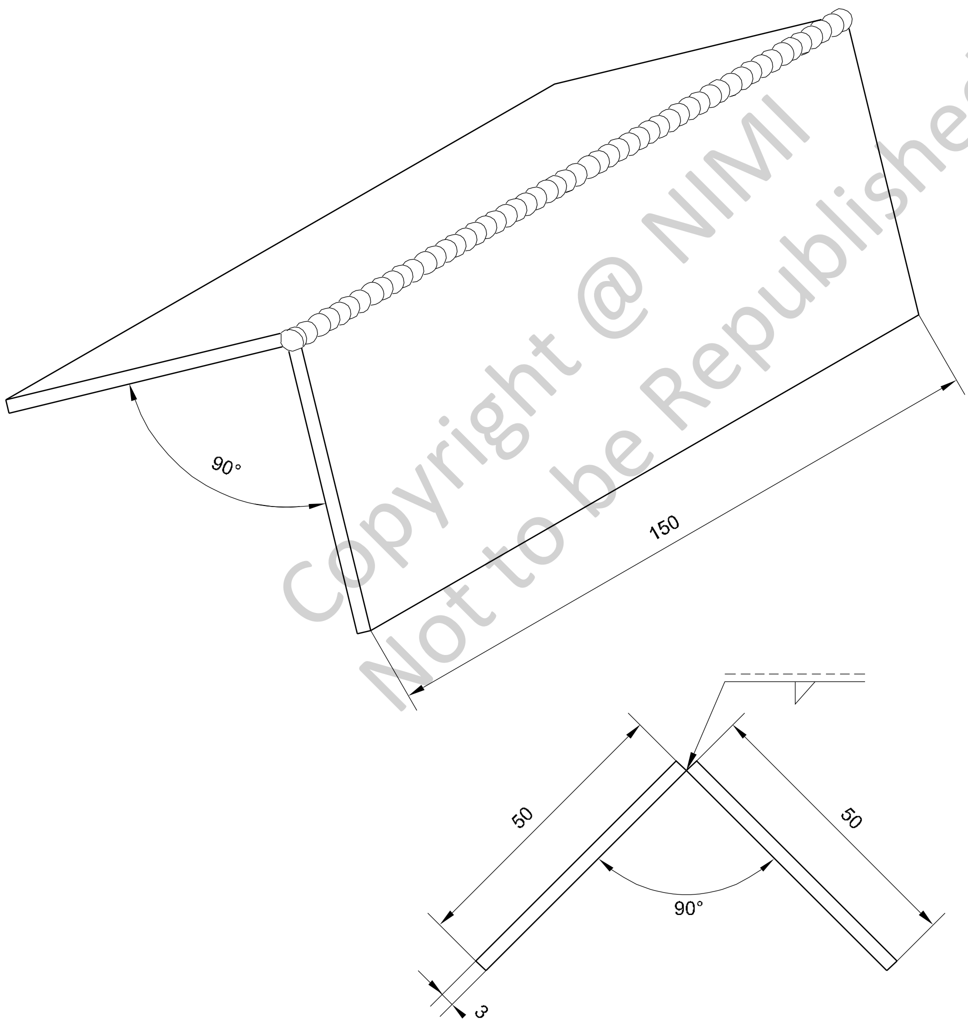
Fig 1



TEE FILLET JOINT

Fillet weld - Corner joint on M.S sheet 3mm thick in flat position by dip transfer 1F

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as corner joint**
- **set the corner joint in flat position for welding**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects and penetration.**



2	ISST 50 x 3 - 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 73
SCALE NTS	**FILLET WELD CORNER JOINT ON M.S.SHEET 3mm THICK IN FLAT POSITION BY DIP TRANSFER**				TOLERANCE ±0.5	TIME 09 Hrs
					WLN2273E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of corner joint at 90º with specified root gap in flat position as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

7 Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the lap joint as shown in Fig 1.

9 Keep the tack welded job on the welding table in flat/ down hand position.

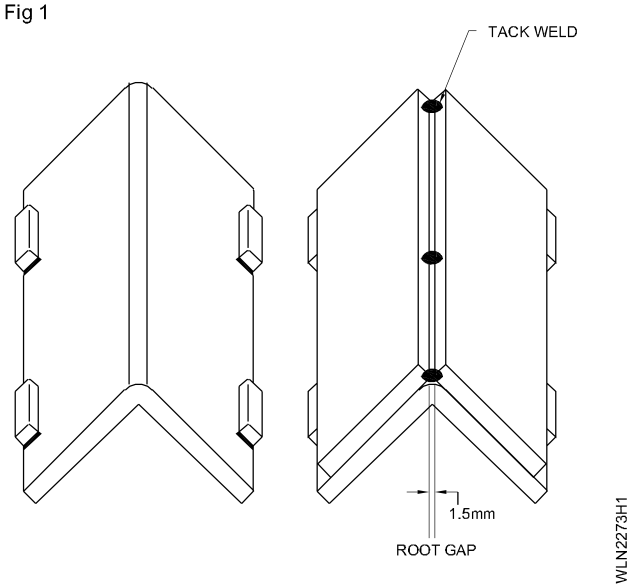
10 Deposit run in the joint by forming a key hole and obtain complete penetration and even fusion of plates.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut.

13 Ensure the edges of the plate is not melted off due to excessive weaving.

Fig 1



14 Ensure there is no undercut at the other toe of the corner weld on plate

15 Clean the bead by wire brush

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

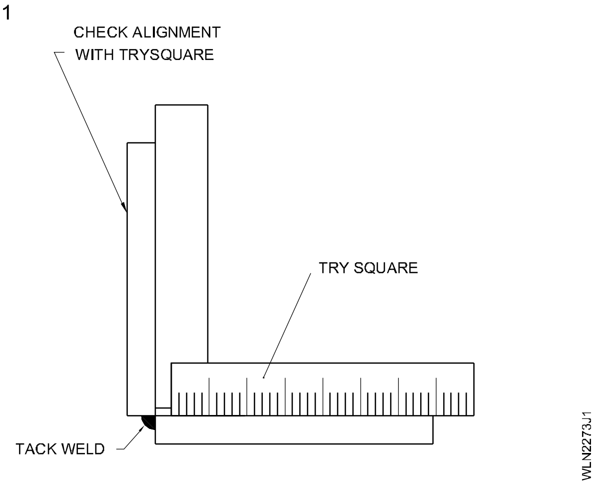
While tack welding, plates A and B for the corner joint the angle between them is to be at 90 degree. (Fig.1)

Since the GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, penetration and height.

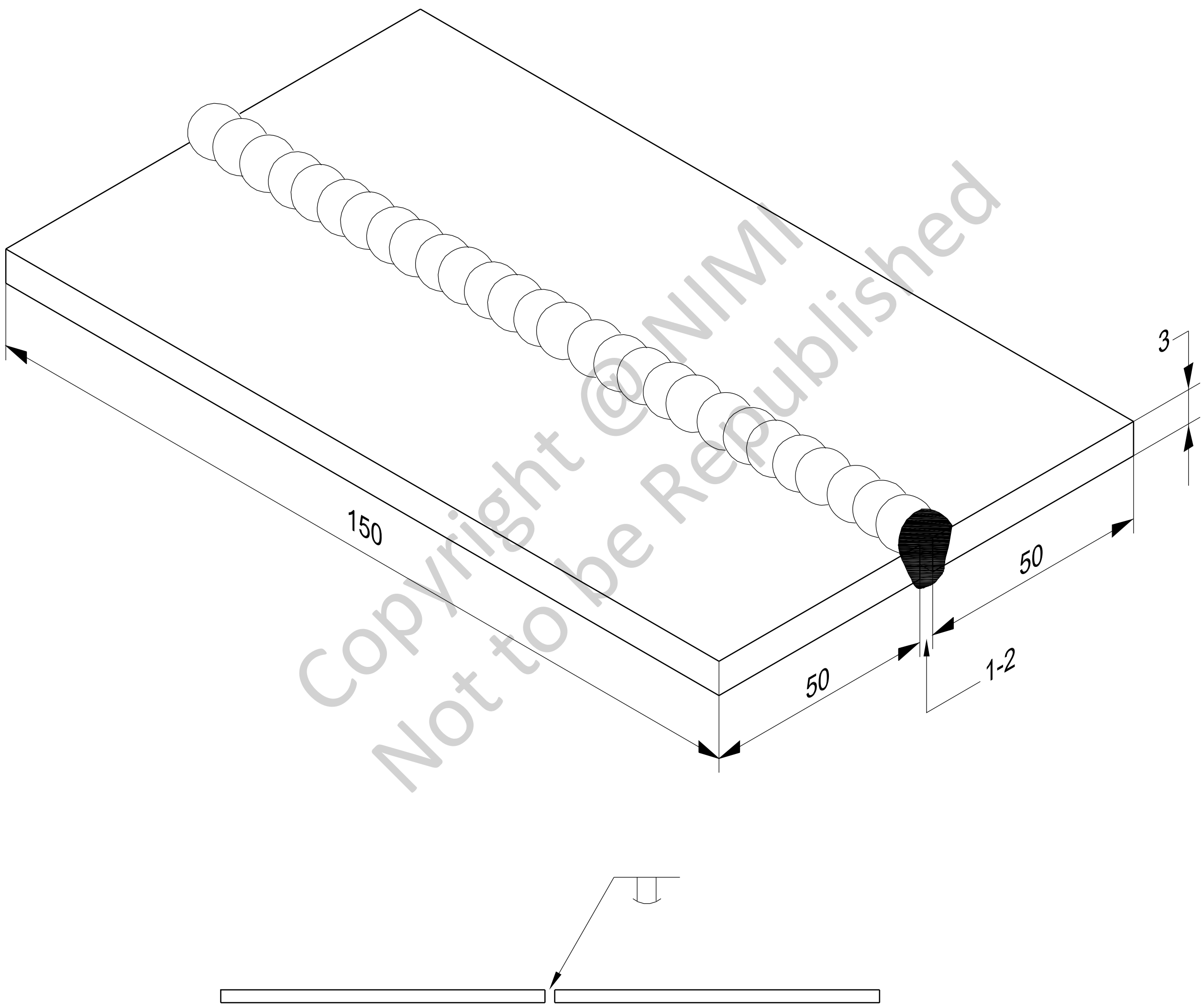
Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fig 1



Butt weld - Square butt joint on M.S sheet 3mm thick in flat position 1 G

Objectives: At the end of this exercise you shall be able to
- **prepare the M.S sheets as per drawing**
- **set the sheet as square butt joint with root gap and tack weld**
- **weld the square butt joint in flat position in one run**
- **clean and inspect for surface defects and penetration.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 74
2	ISST 50 x 3 - 150		Fe 310 - W			GMAW- 02

SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON M.S SHEET 3mm THICK IN FLAT POSITION	TOLERANCE ±1	TIME 10 Hrs
		WLN2274E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of square butt joint with 1 to 2mm root gap in flat position as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

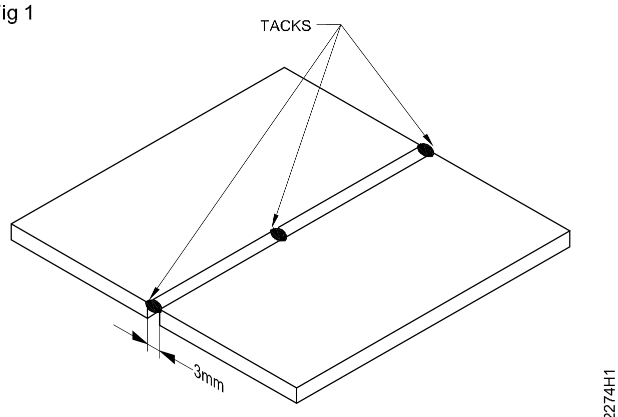
7 Tack weld (min. 10mm length) on both ends of the butt joint as dhown in Fig 1.

8 Keep the tack welded job on welding table flat / down hand position.

9 Weld the butt joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

10 Adjust the welding current to DCEP and 90-100amperes/ corresponding wire feed rate(3-4m/min), 18 to 20 arc voltage, gas flow of 8 to 10 LPM and stick out of 8 to 10mm and deposit the run by using dip transfer mode.

Fig 1



SETTING AND TACKING

11 Deposit forming a key hole and obtain complete penetration and even fusion of plates.

12 Clean the bead by wire brush.

13 Inspect the welded joint for undercut, uneven bead formation, penetration, distortion and good bead profile.

Skill Sequence

Adjust the welding current to DCEP and 90-100amperes/ corresponding wire feed rate, 18 to 20 arc voltage, gas flow of 8 to 10 LPM and stick out of 8 to 10mm and deposit the run by using dip transfer mode While tack welding, plates A and B for the butt joint the angle between them is to be at 180 degree.

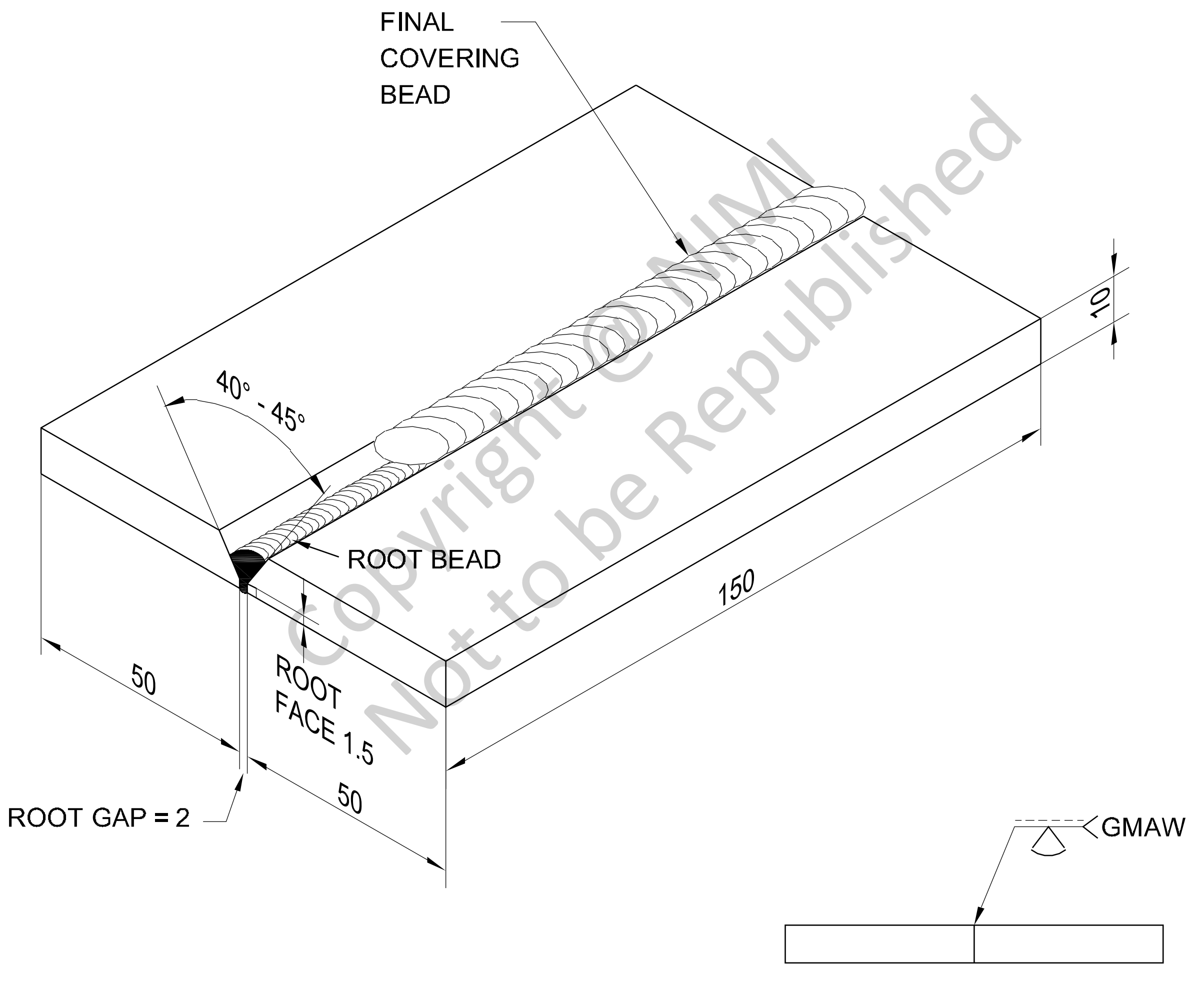
Since the GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, penetration and height.

Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Butt weld single V Butt joint on M.S plate 10mm thick by dip transfer in flat position 1 G

Objectives: At the end of this exercise you shall be able to
- **prepare the plates with necessary bevelling and root face using gas cutting and grinding**
- **preset the plates in alignment in horizontal plane with necessary root gap and tack weld**
- **clean the joint using wire brush**
- **set the welding parameters on the welding machine for the root, 2nd and 3rd passes**
- **deposit the root run with root penetration and uniform melting of both root faces of the joint**
- **ensure effective interbead cleaning after depositing each run using wire brush**
- **deposit the 2nd and 3rd run using weaving technique**
- **ensure crater filling and avoid weld defects in the joint.**



NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 75
2	50 ISF 10 - 150		Fe 310 - W			GMAW- 02

SCALE NTS	**BUTT WELD SINGLE 'V' BUTT JOINT ON M.S. PLATE 10mm THICK BY DIP TRANSFER IN FLAT POSITION**	TOLERANCE ±1	TIME 15hrs
		CODE NO.WLN2275E1	

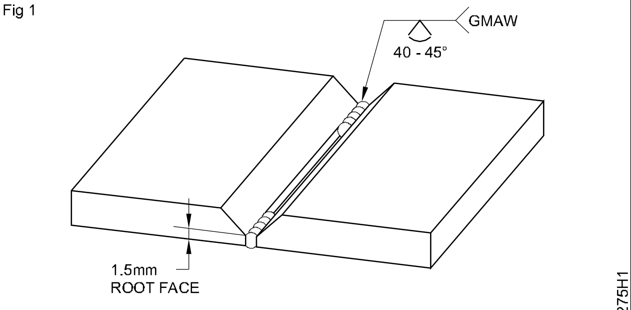
Job Sequence

1 Adjust the power source and wire feeder to obtain 18 to 19 volts and 90 and 100 amperes, gas flow 8-10 LPM.

2 Thoroughly clean the pieces to be joined. Pay particular attention to the top of the plate, the sidewalls of the groove and the underside of the joint. Grind or file a 1.5mm root face on each beveled edge as shown in Fig.1.

3 Tack the pieces together and position as shown in Fig.1. Put spacers under the plate so that you don't weld the plate to your table.

Fig 1

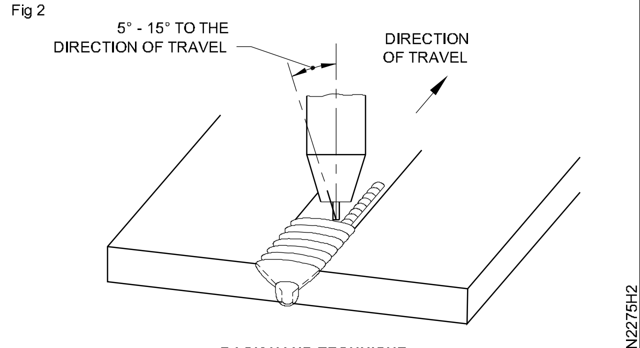


TACK WELDED AND WELD POSITION FOR A FLAT V - GROOVE BUTT JOINT

4 Hold the gun perpendicular to the joint and strike the arc at the tack. Move the torch from left to right end of the joint i.e use backhand technique.(Fig.2) Weave the gun from side to side. When the gun is in the center of the joint, watch the arc very closely. By concentrating the arc on the leading edge of the puddle, you can cause the bead to penetrate through the joint and fuse both root faces. If you bring the arc too far down in the puddle, the wire will go through the joint and the arc will become very erratic. If you allow the arc to go too far up on the puddle, your penetration will decrease and you will not penetrate the joint. Practice will help you use the arc to control the flow of the weld puddle.

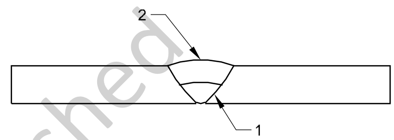
5 Complete the joint using the bead sequence shown in Fig 3. Use a slight weave to help the weld flow and to fuse to the sidewalls of the groove and the previous beads.

Fig 2



BACK HAND TECHNIQUE

Fig 3



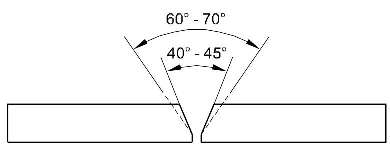
BEAD SEQUENCE

6 When you have completed the weld, cool it and examine it. The root should show full penetration along the entire length. The root reinforcement should protrude beyond the joint from 0.5 to 1mm. The face of the weld should merge smoothly with the base metal. The reinforcement should be atleast 1mm above the surface of the base metal and also should not exceed beyond 1.5.

Skill Sequence

For CO_2 welding (GMAW process) the plates are bevelled so that the included angle (groove angle) of the single Vee butt joint is 40 to 45^0 as shown in the Fig 1. This is less compared to MMAW groove angle which is kept at 60 - 70^0.

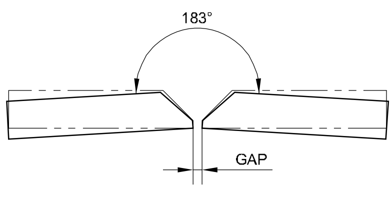
Fig 1



To control the transverse distortion it is advisable to preset the joint to 183^0 for 10mm thick plates as shown in Fig 2.

Distortion may be allowed for by pre-setting the plates in the opposite way so that the weld pulls them to the desired shape. When the weld shrinks it will pull the plate to its correct position shown by dotted line in Fig 2.

Fig 2



PRE-SETTING TO COMPENSATE FOR ANGULAR DISTORTION

Maintaining the angle of the torch 5 to 15^0 towards the direction of travel as shown in Fig 2 in Job Sequence will help to get better root penetration.

Maintain a stick-out of 5 to 8mm (maximum 10mm)

Set a current of 80-90A for 0.8mm dia wire with a corresponding arc voltage of 18 to 19V.

Set a gas flow rate to 8-10LPM so as to protect the weld metal from atmospheric contamination.

Maintain a faster travel speed of 3 to 4m/min. to avoid burn throughs during the root run. At the same time ensure to get full and even root penetration throughout.

It is very important to clean the root run by Carbon Steel wire brush to avoid any non-metallic inclusions during the 2nd pass/run.

Set the current to 90 to 100A and an arc voltage of 19 to 20V for the 2nd run.

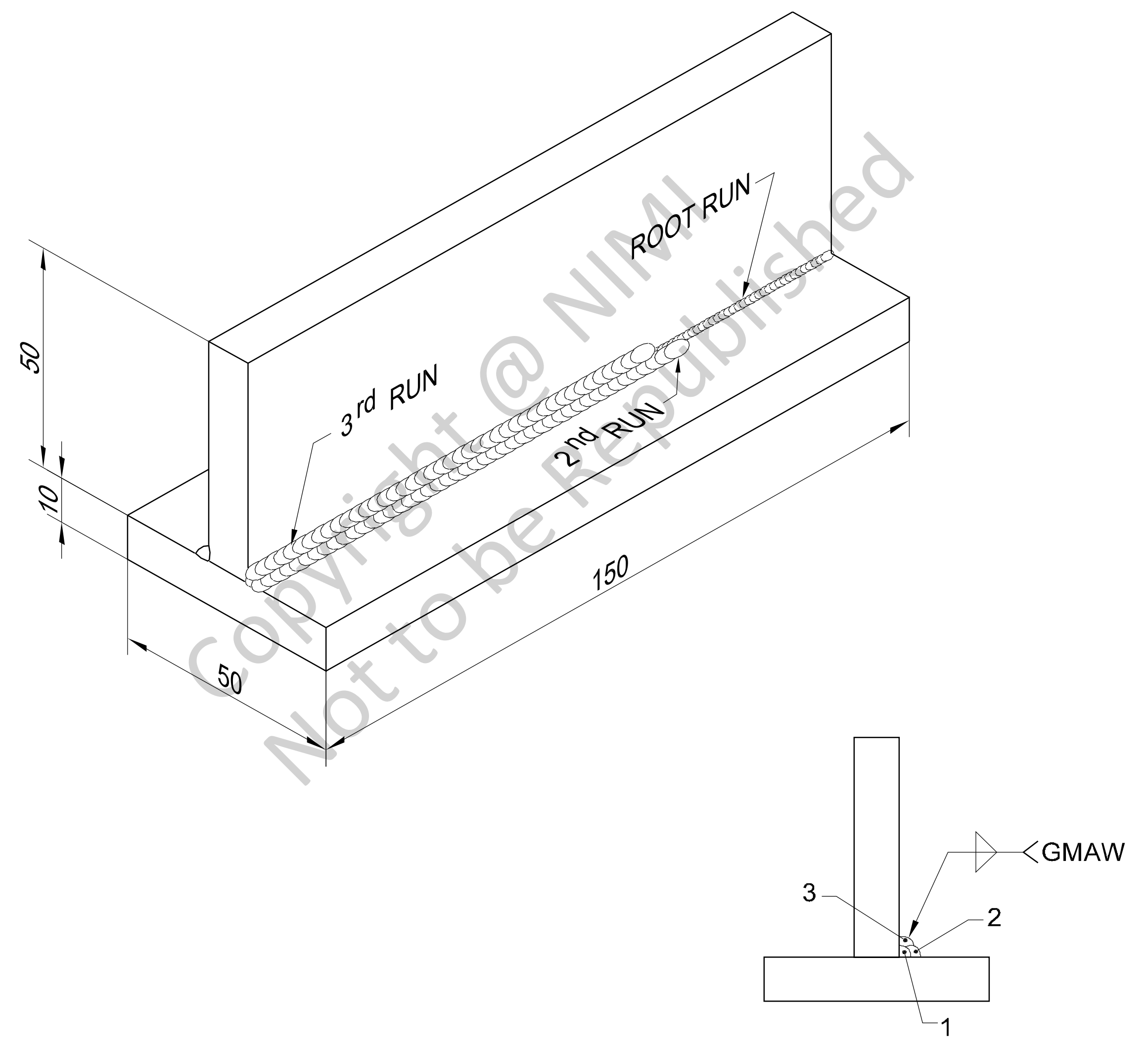
Maintain a slower travel speed compared to the root run for the 2nd run. Use semicircular side to side weaving movement (crescent motion) to achieve full side wall fusion without any undercuts at either end of the bead.

Maintain a dwell time (pause) of 1 to 2 seconds to get a proper, even filling at the end of the toes on either side of the bead.

Maintain a proper and even bead profile and a face reinforcement of 1 to 1.5mm.

Fillet weld Tee joint on M.S plate 10mm thick in horizontal position by dip transfer 2F

Objectives: At the end of this exercise you shall be able to
- **set the plate as a Tee joint in Horizontal position**
- **deposit the root run using 0.8mm diameter filler wire to get a root penetration and fusion**
- **deposit the 2nd and 3rd run using the stringer bead technique and maintain an equal leg length of 8mm**
- **avoid overlap on the bottom plate and undercut on the vertical plate**
- **maintain a good contour and weld reinforcement of 1.5 to 2.0mm.**



2	50 ISF 10 - 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 76

SCALE NTS	FILLET WELD TEE JOINT ON M.S.PLATE 10mm THICK IN HORIZONTAL POSITION BY DIP TRANSFER (2F)	TOLERANCE ±1	TIME 10h
		CODE NO. WLN2276E1	

Job Sequence

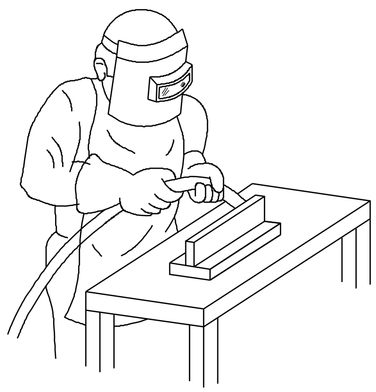
1 Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting, grinding and filing.

2 Clean the base metal surface along the welding line with a carbon steel wire brush.

3 Set the plates in the form of an inverted "T".

4 Wear all protective devices Fig.1.

Fig 1



WLN2276H1

5 Tack weld the 2 plates on either end keeping the T joint in Horizontal position.

6 Set the welding parameters as done in earlier exercises.

7 Strike the arc keeping proper angles for the torch.

8 Deposit the root run without weaving and ensure proper penetration and fill the crater.

9 Clean the root run.

10 Deposit the 2^{nd} run using stringer bead.

11 Clean the 2^{nd} run with wire brush.

12 Deposit the 3^{rd} run using stringer bead.

13 Clean the 3^{rd} run.

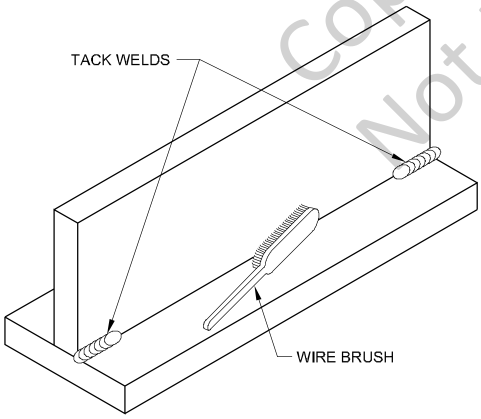
14 Check for defects like overlap, undercut, porosity and check for corret leg size and throat thickness.

Skill Sequence

Setting and tacking of the Tee joint in horizontal position : Clean the base metal surface along the welding line with a wire brush.

Place the horizontal plate on the table and the vertical plate at the centre of the horizontal plate as shown in the Fig.1 to form an inverted T joint.

Fig 1



WLN2276J1

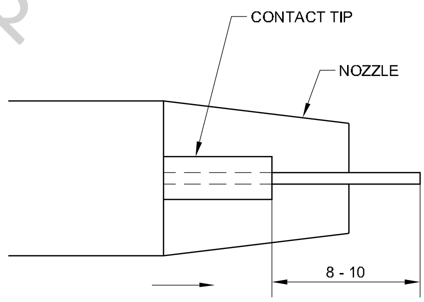
Tack weld the two plates at the ends.

Set the welding conditions: Adjust the gas flow rate to 8 to 10 LPM (Litre per minute).

Cut off the wire end so that the distance between the tip and base metal is about 8 to 10mm Fig.2.

Adjust the welding current to about 90 to 100A for 0.8mm filler wire used in Dip Transfer.

Fig 2



WLN2276J2

Adjust the welding Arc voltage to about 19 to 20V.

Generate an arc: Generate an arc at about 10mm ahead of the starting and return to the start point to avoid excessive reinforcement at the start and starting porosity.

Keep the distance (stick-out) of about 8 to 10mm between the contact tip and base metal.

Hold the torch at about 70 to 80^0 against the welding direction and at 45^0 against the base metal surface.

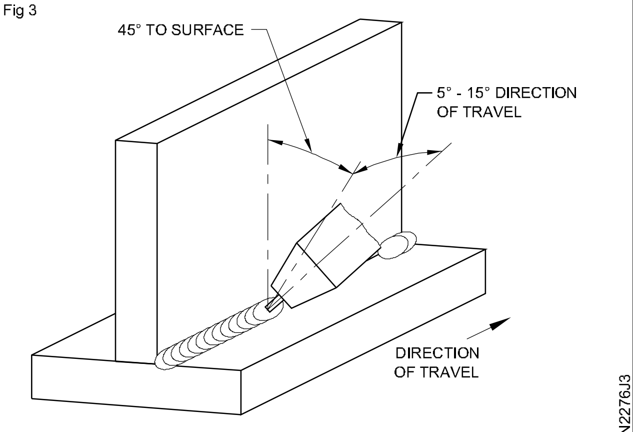
The wire tip should point at the root for the root run Fig 3.

Depositing the root run: Move the torch from left to right (backhand technique) taking care to point the tip at the leading end of the weld puddle.

Fuse both base metals evenly.

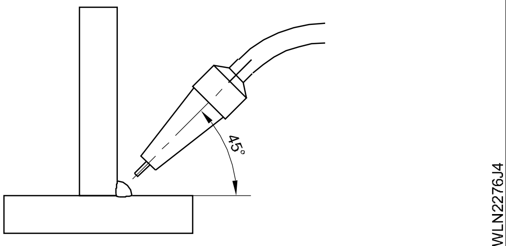
Do not weave the torch. Use stringer bead technique only. (Fig 3 & 4)

Fig 3



A TEE FILLET JOINT IN HORIZONTAL POSITION

Fig 4



Fill the crater: Repeat it until the level of the crater becomes the same as the bead reinforcement.

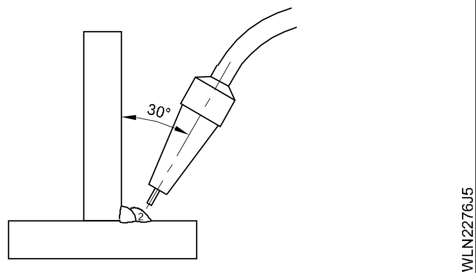
Clean the scales and other non-metallic materials and spatters from the root run and the joint.

Deposit the 2^{nd} run using stringer bead technique such that the bead covers two thirds of the root run deposit and the bottom plate as shown in the Fig 5.

Clean the bead and the plate surface with carbon steel wire brush.

Deposit the 3^{rd} run using stringer bead technique such that the bead covers the root run, two thirds of 2^{nd} run and the vertical plate member as shown in the Fig 6.

Fig 5

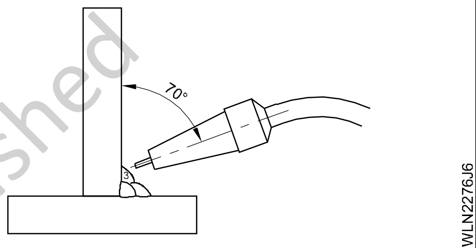


In addition the leg length 'L' has to be maintained as 8mm.

The torch angle between the plates has to be changed as shown in the Figs 4, 5 and 6.

The torch angles are to be changed for 2^{nd} and 3^{rd} run in order to deposit the weld metal at proper places so that the correct leg length can be obtained. This also helps to avoid defects like overlap, undercut, insufficient throat thickness etc.

Fig 6



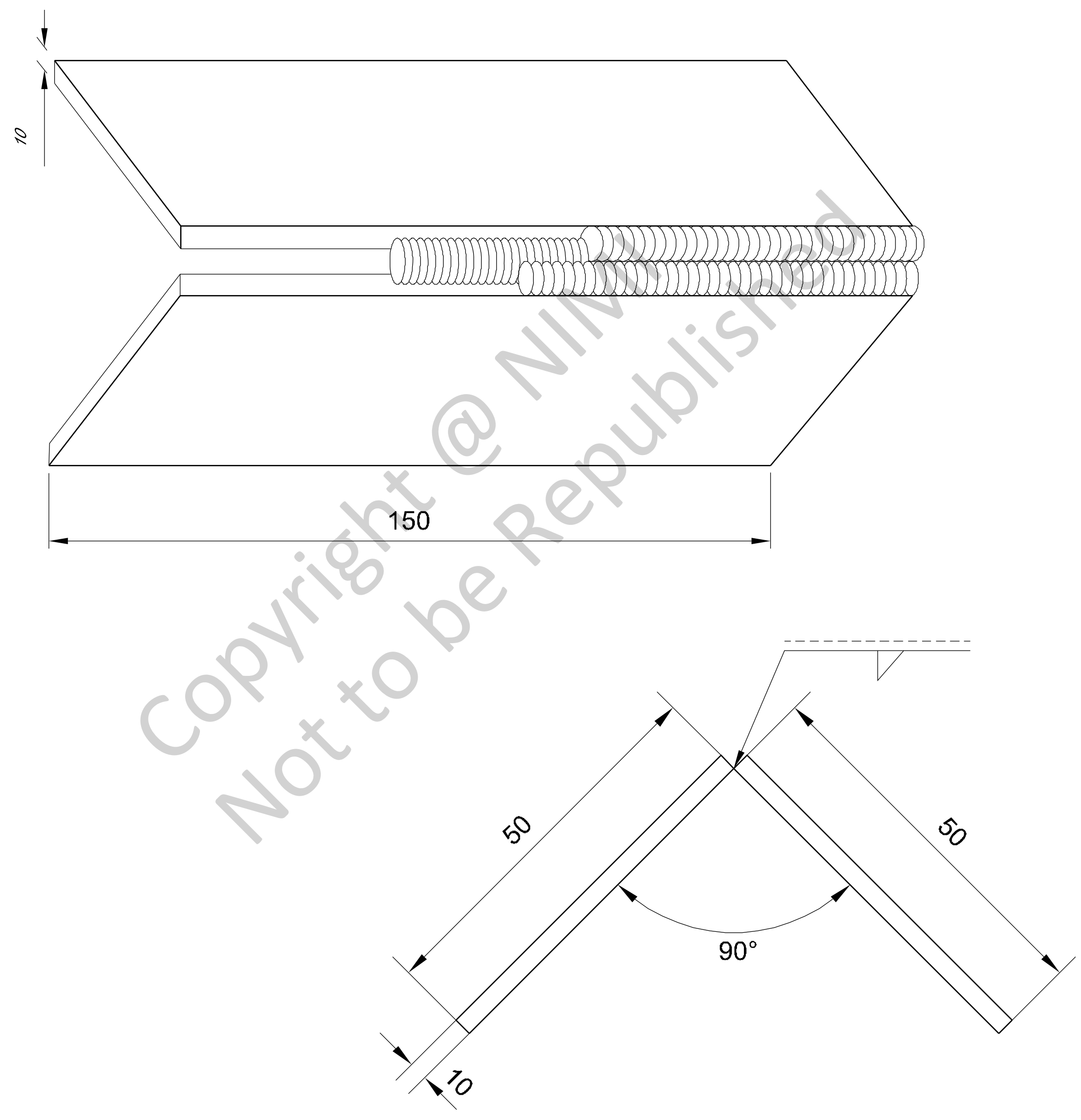
Ensure uniform travel speed for the torch for all the 3 runs to get proper bead profile and appearance.

Clean the joint after completion of the 3^{rd} run.

As and when required, the torch nozzle is to be cleaned with anti-spatter spray / gel during welding.

Fillet weld corner joint on M.S plate 10mm thick in horizontal position by dip transfer (2F)

Objectives: At the end of this exercise you shall be able to
- **set the plate as a corner joint**
- **put tack weld and set in horizontal position**
- **deposite the root run using 0.8mm filler wire to get root penetration**
- **deposite the 2nd and 3rd run using the stringer bead and leg length**
- **clean and inspect for surface defects and penetration.**



2	ISST 50 x 10 - 150		Fe 310			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 77

SCALE NTS	FILLET WELD - CORNER JOINT ON M.S.PLATE 10mm THICK IN HORIZONTAL POSITION LAY DIP TRANSFER (2F)	TOLERANCE ±0.5	TIME 15 Hrs
		WLN2277E1	

Job Sequence

1 Prepare the plates to size i.e 150 x 50 x 10mm by using gas cutting, grinding and filling.

2 Clean the base metal surface along the welding line with a carbon steel wire brush.

3 Set the plate in the form of corner joint as per drawing.

4 Wear protective clothing's.

5 Connect the torch to the positive terminal of the machine.

6 Set the current 90 to 100amps by corresponding wire feeding rate, 19 to 20 arc voltage and use dip transfer mode.

7 Tack weld (min. 10mm length) on both ends of the corner joint as shown in Fig 1.

8 Deposit root run by maintaing key hole for fine penetration.

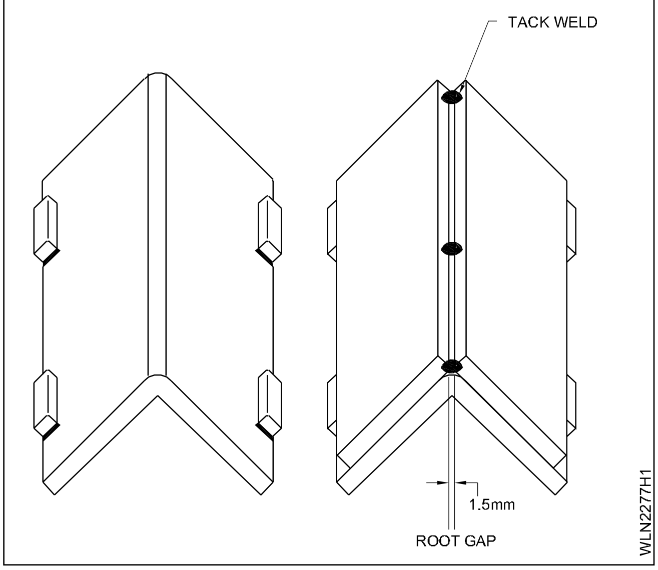
9 Clean the root run by wire brush.

10 Deposit the 2nd run using stringer bead.

11 Clean the 2nd run with wire brush.

12 Deposit the 3rd run using stringer bead and clean the bead by wire brush.

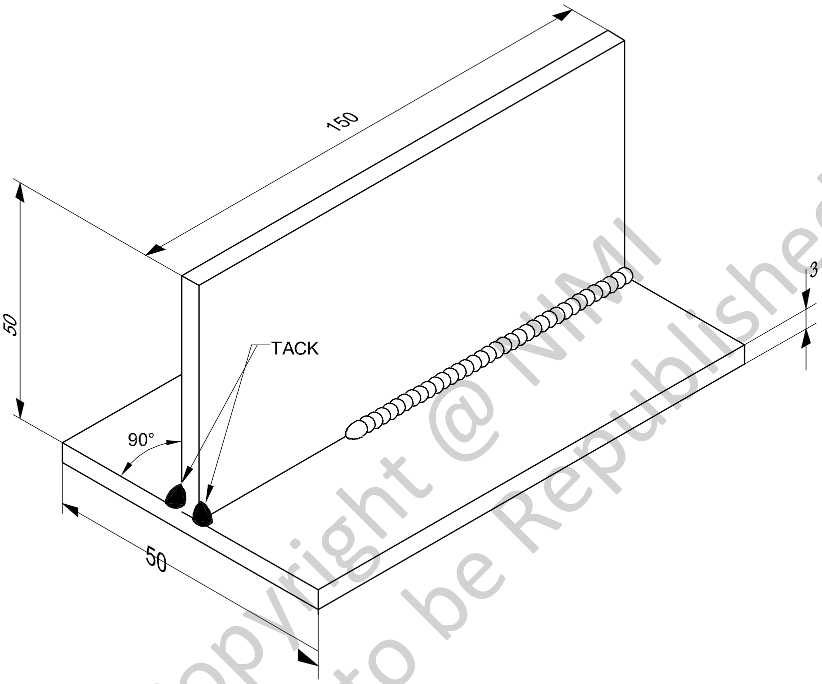
Fig 1

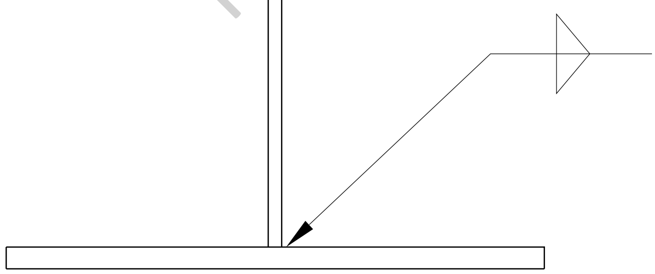


13 Check for defects like overlap, under cut, penetration, distortion and good bead profile.

Fillet weld 'T' joint on M.S sheet 3mm thick in horizontal position by dip transfer 2 F

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as 'T' joint as per drawing**
- **set the 'T' joint in Horizontal position for welding**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the weld and bead appearance.**





2	ISST 50 x 3 - 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 78

SCALE NTS	FILLET WELD TEE JOINT ON M.S. SHEET 3mm IN HORIZONTAL POSITION BY DIP TRANSFER (2F)	TOLERANCE ±0.5	TIME 10 Hrs
		WLN2278E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheet to square

3 Deburr and clean the surface of the plates by carbon steel wire brush and filing.

4 Set the plate A on the plate B in the form of Tee as per drawing.

5 Wear protective clothing's.

6 Connect the torch to positive terminal of the machine.

7 Tack weld(min. 10mm length) on both ends of the tee joint as shown in the Fig 1.

8 Keep the tack welded job in horizontal position.

9 Set current to 90 - 100 ampheres / corresponding wire feeding rate (3 to 4 m/min), 19 to 20 arc voltage and deposit the root run using dip transfer mode.

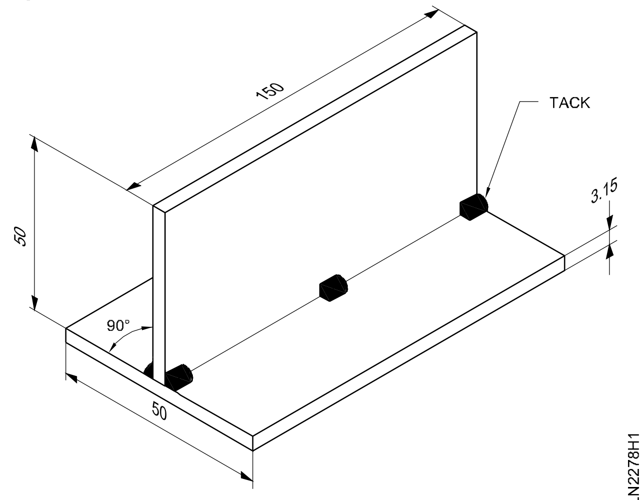
10 Weld the Tee joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut.

13 Ensure the edges of the plate is not melted off due to excessive weaving.

Fig 1



TACK WELDING A TEE JOINT

14 Ensure there is no undercut at the other toe of the lap weld on plate.

15 Clean the bead by wire brush.

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

While tack welding plates A and B for the Tee joint the angle between them is to be kept at 91° initially as shown in Fig 1(i.e a distortion allowance of 1° per run) or Tee fillet joints distortion allowance is recommended.

Since GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

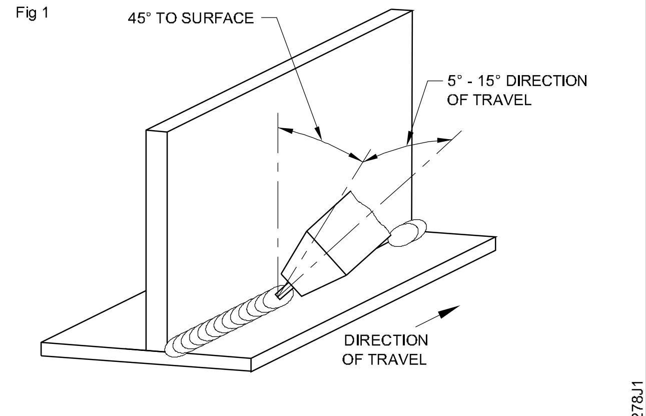
For welding the joints in flat (downhand) position it is convenient to use the channel to position the joints. This will permit the tack welded job to be kept at 45° angle with the horizontal plane.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig.1

The torch movement at the edge of the top plate of the Tee joint should be so controlled that the edge is not melted off. Also the torch has to be paused when reaching the bottom toe of the weld for a short period so that the undercut, if developed, at toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.Use

Fig 1



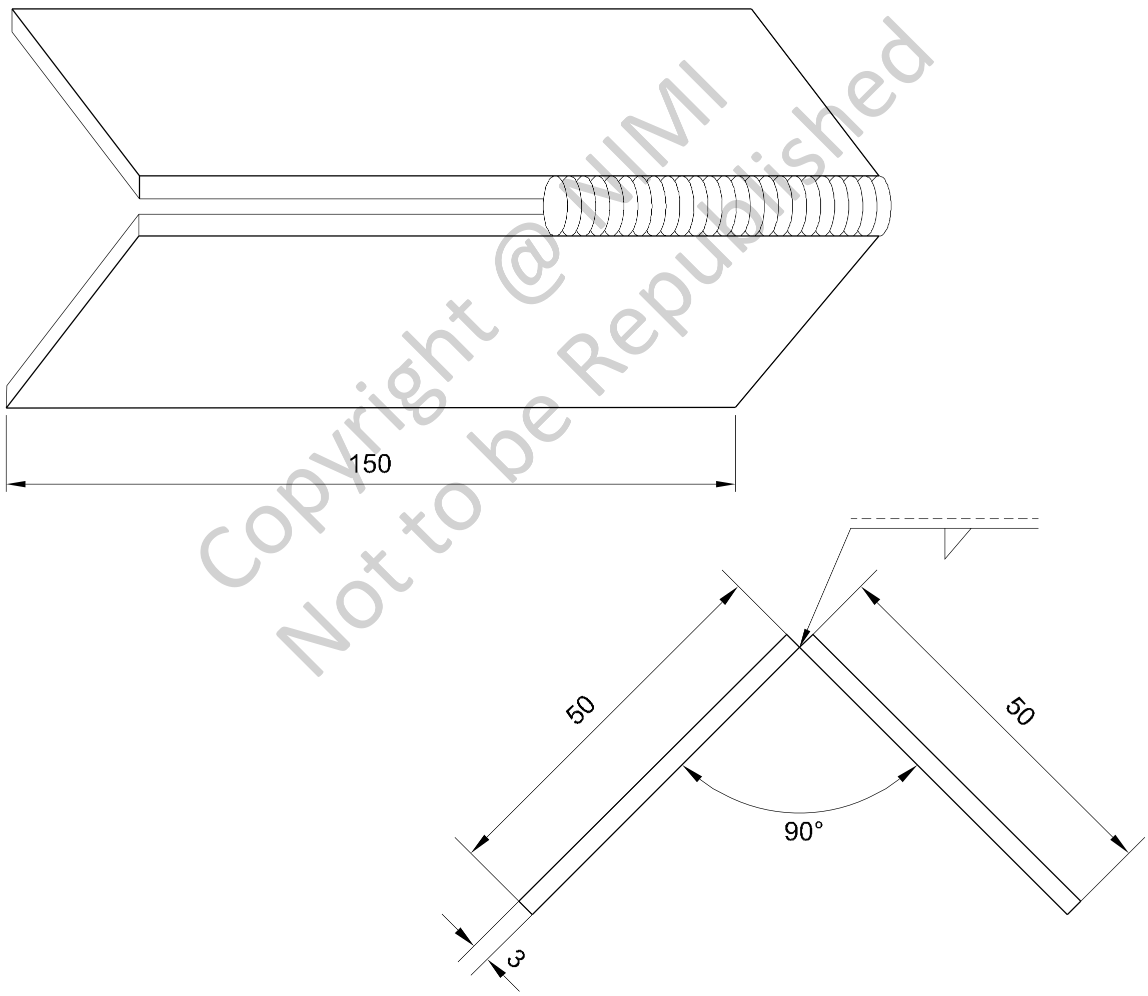
A TEE FILLET JOINT IN HORIZONTAL POSITION

the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fillet weld - corner joint on M.S sheet 3mm thick in horizontal position by dip transfer

2F

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as corner joint**
- **set the corner joint in Horizontal position for welding**
- **deposite the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the weld and head appearance.**



2	ISST 50 x 3 - 150		Fe 310 - W			GMAW- 02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 79

SCALE NTS	**FILLET WELD OUTSIDE CORNER JOINT ON M.S.SHEET 3mm IN HORIZONTAL POSITION BY DIP TRANSFER**	TOLERANCE ±0.5	TIME 15 Hrs
		WLN2279E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheet to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filing.

4 Set the plate in the form of Corner joint at 90 degree with specified root gap in flat position as per drawing.

5 Wear protective clothings.

6 Connect the torch to positive terminal of the machine.

7 Set current to 90 - 100 ampheres / corresponding wire feeding rate 19 to 20 Arc voltage and deposit the root run using dip transfer mode.

8 Tack weld(min. 10mm length) on both ends of the corner joint as shown in the Fig 1.

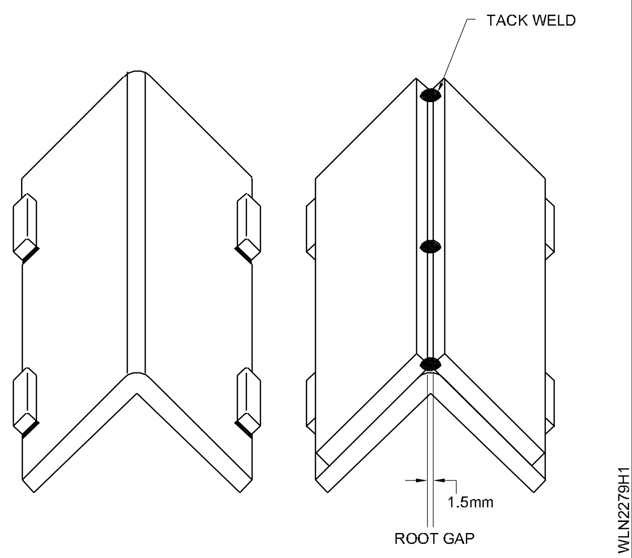
9 Keep the tack welded job in horizontal position.

10 Weld the corner joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

11 Deposit root run on the joint by forming key hole and obtain complete penetration and even fusion of plates.

12 Clean the bead by wire brush.

Fig 1



13 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

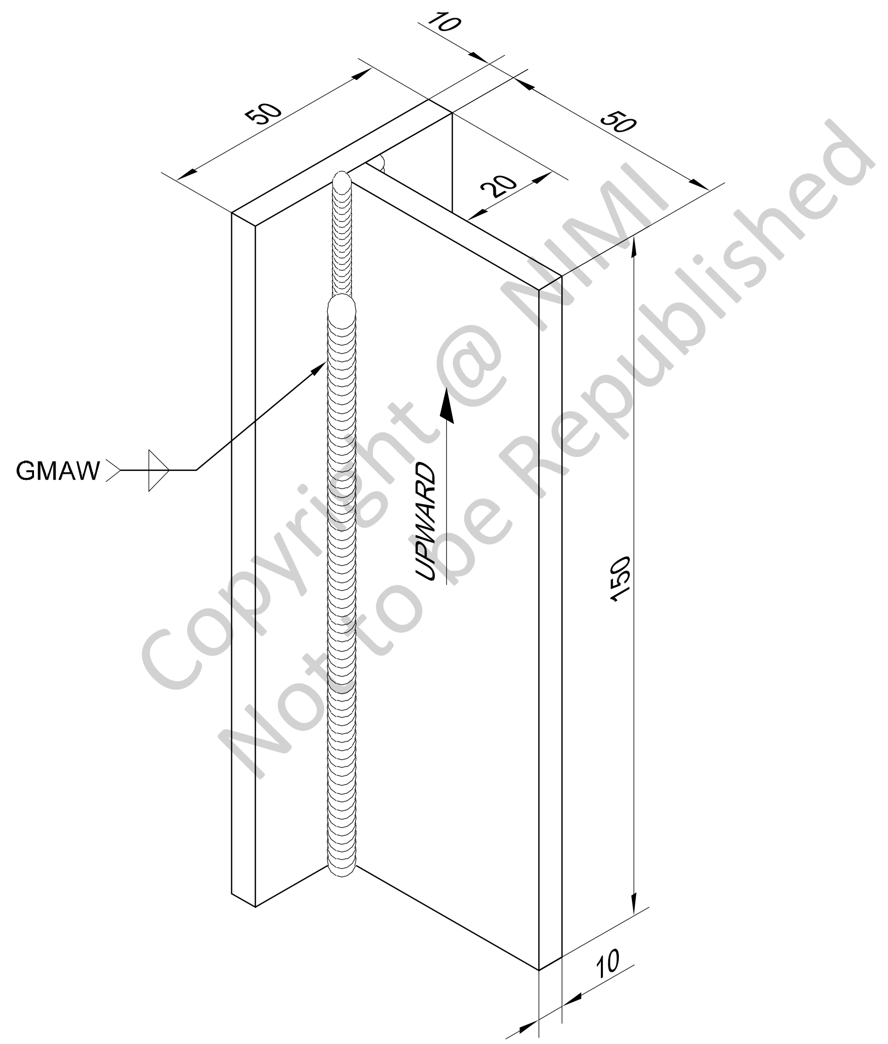
While tack welding plates A and B for the corner joint the angle between them is to be kept at 90º.

Since GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

Maintain a key hole and uniform travel speed for the torch to get the required bead appearance, reinforcement, height. Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fillet weld - Tee joint on M.S plate 10mm thick in vertical position by (vertical up) dip transfer 3F

Objectives: At the end of this exercise you shall be able to
- **prepare the plates and tack weld them as inverted 'T' joint**
- **set the tack welded joint in the weld positioner in vertical position**
- **deposit the root run by slight weave bead technique from bottom to top**
- **deposit the 2nd run by weaving technique to obtain necessary leg length and throat thickness**
- **ensure to avoid too much sagging of weld metal by adopting proper weaving and weave-pause technique**
- **ensure proper cleaning of the plate surfaces and interbead cleaning**
- **ensure that weld defects like undercut, porosity, irregular bead appearance etc., do not occur.**



2	50 ISF 10 - 150		Fe 310 - W			GMAW- 02
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 80
SCALE NTS	FILLET WELD TEE JOINT ON M.S. PLATE 10mm IN VERTICAL POSITION(UPWARD)				TOLERANCE ±1	TIME 10hrs
					CODE NO. WLN2280E1	

Job Sequence

1 Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting, grinding and filing.

2 Clean the base metal surface along the welding line with a carbon steel wire brush.

3 Set the plates in the form of an inverted "T".

4 Wear all protective devices.

5 Tack weld the 2 plates, keeping the T joint in horizontal position.

6 Set the welding parameters as done in earlier exercises.

7 Strike the arc keeping proper angles for the torch.

8 Deposit the root run without weaving and ensure proper penetration and fill the crater.

9 Clean the root run.

10 Deposit the 2nd run.

11 Clean the 2nd run.

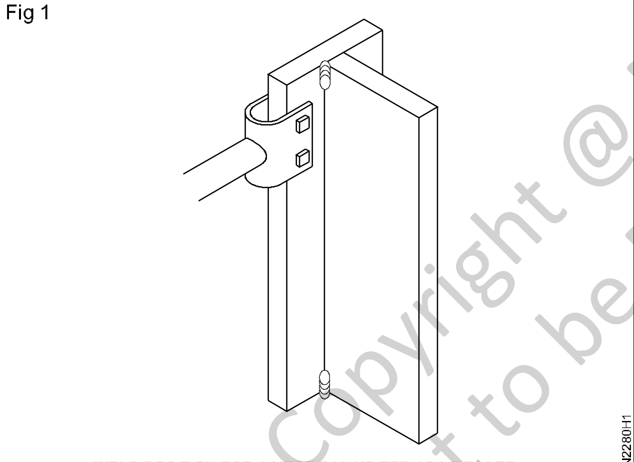
12 Check for defects like overlap, undercut, porosity and check for correct leg size and throat thickness.

Skill Sequence

Adjust the power source and wire feeder to obtain 18 to 19 volts and 90 - 100 amperes, gas flow of 8 - 10LPM (Litre per minute). Select the lower side of the range for vertical welding.

Thoroughly clean the pieces to be joined, tack them together and position them as shown in Fig 1.

Fig 1



WELD POSITION FOR A VERTICAL UP TEE JOINT FILLET

Beginning at the bottom of the joint, use the gun angles shown in Fig 2. Begin to weld using a weaving motion similar to that given in Fig.3.

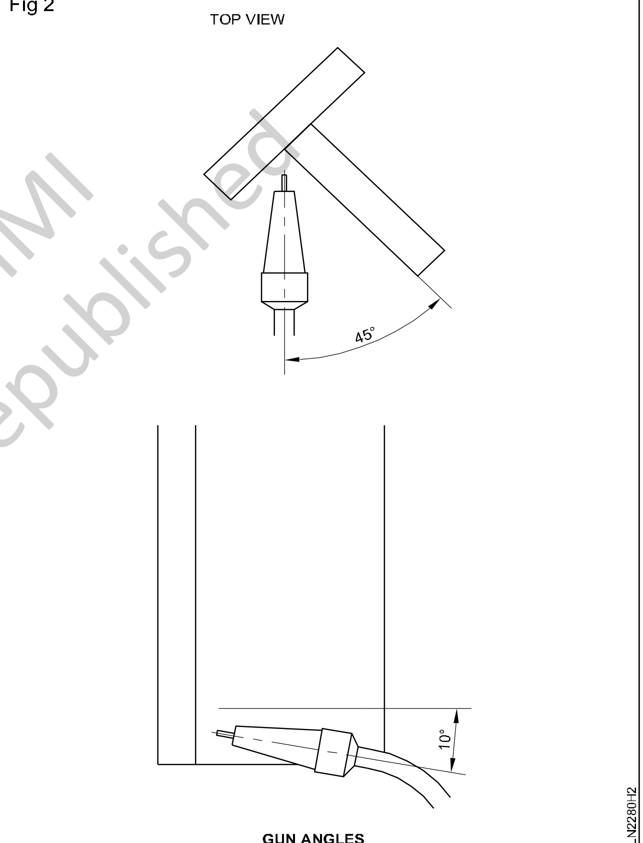
The weld will deposit a shelf at the bottom of the joint on which you can build. Be certain when you weave the gun that the arc reaches the root of the joint to ensure good root penetration. Pause on the sides to fill in the weld and prevent undercut. Increase the travel speed of the gun when moving from side to side to prevent excessive buildup, which would make a very convex bead.

Complete the first pass, keeping the fillet size as close to 6mm as possible.

Cool the plate thoroughly and deposit a second pass. Keep the size of the second pass fillet to 8mm. (see Fig 4)

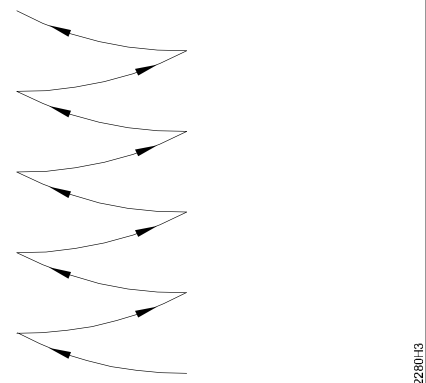
The weaving pattern to be used for the second pass is shown in Fig 5.

Fig 2



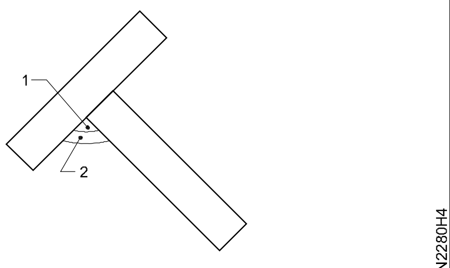
GUN ANGLES

Fig 3



WEAVE PATTERN

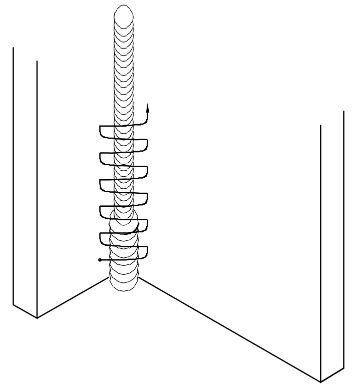
Fig 4



BEAD SEQUENCE

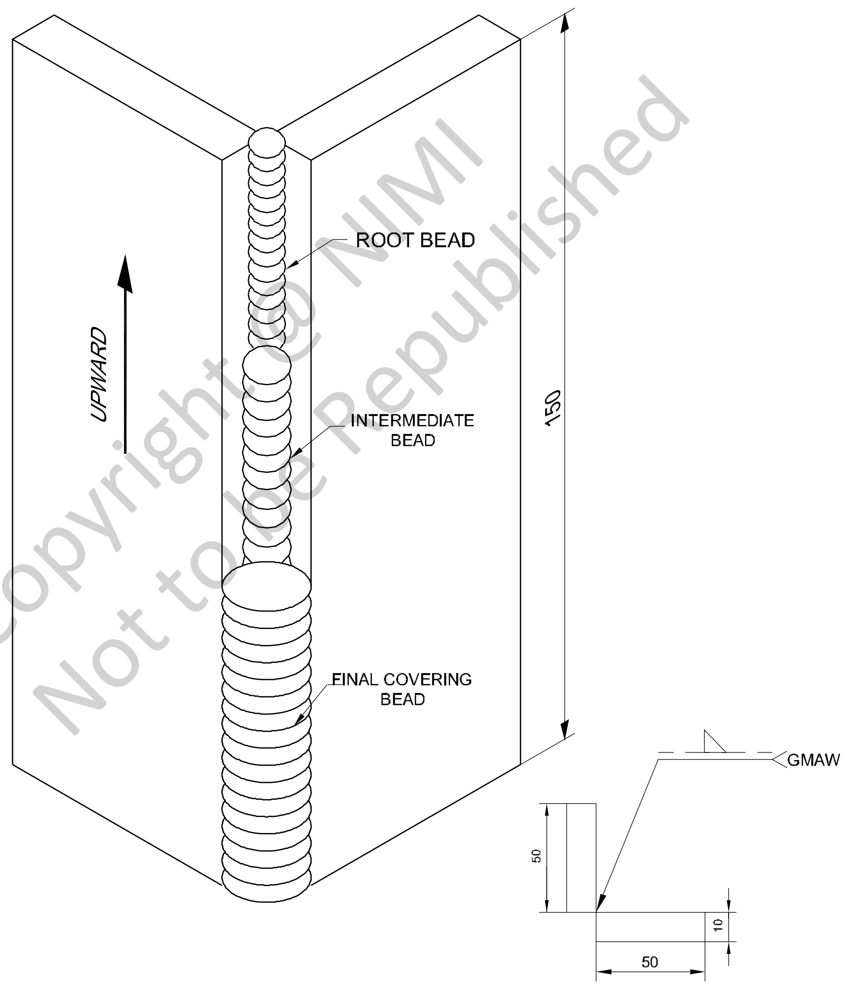
Weld the other side of the T assembly, using the same technique as for the first side.

Fig 5



Fillet weld outside corner joints on MS plate 10mm vertical position upward by dip transfer 3F

Objectives: At the end of the exercise you shall be able to
- **mark the profile of the job in work piece**
- **cut the work piece**
- **file the job for welding**
- **weld the corner joint in vertical position**
- **inspect the corner joint.**



9	50 ISF 10 - 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.81

SCALE NTS	**FILLET WELD OUTSIDE CORNER JOINT ON MS PLATE 10mm IN VERTICAL POSITION (UPWARD) LAY DIP TRANSFER (3F)**	TOLERANCE ±1	TIME 15 Hrs
		WLN2281E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate in the form of corner as per drawing.

5 Wear protective clothes.

6 Connect the torch to the positive terminal of the machine.

7 Set the current 90 to 100 amps by corresponding wire feeding 19 to 20 arc voltage and use dip transfer mode.

8 Tack weld (min.10 mm length) on both ends of the corner joint as shown in Fig 1.

9 Keep the tack welded jib in vertical position on a weld positioner.

10 Strike an are and move the torch steady straight from the tor if the joint downwards.

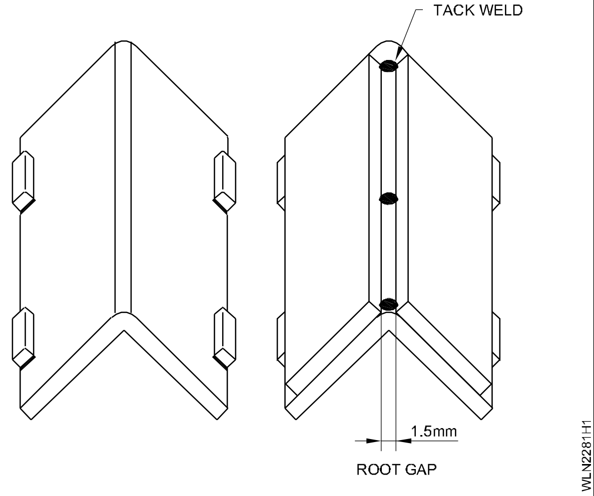
11 Weld the lap joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

12 Ensure good leg length and even fusion of plates.

13 Avoid under cut.

14 Ensure the edges of the plate is not melted off due to excessive weaving

Fig 1



15 Ensure there is no undercut at the other toe of the lap weld on plate

16 Clean the bead by wire brush

17 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

While tack welding plates A and B for the corner joint, the angle between them is to be kept at 90º.

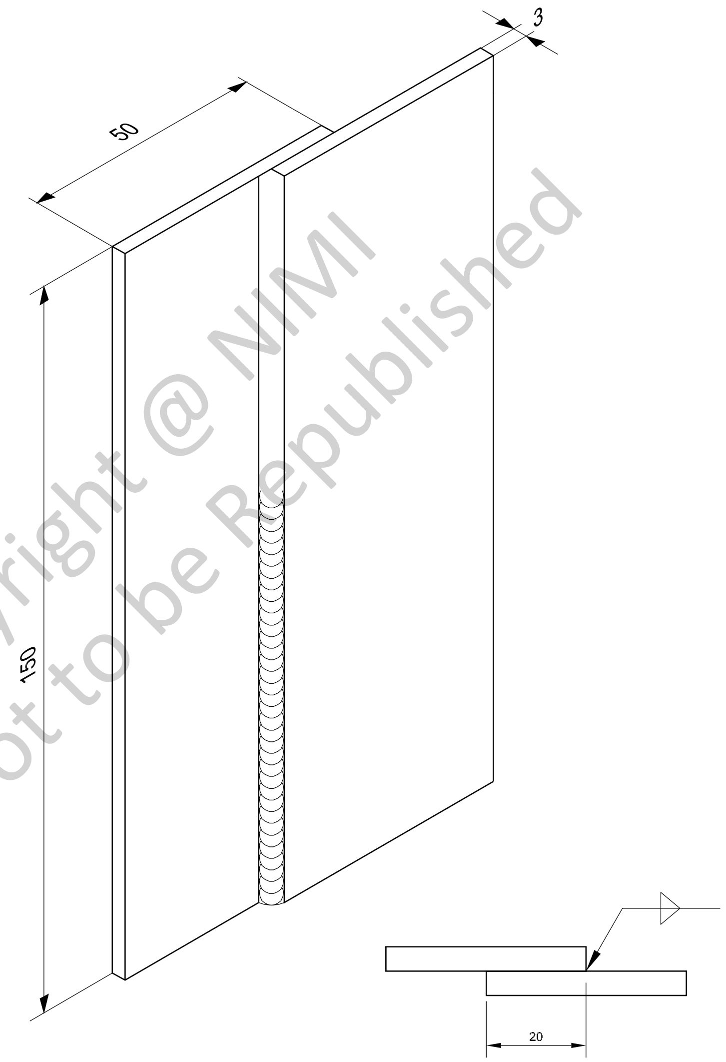
Since GMAW welding process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, and height.

Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilished arc and the CO_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fillet weld - Lap joint on M.S sheet 3mm thick in vertical position by dip transfer 3F

Objectives: At the end of this exercise you shall be able to
- **prepare the plates and tack weld than as lap joint**
- **set the tack welded joint in the weld positioner in vertical position**
- **set the root run and 2nd run by weaving bead slightly**
- **ensure proper cleaning of the plate surfaces and inter bead cleans**
- **clean and inspect for surface defects on the weld and bead appearance.**



2	ISST 50 x 3 x 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.82

SCALE NTS	**FILLET WELD - LAP JOINT M.S. SHEET 3mm THICK IN VERTICAL POSITION BY DIP TRANSFER (3F)**	TOLERANCE ±0.5	TIME 10 Hrs
		WLN2282E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

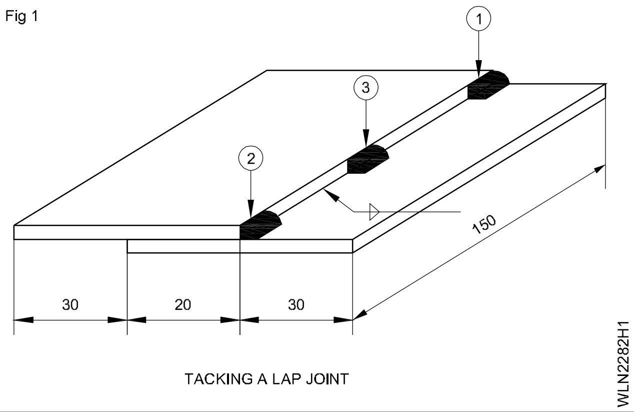
3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of lap as per drawing.

5 Wear protective clothes.

6 Connect the torch to the positive terminal of the machine.

Fig 1



TACKING A LAP JOINT

7 Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the lap joint as shown in Fig 1.

9 Keep the tack welded job in vertical position on a weld positioner.

10 Strike an are and move the torch steady straight from the bottom if the joint upwards.

11 Weld the lap joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

12 Ensure good leg length and even fusion of plates.

13 Avoid under cut.

14 Ensure the edges of the plate is not melted off due to excessive weaving.

15 Ensure there is no undercut at the other toe of the lap weld on plate.

16 Clean the bead by wire brush.

17 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

For the lap fillet joints no distortion allowance is recommended

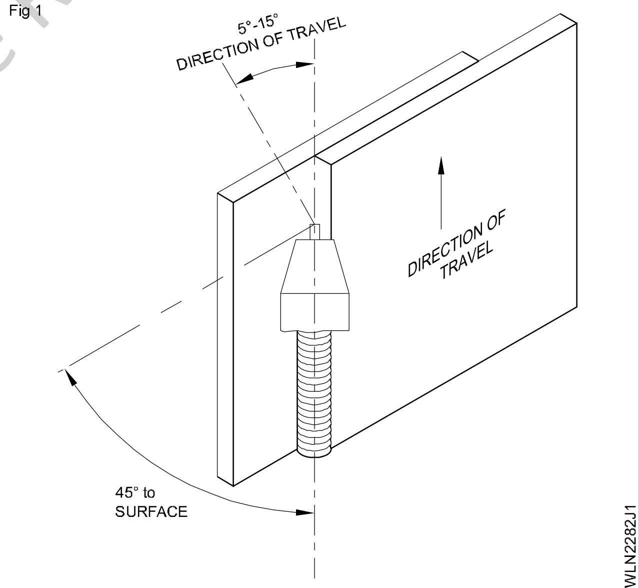
Since the GMAW process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig 1.

The torch movement at the edge of the top plate of the Lap joint should be so controlled that the edge is not melted off. Also the torch has to be paused when reaching the bottom toe of the weld for a short period so that the undercut, if developed, at toe is properly filled with filler metal.

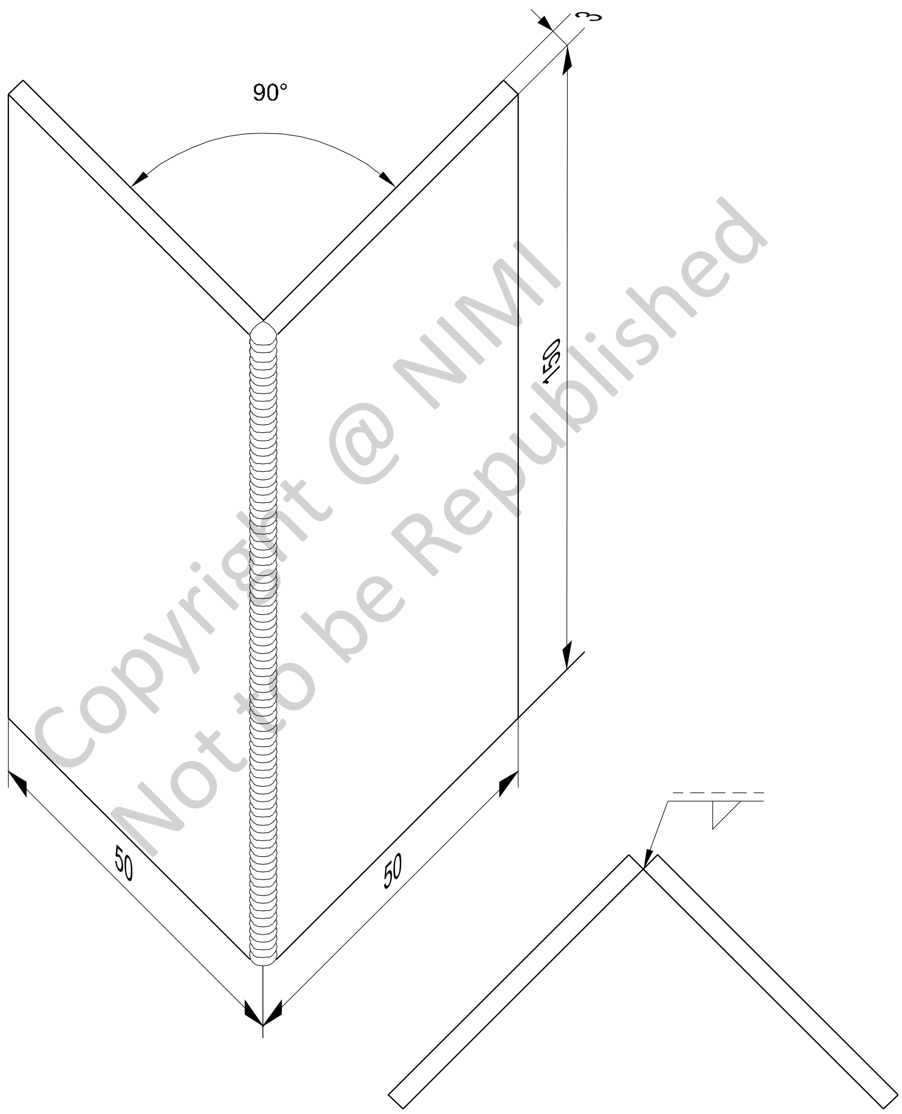
Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fig 1



Fillet weld - out side corner joint on M.S sheet 3mm in vertical position by dip transfer 3F

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as corner joint**
- **set the corner joint in vertical position for welding**
- **deposite the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects and penetration and bead appearance.**



2	ISST 50 x 3 - 150		Fe 310 - W			GMAW- 02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 83

SCALE NTS	**FILLET WELD OUT SIDE CORNER JOINT ON M.S.SHEET 3mm IN VERTICAL POSITION BY DIP TRANSFER (3F)**	TOLERANCE ±0.5	TIME 15 Hrs
		WLN2283E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate in the form of corner as per drawing.

5 Wear protective clothes.

6 Connect the torch to the positive terminal of the machine.

7 Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the corner joint as shown in Fig 1.

9 Keep the tack welded job in vertical position on a weld positioner.

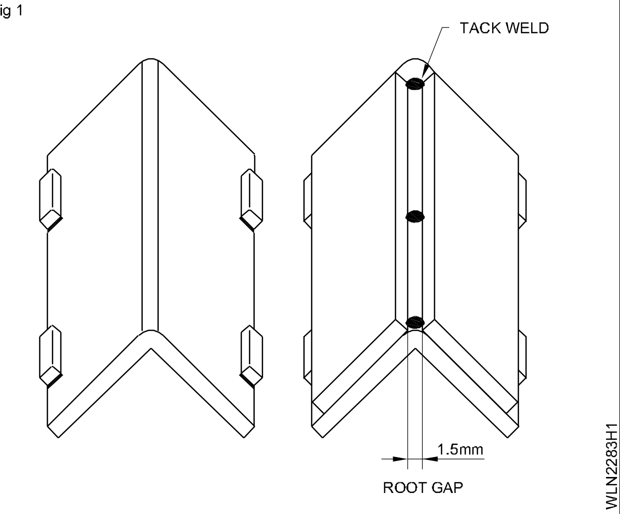
10 Strike an arc and move the torch steady straight from the tor if the joint downwards.

11 Weld the corner joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique.

12 Ensure good leg length and even fusion of plates.

13 Avoid under cut.

Fig 1



14 Ensure the edges of the plate is not melted off due to excessive weaving.

15 Ensure there is no undercut at the toe of the weld on plate.

16 Clean the bead by wire brush.

17 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

While tack welding plates A and B for the corner joint, the angle between them is to be kept at 90º.

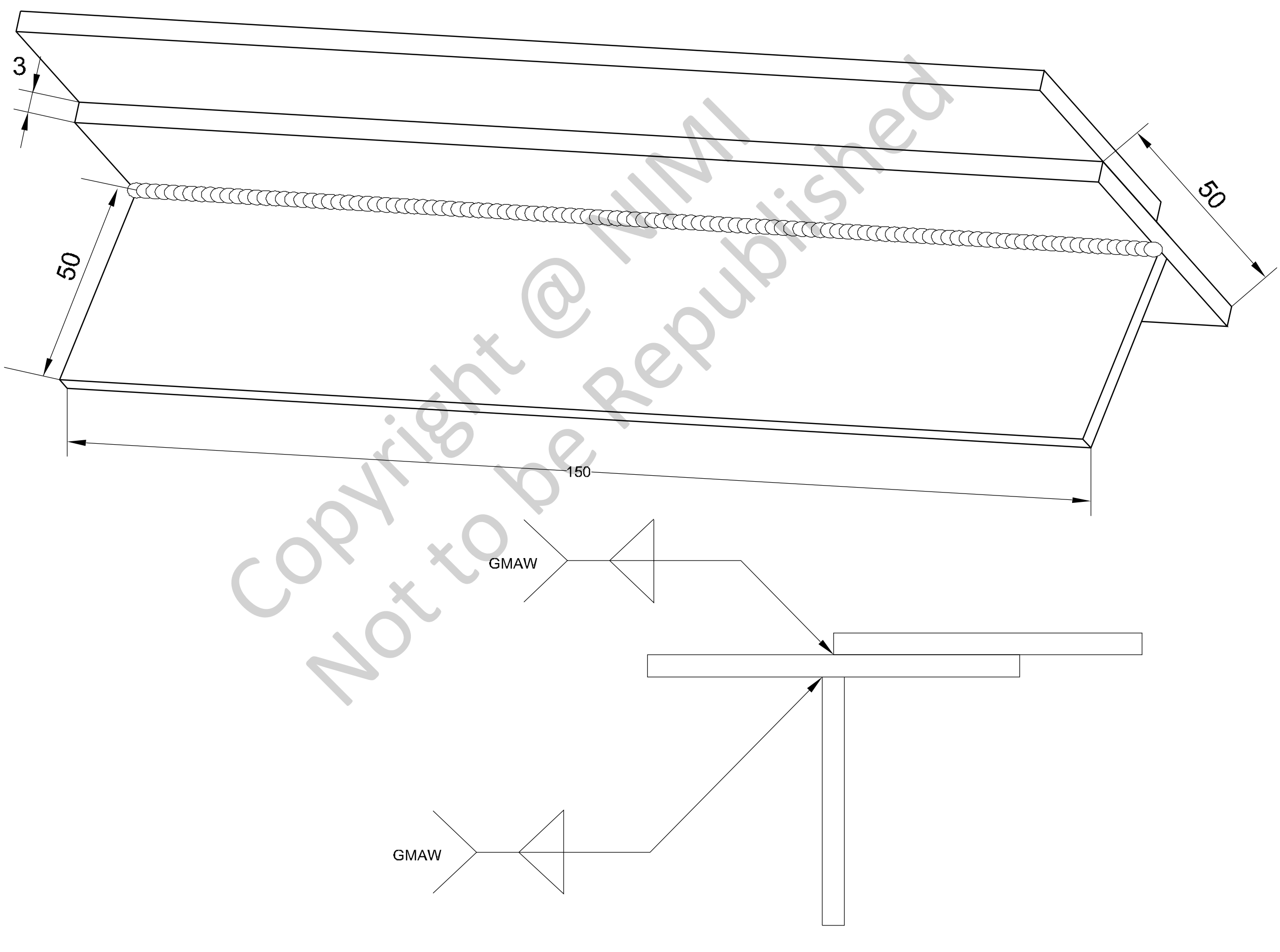
Since GMAW welding process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, and height.

Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilished arc and the CO_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fillet weld - lap and 'T' joint on M.S sheet 3mm thick in over head position by dip transfer 4F

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates as lap and 'T' as per drawing**
- **set the lap and 'T' joints in over head position for welding**
- **deposite the metal in the joints with proper leg length**
- **inspect for surface defects on the weld and bead appearance.**



3	ISST 50 x 3 x 150		Fe 310 - W			GMAW-02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 84

SCALE NTS	FILLET WELD LAP AND TEE JOINT ON M.S.SHEET 3mm THICK IN OVER HEAD POSITION BY DIP TRANSFER (4F)	TOLERANCE ±1	TIME 25 Hrs
		WLN2284E1	

Job Sequence

1 Cut the sheets by power shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

3 Use plain goggles while grinding

4 Deburr and clean the surface of the sheets by carbon steel wire brush and filling.

5 Set the sheet B on the sheet A in the form of Tee as per drawing Fig 2.

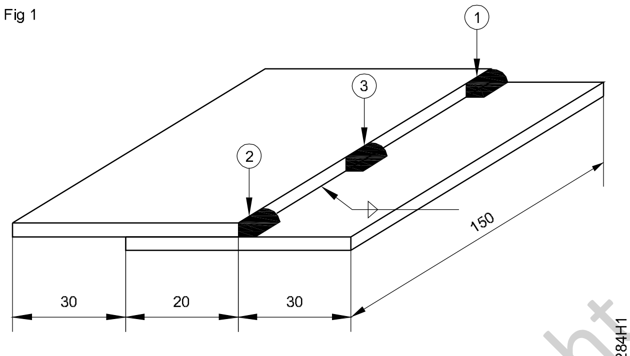
6 Wear protective clothes.

7 Tack weld (min. 10mm length) on both ends of the Tee joint as shown in Fig 2.

8 Set the sheet C as Lap joint as per drawing Fig 1 on the 50mm wide sheet A.

9 Tack weld (keeping minimum length of 10 mm) on both sides of the lap joint as shown in the Fig 1.

Fig 1



TACKING A LAP JOINT

10 Fix the tack welded job in the weld positioned to over head position.

11 Connect the torch to the positive terminal of the machine.

12 Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the run using by transfer with 0.8mm dia mild steel filler wire mode.

13 Ensure proper leg length and even fusion of sheets A and B with suitable welding gun / torch angle and arc travel speed.

14 Clean the welded joint by wire brush.

15 Deposit the bead on the lap joint (joint II) with the same parameters and technique used for the Tee joint.

16 Ensure good penetration and even fusion of sheets A and C with suitable torch angle and arc travel.

17 Avoid under cut on sheet C

18 Ensure the edge of the sheet A (at the toe of the weld) is not melted off due to excessive weaving.

19 Ensure there is no undercut at the other toe of the lap weld on sheet C.

20 Clean the bead and the lap joint with wire brush

21 Inspect the welded joint for undercut, uneven bead, edge of the plate melted off, distortion and good bead profile.

Fig 2

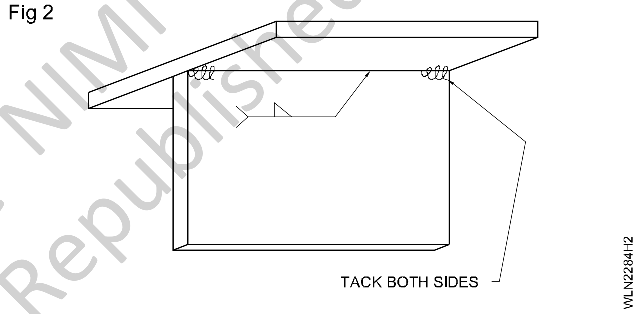
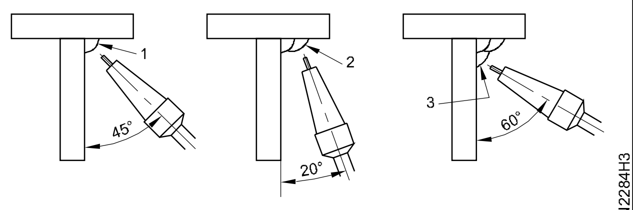


Fig 1



GUN ANGLES

Skill Sequence

It is important to ensure that the Tee and lap joint is held in the weld positioner firmly

The line of weld of the joint should be parallel to the ground and is in such as a height from the ground that it is easily accessible to the welder depending on the height of the welder.

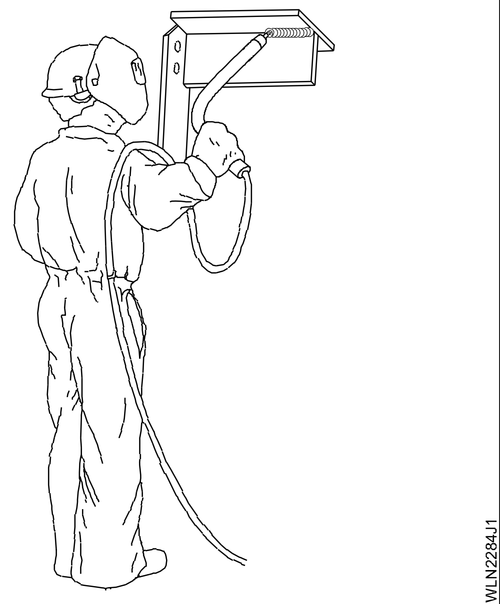
Ensure that the torch assembly hose, containing the spiral, filler wire, gas hose etc is long enough so that it can be carried over your shoulder while welding in over head position refer Fig 1.

This will help in maintaing the constant distance between the torch and joint to be welded.

Using a welding helmet and wearing a welders overall is very essential to protect the whole body from the spatters in over head welding position.

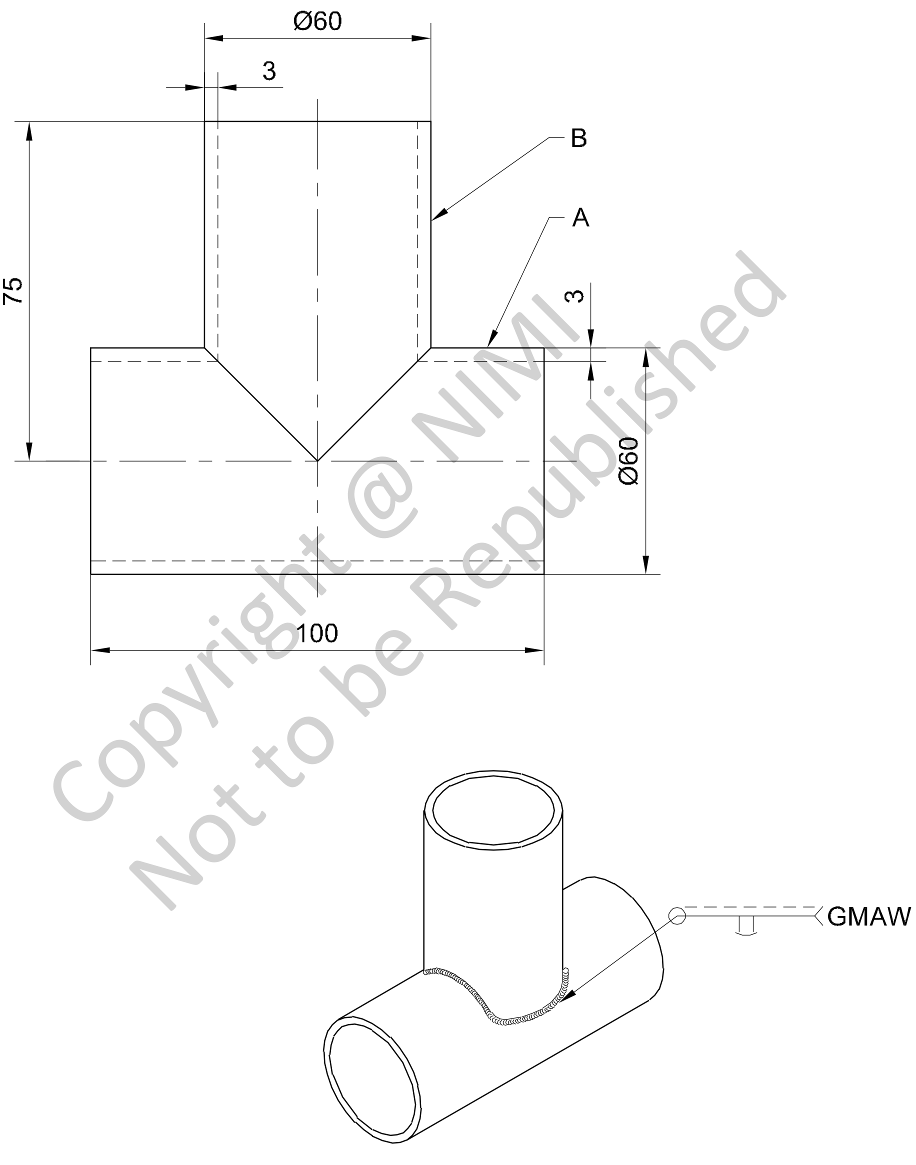
Use stringer bead welding technique and follow the same procedure to complete the lap joint.

Fig 1



Tee joints on M.S pipe φ60 mm OD x 3mm WT 1G position rolling

Objectives: At the end of this exercise you shall be able to
- **prepare the edges and set the pipe in alignment**
- **tack-weld and deposit root pass**
- **deposite the root and second runs of weld beads**
- **inspect the completed pipe weld.**

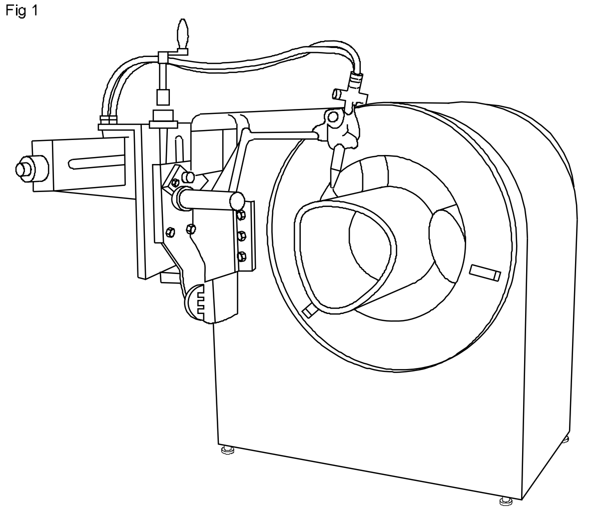


1	Ø60 x 3 - 180	- -	Fe 310W	- -	A & B	GMAW - 02
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 85
SCALE NTS	**TEE JOINT ON M.S.PIPE Ø60MM OD X 3MM WT FLAT POSITION (ROLLING)**				TOLERANCE ±1	TIME 25 hrs
					CODE NO. WLN2285E1	

Job Sequence

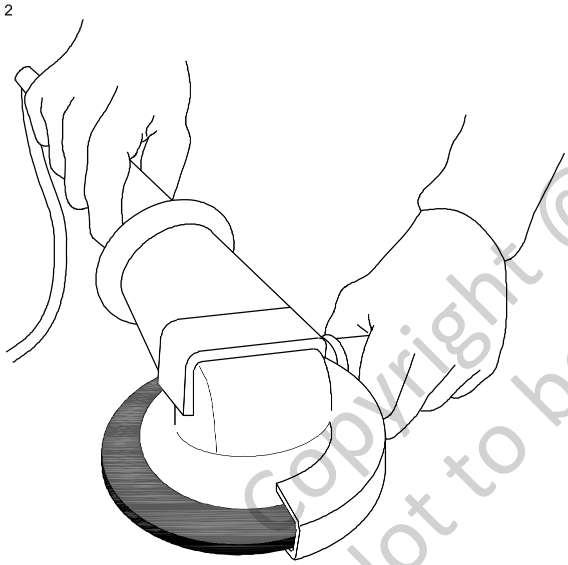
1 Cut the pipes to the given size.

Fig 1



PROFILE MACHINE

Fig 2



HAND GRINDER

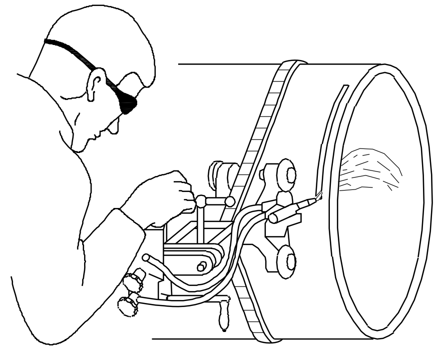
Cutting of branch components in mild steel

2 Branch pipes in mild steel may be cut on a special oxy-fuel gas profiling machine. Where such equipment is not available, the branch can be produced by marking the outline using a templete figure as shown in Fig 4 and scriber or pointed chalk followed by centre punching. The branch can then be produced by cutting to the marked outline, using manually operated oxy-fuel gas cutting equipment.

3 Branch holes may be cut by any of the following methods, depending on the equipment available:

a Oxy-fuel gas profiling machines, which cut the hole and produce the required angle for weld preparation.

Fig 3



ROTATED PIPE-CUTTING HEAD

b Cutting manually using the oxy-fuel gas process, the cut edge being dressed smooth by using a hand grinder or file. With this method, care must be taken to ensure that the cut sections are removed from inside the pipe.

4 Cut large diameter pipe by:

a Power saw

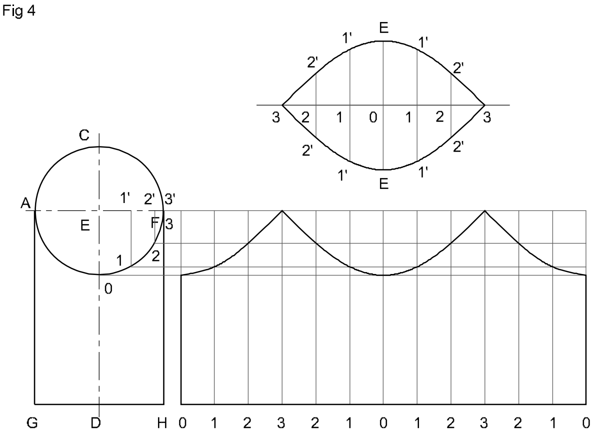
b Portable oxy-fuel gas cutting machine, either mechanically or electrically driven.

5 After cutting to length, remove any burrs on the inside of the pipe by reaming or filing.

6 Ensure the correct size of pipes.

7 Prepare development for 90^0 Tee. (Fig 4)

Fig 4



DEVELOPMENT FOR 90° T JOINT "50 mm OD PIPES"

8 Mark the development on the pipe and cut accordingly.

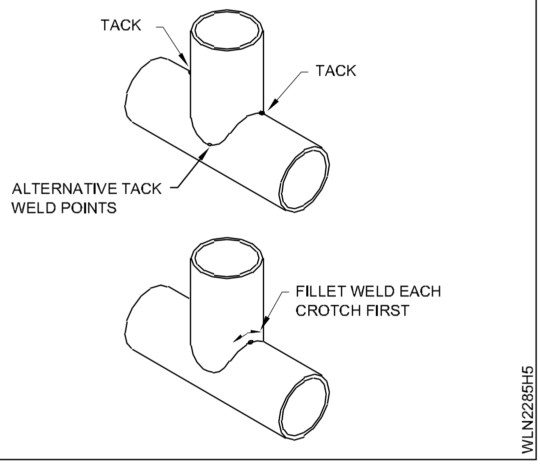
9 Deburr the cutting edges and file the edges.

10 Clean the surface of the pipe if any oxide is found.

11 Set and align the branch pipe with the main pipe at an angle of 90^0. (Fig 5)

12 Tack-weld the joint with a 2mm root gap to control distortion and to obtain penetration. (Fig.5)

Fig 5



13 On T joints, angle joints and cluster joints, use a sequence welding technique. This prevents weld metal contraction from pulling the pipe out of line. Fig.6 illustrates one satisfactory sequence for a T-pipe assembly. Whenever possible, do all the welding in a downhand position. As in all pipe welding, the weld metal must be well fused into the base metal. There must be good penetration and no undercutting.

14 Manipulation of the torch during welding the 'Tee' joint should be correctly followed. (Fig.7)

15 Weld and complete the joint-clean it.

16 Inspect for surface defects.

Fig 6

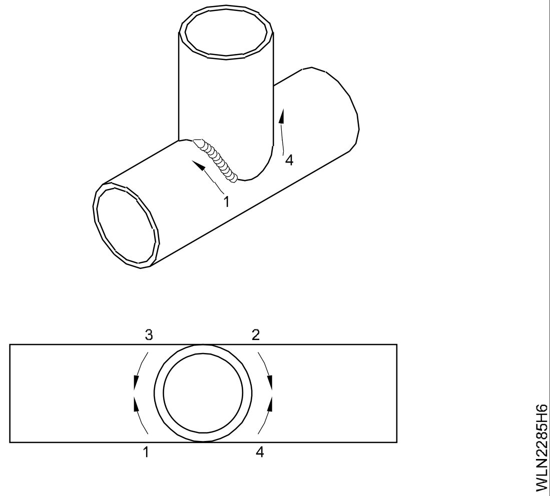
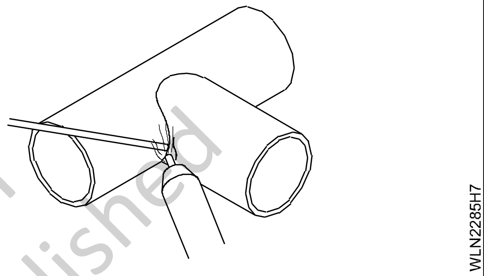


Fig 7



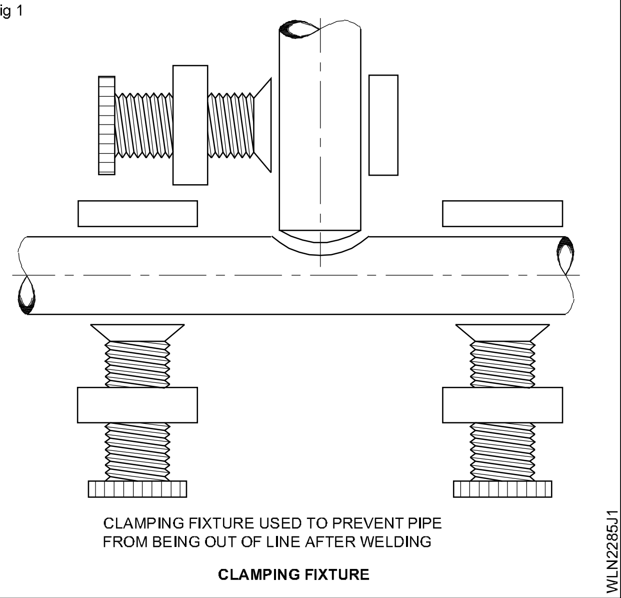
Skill Sequence

One difficulty encountered with all pipe and tube welding is the distortion or misalignment of the pipes/tubes after welding is completed. One, very frequently used method to prevent or reduce distortion is to clamp the pipes or tubes in a fixture while welding and allow it to cool before removing the clamps.

Tube welding is similar to thin sheet metal welding except the weld joint is a three dimensional curve, as in pipe welding. Also, since the root of the weld is not accessible and because the inner surface is in contact with flowing fluides, the penetration standards are high.Two common tube welding faults are too much penetration and lack of penetration. These faults must be repaired before the tubing can be used.

In pipe welding other than butt joint - it is very essential to get a development and prepare the template for the appropriate joints.

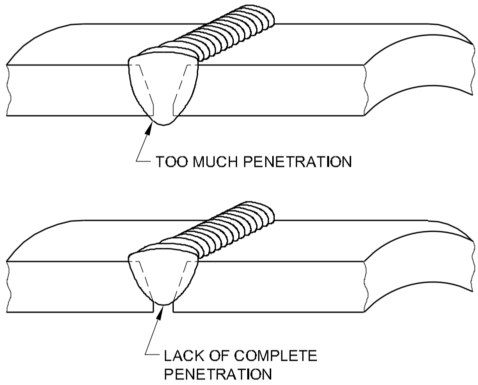
Fig 1



CLAMPING FIXTURE USED TO PREVENT PIPE FROM BEING OUT OF LINE AFTER WELDING

CLAMPING FIXTURE

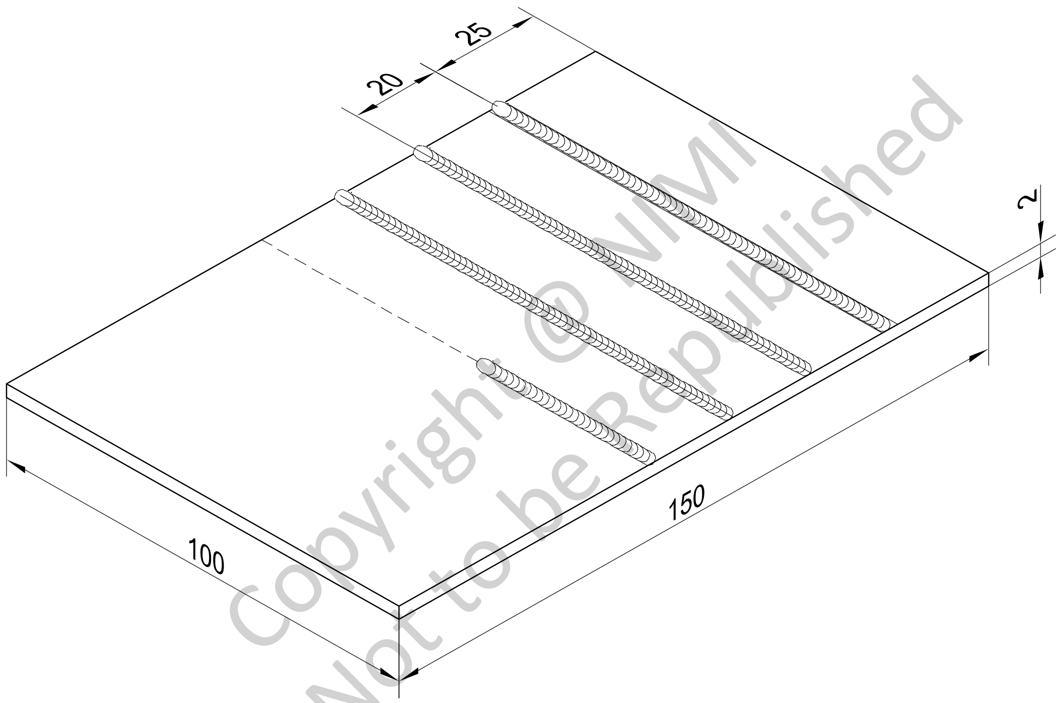
Fig 2

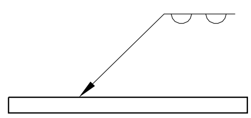


TUBE JOINT WELD SHOWING TWO COMMON PENETRATION DEFECTS

Depositing bead on S.S sheet in flat position

Objectives: At the end of this exercise you shall be able to
- **mark and set the plate as per drawing**
- **select filler wire and set the gas flow and current**
- **deposite the bead with or without weaving**
- **clean and inspect the weld.**





1	100 x150 x 2	- -	X04Cr19I9	- -	- -	GMAW- 02
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 86

SCALE NTS	DEPOSITING BEAD ON S.S.SHEET IN FLAT POSITION	TOLERANCE ±1	TIME 10hrs
		CODE NO. WLN2286E1	

Job Sequence

1 Prepare the job to size as per drawing.

2 Clean the job surface with stainless steel wire brush.

3 Mark parallel lines on the job surface as per drawing and punch the lines.

4 Set the workpiece (job) on the work table in flat position.

5 Fix the 0.8mm diameter S.S.wire spool in position, lock it up and pull the wire through the guide tube, rollers, spiral and contact tip of the torch.

6 Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.

7 Open the argon gas flow before striking the arc.

8 Set the arc voltage at 19-21 volt as required for dip transfer mode.

9 Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute).

10 Set the wire feed rate so as to get 90-100 Amp by striking the arc on a scrap plate.

11 Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.

12 Wear the protective clothing as required.

13 Switch over to Weld Mode as indicated in the machine.

14 Strike the arc, maintain a filler wire stick out of 8-10mm from the end of the contact tip to the job as required for Dip Transfer Mode.

15 Deposit the bead on punched lines of the job from one end to other.

16 Remove spatters with chipping hammer and clean the joint using Carbon Steel Wire Brush.

17 Self inspect the weld bead for finish and defects.

Skill Sequence

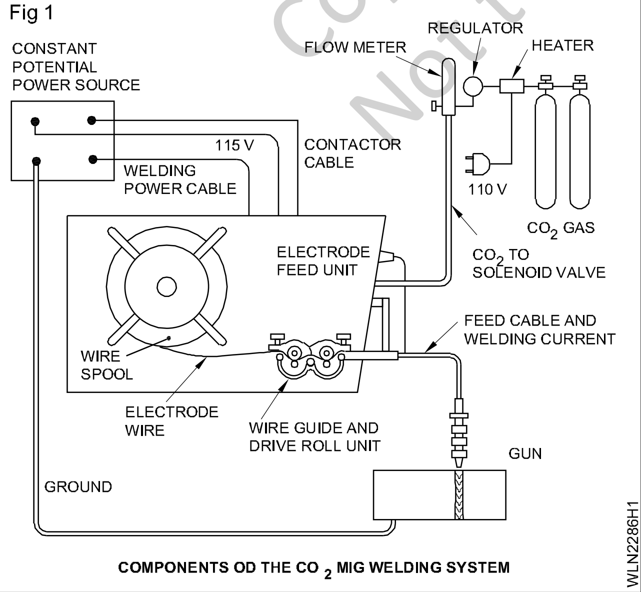
Preparation and setting of the job: Prepare a M.S plate piece of size 150 x 100 x 3mm thick.

Mark striaght lines with punch marks spaced at 15mm.

Set the job on the welding table in a Flat position as done in earlier exercises.

Setting up of the MIG welding machine: Fix the wire spool and take the wire through the guide tube, rollers spiral and contact tip at the end of the torch/gun. (Fig 1)

Fig 1



COMPONENTS OD THE CO_2 MIG WELDING SYSTEM

Draw the wire from the spool, pass it on through the Inlet wire guide, driver rollers and outlet wire guide. (Fig 2 & 3)

Fig 2

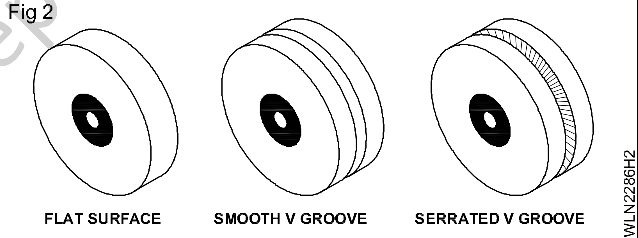
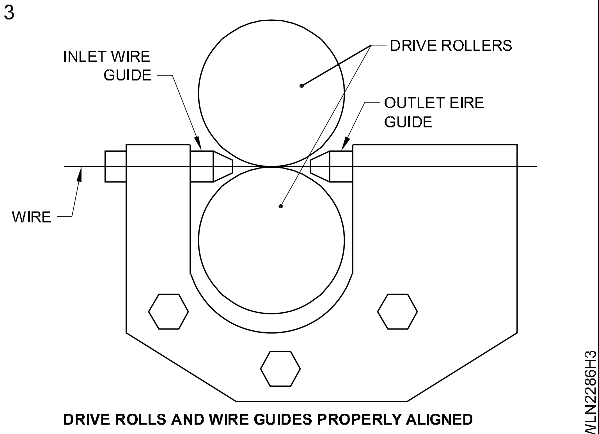


Fig 3



DRIVE ROLLS AND WIRE GUIDES PROPERLY ALIGNED

The roller should not be over tightned to avoid flattening and peeling of copper coating on the wire.

Fig 4

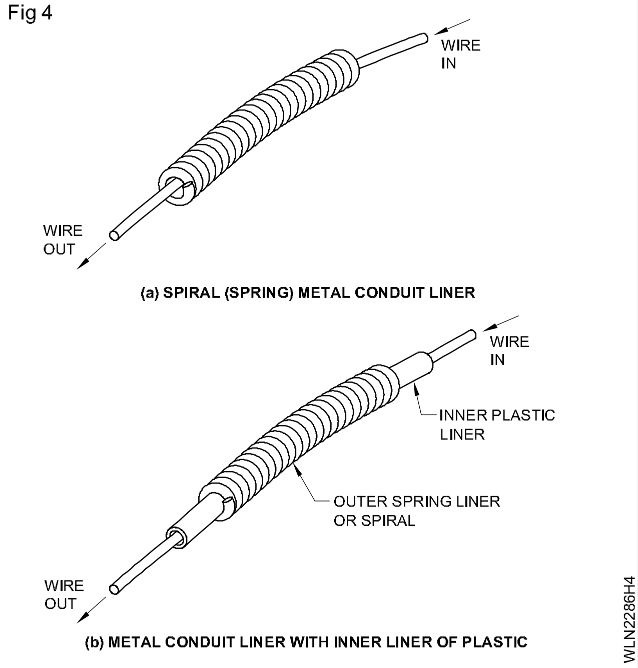
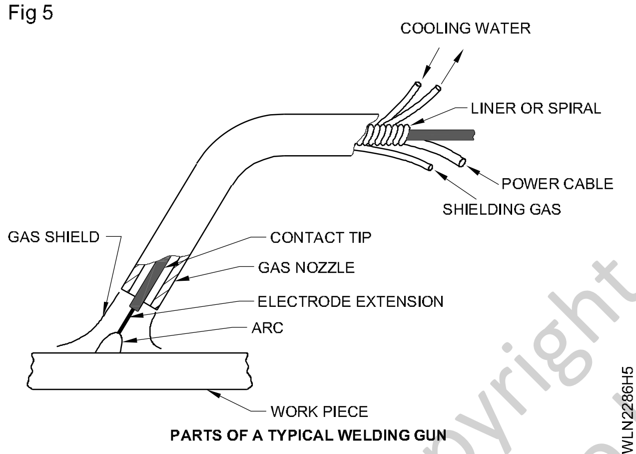


Fig 5



PARTS OF A TYPICAL WELDING GUN

The wire is further passed through the conduit liners with spring liners called spiral Fig 4 to the welding torch outlet through the contact tip. (Fig 5)

The wire should not develop any bends (or) kinks while inserting.

The contact tip should be removed to facilitate easy flow of the wire from the spiral and put in position into the Torch later.

Start the MIG welding machine after the machine is connected to the 3 phase supply mains.

Connect the welding torch to the positive terminal.

The positive terminal influences deeper, wider weld penetration with a good ripple formation.

Fix a two stage regulator using a flat spanner to the outlet end of the gas heater and ensure proper functioning of the dialgauges.

Connect finally the flow meter, gas hose to the welding torch/gun.

Set an outflow pressure for argon gas to get a gas flow of 8 to 10 LPM as required for the dip transfer mode.

Ensure to avoid leakage at all connections so as to get correct pressure at the nozzle end. This could be checked by using soap-water solution. When used with correct gas flow rate a rapid cracking and hissing sound shall be heard. Too little flow results in porosity and too high flow rate creates turbulances and in turn contaminates weld.

Setting up arc voltage, stickout and wire feed rate of dip transfer

Setting the current level by selecting proper wire feed rate: For this exercise of depositing straightline beads it is desirable to select a smaller diameter wire i.e. 0.8mm dia wire and Dip Transfer method. Accordingly a current range of 80-100A is to be set for the 0.8mm dia wire. The current to be set has a direct relationship with the wire feed rate in Co_2 welding/GMAW process. So the correct wire feed rate corresponding to the 80-100A current is set on the Electrode Feed unit of the machine.

Setting appropriate arc voltage for the corresponding current used: The Arc voltage to be set depends on the filler wire diameter, the type of metal transfer and the current selected. The thumb rule to select arc voltage for DIP transfer mode in GMAW process is calculated by using an imperical formula i.e. Arc voltage = 14 + 0.05 (I) ± 2 where I is the current selected for the diameter of the wire. This can be up further by +2 volts for globular and spray transfer mode and depending upon bead finish. For laying straight line beads on 3mm steel plate set an voltage of 23 to 24 volts using set voltage control knob of MIG welding machine. This set voltage will drop down and settle at 19-21 volts after Arc initiation. The reduction in voltage from set to Arc voltage is due to lenght of the cable and other factors.

The welder should select 19 to 21 volts, strike the arc without changing the current; The right arc voltage is selected by Trial and Error method to get a uniform bead profile.

Setting the stick-out: This is the distance between the end of the outer tip of the electrode till it touches the base metal refer (k) in the Fig.6. The stick out recommended is 5 to 10mm for Dip Transfer. If the stickout is too short then excessive spatters will get deposited at the end of the nozzle which in turn restricts the shielding gas flow and may cause porosity. If the stickout is too large, arc voltage will shoot up, current diminishes, the arc will tend to become weaker and the metal deposition will become irregular.

Welding procedure (depositing the beads): Strike the arc by pressing the trigger in the welding torch (Fig.7) and at the same time touching the tip of the electrode wire to the job at the starting of the marked line.

Fig 6

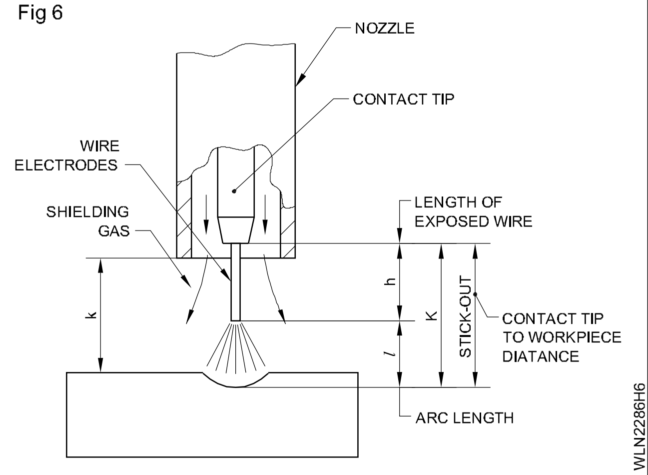
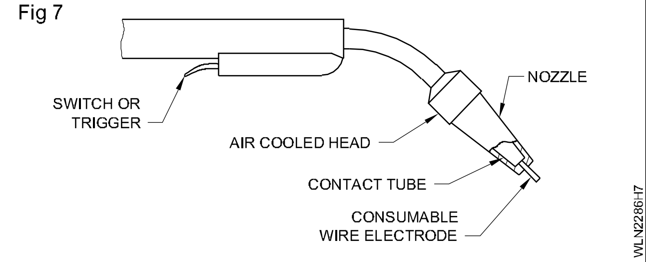
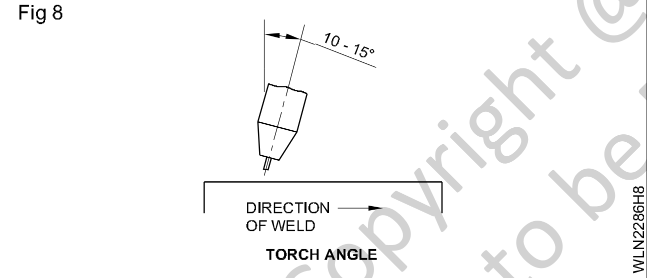


Fig 7



Hold the torch 15mm above the work piece at an angle of 10 to 15° to the vertical in the direction of welding as shown in the Fig.8.

Fig 8



Move the torch uniformly starting from the left end of the job towards the right end or from the right end to the left end of the job Fig.9 and 10. Based on the welding direction, the welding technique is called as Backhand or Backward or Pulling technique Fig.9 and Forehands or Forward or Pushing technique (Fig.10).

Use anti spatter spray or Gel periodically to avoid the sticking of the spatter at the mouth of the torch nozzle.

Fig 9

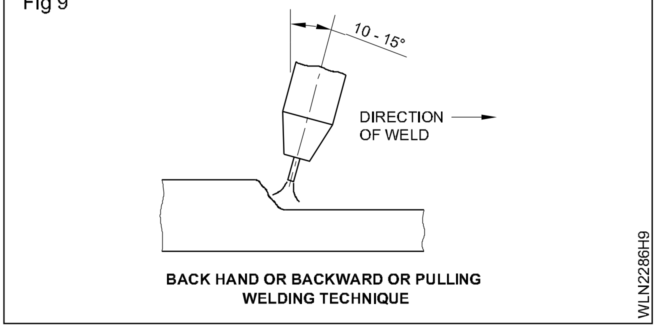
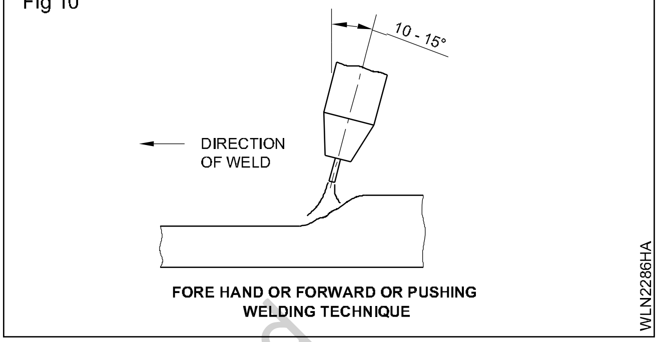


Fig 10



Ensure the crater is filled properly at the end of the bead as done in shielded metal arc welding.

Avoid excessive travel speeds for the torch to get correct bead width, height and ripple formation and to avoid undercut.

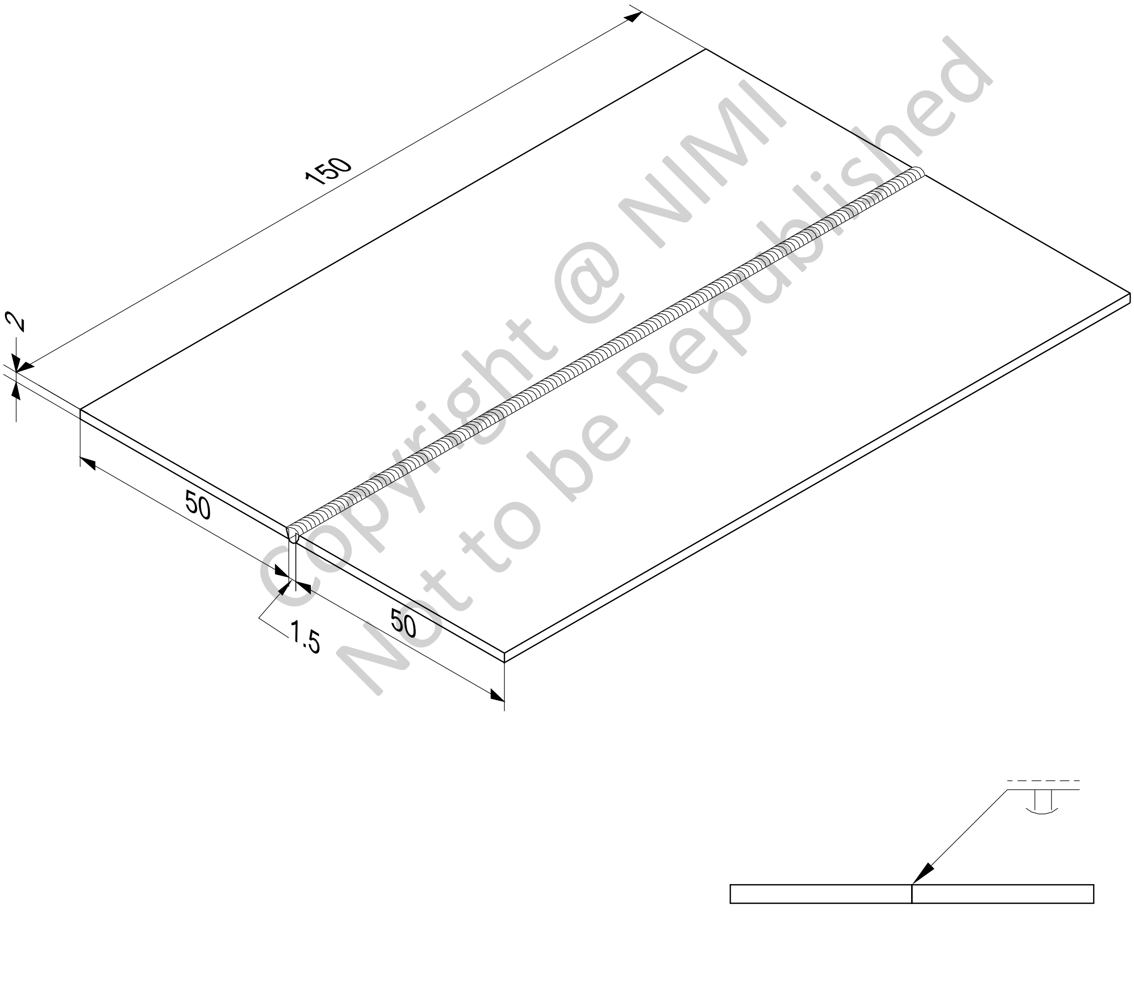
Cleaning the weld bead: The spatters, if present, on the surface of the bead and base metal are to be removed by using a chipping hammer. Also use protective goggles for safety. Further the bead has to be cleaned by carbon steel wire brush to remove any non-metallic deposits on the bead.

Repeat the above procedure for other runs done alternately by both Forehand and Backhand techinques (push and pull welding).

Inspecting the finished welded job: Use visual inspection method to verify whether any weld defects such as undercut, uneven bead width, height, ripple formation and wavy line of bead are there.

Butt joint on stainless steel 2mm thick sheet in flat position by dip transfer

Objectives: At the end of this exercise you shall be able to
- **prepare the plate and tack weld as per the drawing**
- **set the tack welded joint in flat position**
- **deposite the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects and penetration and bead appearance.**



2	150 x 50 x 2		X 04 Cr19 Ni9			GMAW- 02
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 87

SCALE NTS	BUTT JOINT ON STAINLESS STEEL 2mm THICK SHEET IN FLAT POSITION BY DIP TRANSFER	TOLERANCE ±1	TIME 15 Hrs
		WLN2287E1	

Job Sequence

1 Prepare the sheets as per drawing using shearing and grinding.

2 Use necessary safety precautions .

3 Clean the edges of the sheet.

4 Set the sheets as a square butt joint and tack weld at the ends.

5 Fix the joint in on backing strip in flat position.

6 Strike an arc and move the torch steadily.

7 Use proper torch angles with slight weaving.

Skill Sequence

Adjust the welding current to DC RP and 60-80 amperes and set corresponding Arc voltage to 18-20V.

Fit the joint as a square butt joint and tack weld the plates using spacers so as to maintain minimum 1.5mm, root gap and tack weld placing the tacks at 40-50mm apart. Be sure to have more tacks; otherwise the root gap get closed at bottom end of the plate during welding.

Brush the tacks, remove all non-metallic particles from the intended weld area.

As you follow the groove it may be necessary to weave the torch slightly from side to side. This will fuse both the sheet edges of the joint.If the puddle is wide enough, the weaving is not necessary.

Hold a stick out of 8-10mm on an average to get a good penetration while welding without backup strip so that a proper/even root penetration could be achieved throughout.

Have a pause in between so that continuity of beads could be uniformly achieved.

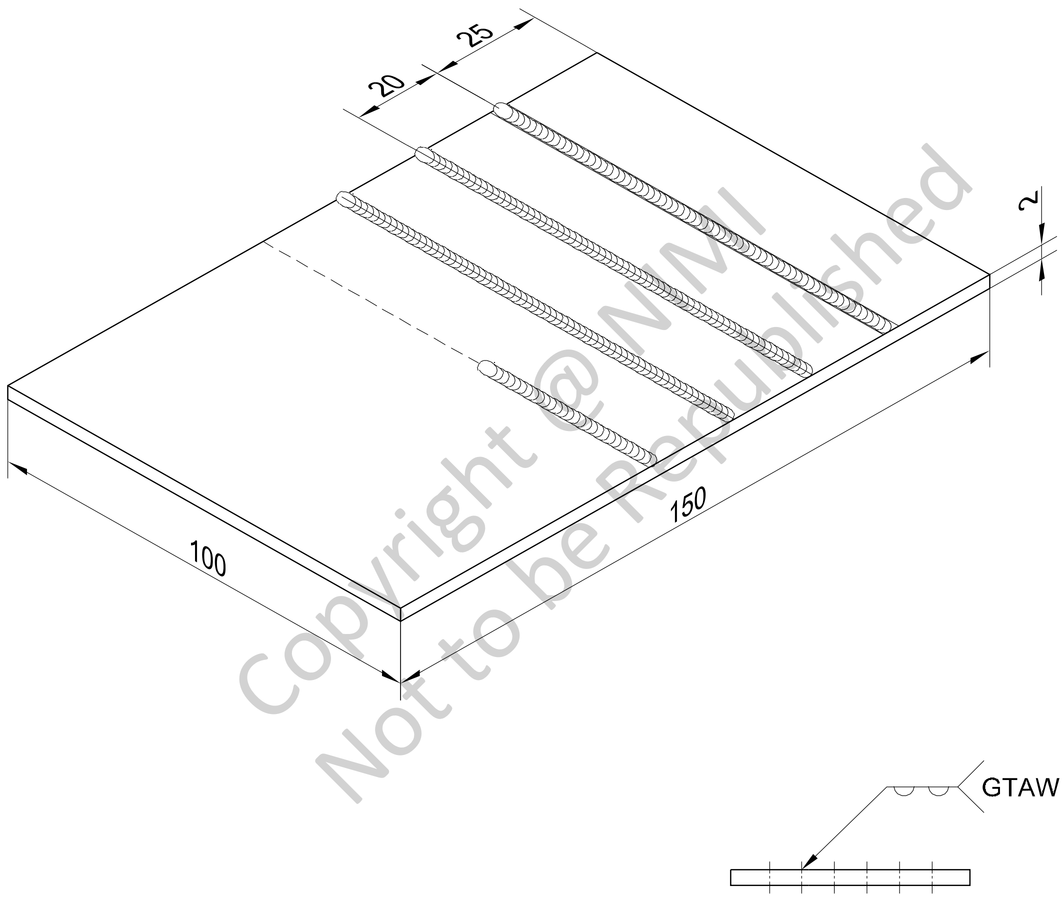
The contour of the bead can range from flat face to slightly convex face.

Make sure to clean the weld joint.

Inspect the joint for required root penetration (0.5 to 1mm) reinforcement (1.0 to 1.5mm). Undercuts, bead profile, contour etc.

Depositing bead on aluminium sheet 2mm thick - position flat

Objective: At the end of this exercise you shall be able to
- **weld fusion runs with filler wire on aluminimum by TIG welding process in flat position.**



1	100 x 2 x 150	- -	AL.199990 - IS 737	- -	- -	GTAW- 03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 88

SCALE NTS	DEPOSITING BEAD ON ALUMINIUM SHEET 2mm ON POSITION FLAT	TOLERANCE ±1	TIME 10hrs
		CODE NO. WLN2388E1	

Job Sequence

1 Prepare the aluminimum sheet as per dimensions.

2 Clean the surface with the stainless steel wire brush.

3 Also do the chemical cleaning with acetone/alcohol to remove the grease and surface oxide.

4 Draw parallel lines and punch the lines as per dimensions.

5 Set the job in flat position.

6 Select the power supply as follows:

– In case of helium as shielding gas use DCEN.

– In case of Argon as shielding gas and use AC power source. Majority of welding is done using argon gas.

7 Set up the GTA welding plant as per the Fig.1.

8 Select the type and size of tungsten electrode, current, gas flow rate and set them on the machine.

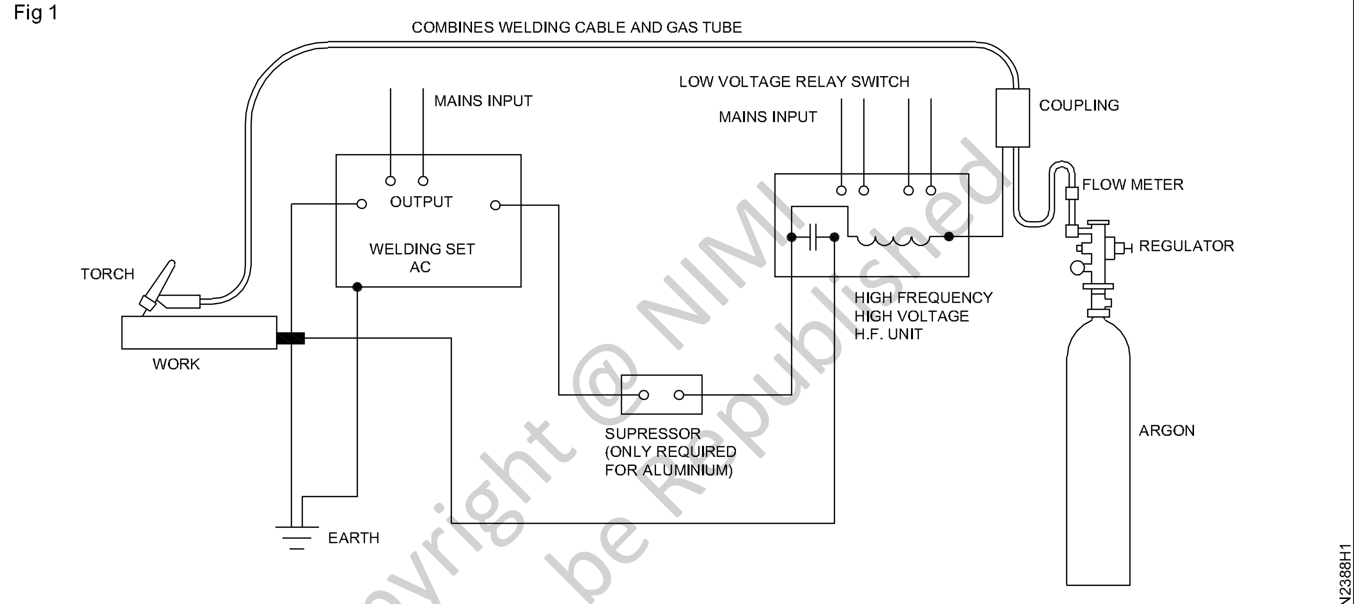
9 Select aluminium filler wire. 1.6mmf with 5% silicon.

10 Switch on the machine and strike the arc.

11 Deposit fusion run with filler wire using leftward welding technique.

12 Clean and inspect the weld job.

Fig 1



CONNECTIONS FOR INERT GAS WELDING USING AIR-COOLED TORCH

Skill Sequence

Ensure to use correct size of the sheet for welding.

Select aluminimum (95% AL and 5% Si) filler wire 1.6mmf.

Set the current and other parameters as per the Table given below.

Open the gas cylinder valve slowly.

Follow leftward technique.

The filler rod and torch are held at an angle of 10 to 15^0 and 70 to 80^0 to the line of weld.

Finish welding and ensure to fill the crater.

Brush the weld using SS wire brush and check for defects if any.

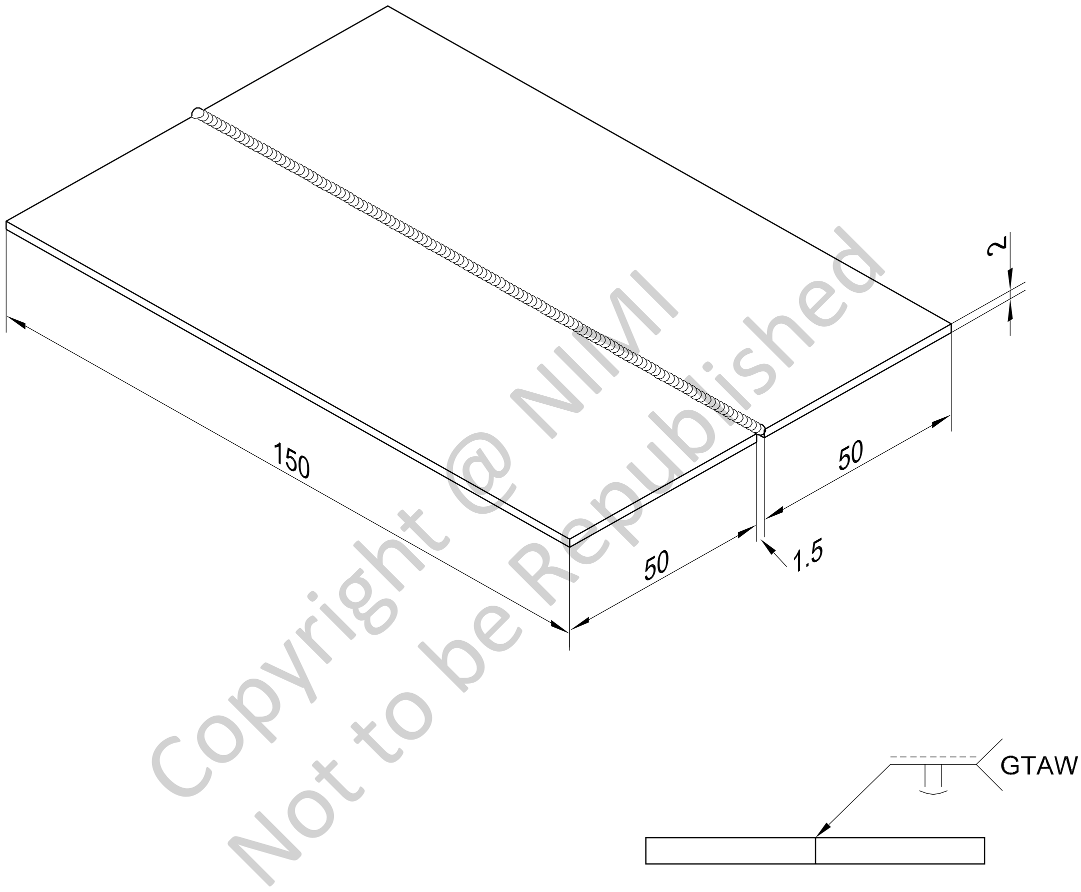
A table-I of the variables used when manually welding aluminium with the gas tungsten arc using AC and high frequency.

Table 1

Metal thickness	Joint type	Diameter of tungsten alloy electrode with 1 to 27 Zirconium	Filler rod diameter (if required)	Amperage	Gas	
					Type	L/min
2 mm	Butt & Corner	1.6 mm	1.6 mm	60 – 85	Argon	7
	Fillet	1.6 mm	1.6 mm	75 – 100	Argon	7
3.15	Butt & Corner	3.15 mm	2.4 mm	120 - 150	Argon	9.5
	Fillet	3.15 mm	2.4 mm	130 – 160	Argon	9.5
5 mm	Butt & Corner	3.15 or 4 mm	3.15 mm	120 - 150	Argon	12
	Fillet	3.15 or 4 mm	3.15 mm	130 – 160	Argon	12
6.3 mm	Butt & Corner	4 or 5 mm		240 - 280	Argon	14
	Fillet	4 or 5 mm		250 – 320	Argon	14

Butt weld square butt joint on aluminium sheet 2mm - position flat

Objective: At the end of this exercise you shall be able to
- **weld square butt joint on Aluminium sheet 3mm thick using TIG welding process.**



2	50 x 2 x 150	- -	AL.199990 - IS 737	- -	- -	GTAW-03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 89

SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON ALUMINIUM SHEET 2mm - POSITION FLAT	TOLERANCE ±1	TIME 15h
		CODE NO. WLN2389E1	

Job Sequence

1 Prepare aluminium sheets as per dimensions.

2 Use Tungsten (zirconium) 2.4mm dia electrode.

3 Clean the edges of the sheets.

4 Use the stainless steel wire brush for surface cleaning.

5 Set the square butt joint.

6 Select the various parameters as given in the Table 1 and set them accordingly.

7 Weld the joint in flat position using leftward technique.

8 Fill the crater.

9 Clean the weld area thoroughly.

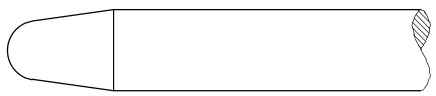
10 Inspect the job for free from defects.

Skill Sequence

Ensure setting of Butt joint as per drawing.

Tungsten electrode tip to be ground for AC welding-Aluminium as shown in Fig 1.

Fig 1



ROUND TIP OF TUNGSTEN ELECTRODE IN AC TIG WELDING

WLN2389H1

Tack weld at equal intervals-keeping the uniform root gap of 1.5mm between the samples along the welding length.

Adjust the current as per guide line given in Table 1.

TABLE 1

Guideline for Manual AC GTA welding of aluminium

Plate thickness (mm)	Welding position	Joint type	Current AC (Amp)	Electrode Dia.(mm)	Nozzle size (10) mm (mm)	Argon flow Rate LPM	Filler rod Dia. mm	Number of runs
2 mm	F	Square butt	70 - 100	2.4	8.0	10	2.4	1
	H, V	Square butt	70 - 100	2.4	8.0	10	2.4	1
	O	Square butt	60 - 90	2.4	8.0	13	2.4	1
3.2	F	Square butt	120 - 150	3.2	9.5	10	3.2	1
	H, V	Square butt	110 - 140	3.2	9.5	10	3.2	1
	O	Square butt	110 - 140	3.2	9.5	13	3.2	1
4.8	F	60^0 Single Vee	180 - 220	4.0	11	12	4.0	2
	H, V	60^0 Single Vee	160 - 200	4.0	11	12	4.0	2
	O	60^0 Single Vee	170 - 200	4.0	11	12	4.0	2
6.35	F	60^0 Single Vee	220 - 240	4.8	12.7	15	4.0	2
	H, V	60^0 Single Vee	220 - 240	4.8	12.7	15	4.0	2
	O	60^0 Single Vee	210 - 250	4.8	12.7	18	4.0	2

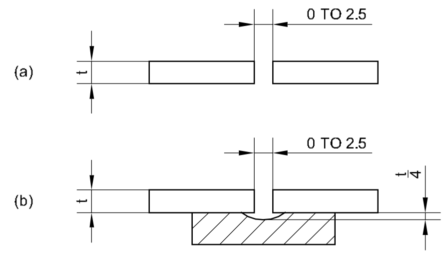
F - Flat, H - Horizontal, V - Vertical, O - Overhead

Maintain uniform short arc throughtout the welding.

Care to be taken to avoid end crater.

During welding a temporary backing is to be given on the underside to support the penetration bead.

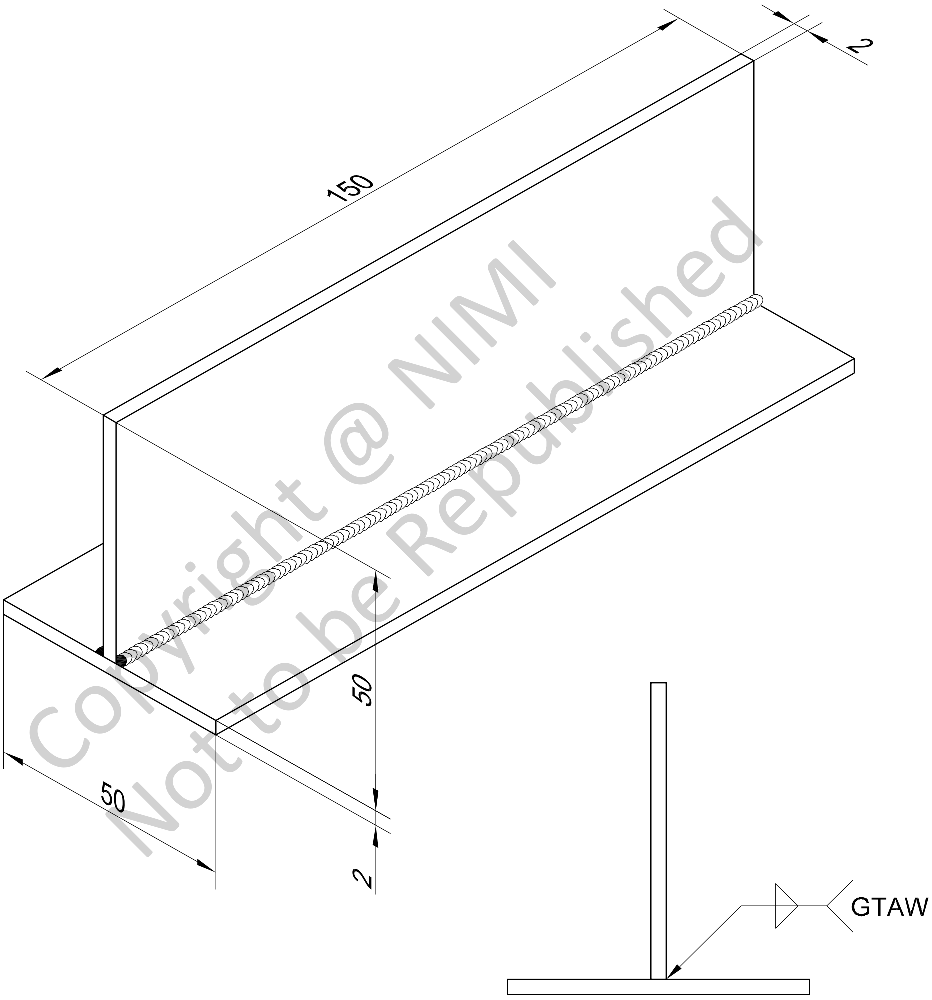
Fig 2



WLN2389H2

Fillet weld - Tee joint on aluminium sheet 2mm - position flat (1F)

Objective: At the end of this exercise you shall be able to
- **weld a Tee fillet joint using 5% Silicon Aluminium Filler wire in flat position by TIG welding process.**



2	50 x 2 - 150	- -	AL.199990 - IS 737	- -	- -	GTAW-03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 90

SCALE NTS	FILLET TEE JOINT ON ALUMINIUM SHEET 2 mm- POSITION FLAT (1F)	TOLERANCE ±1	TIME 10 hrs
		CODE NO. WLN2390E1	

Job Sequence

1 Prepare aluminium sheets as per dimensions.

2 Clean the edges of the sheets by the chemical cleaning method and deburr. Use the stainless steel wire brush for surface cleaning.

3 Set the "Tee" joint for aluminium welding.

4 Use 2.4mm size tungsten (zirconium) electrode.

5 Select 95% aluminium 5% silicon filler wire 1.6mmf.

6 Weld Tee joint in flat position using leftward technique.

7 Clean the weld area thoroughly.

8 Inspect the job.

Skill Sequence

Ensure setting of the Tee joint as per drawing.

Tack weld at equal intervals (50mm spacing) so that the plates are set to form 90^0 equal Tee.

Take adequate care in selection of Tungsten Electrode Tip for alternating current power. (Fig 3)

Lack of penetration is avoided by judicially following the position of the Arc with respect to the joint. See Fig 1 and Fig 2.

Fig 1

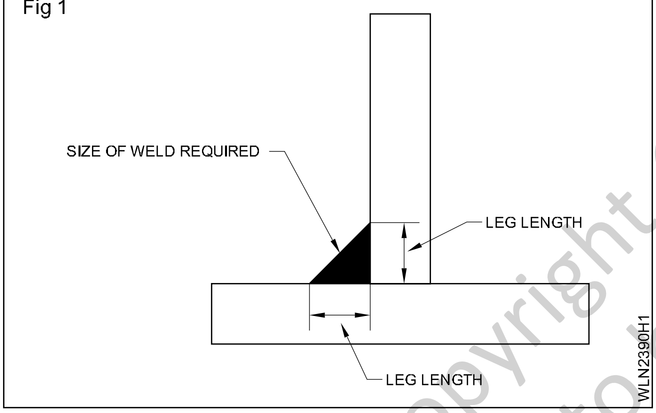


Fig 2

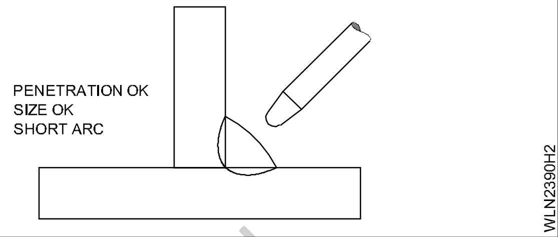
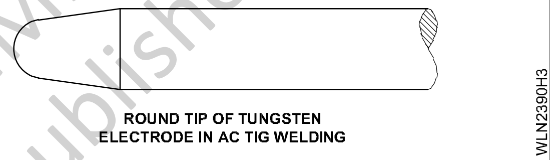
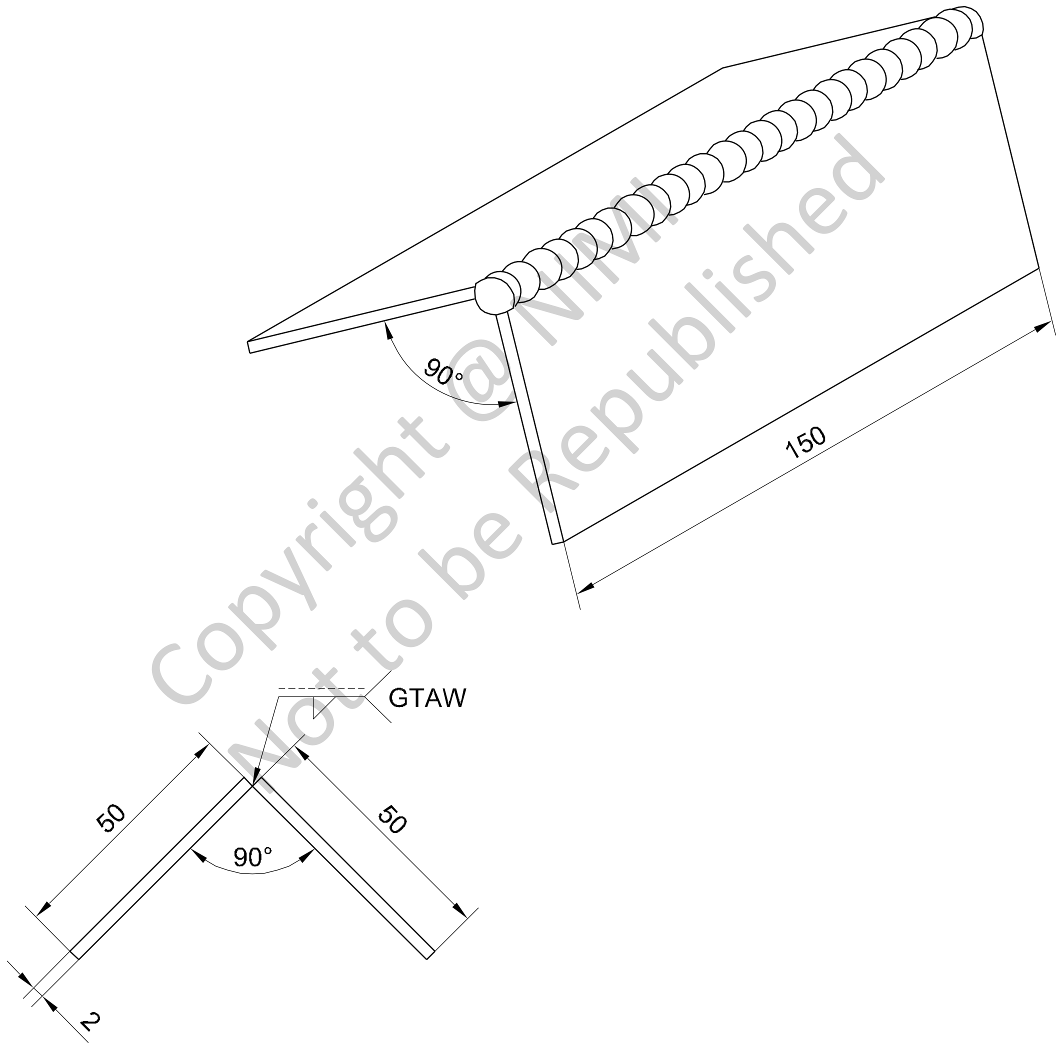


Fig 3



Fillet weld outside corner joint on aluminium sheet 2mm - thick in postion flat (1F)

Objective: At the end of this exercise you shall be able to
- **weld outside corner joint in aluminium sheet 2 mm thickness using TIG welding process.**



2	50 x 2 - 150	- -	AL.199990 - IS 737	- -	- -	GTAW-03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 91

SCALE NTS	**FILLET WELD OUTSIDE CORNER JOINT ON ALUMINIUM SHEET 2mm - POSITION FLAT (1F)**	TOLERANCE ±1	TIME 15 hrs
		CODE NO. WLN2391E1	

Job Sequence

1 Use pure aluminium filler wire/alluminium +5% silicon of 2.4mmj.

2 Use 2.4jmm (Zirconium) tungsten electrode.

3 AC power source with DC suppressor and high frequency units.

4 Shielding gas argon.

5 Prepare aluminium sheet as per dimensions.

6 Clean the edges of the sheets.

7 Use stainless steel wire brush for surface cleaning.

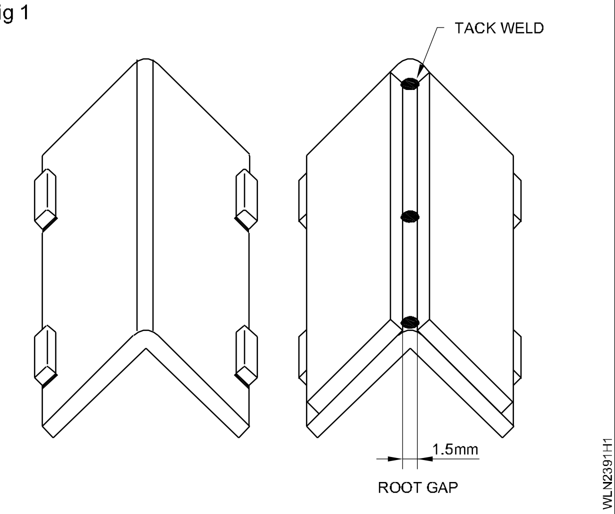
8 Tack the set pieces at correct intervals and in correct alignment for an outside corner joint (Fig 1).

9 Weld the joint in flat position.

10 Make uniform size bead with correct penetration at the root in the outside corner joint.

11 Clean the weld area thoroughly.

Fig 1



12 Inspect the completed outside corner weld for weldment quality.

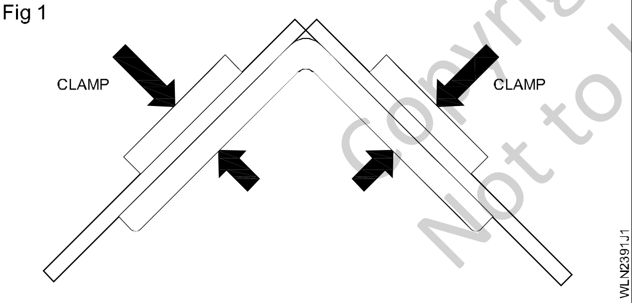
Skill Sequence

Ensure the setting of an outside corner joint as per drawing.

Adjust current 60- 90 Amp in AC.(Refer Table 1 of fabrication - welder Ex.No. 2.2.02)

Use a backing bar made from a piece of steel angle with its apex bevelled or radi used to accommodate the penetration bead.

Fig 1

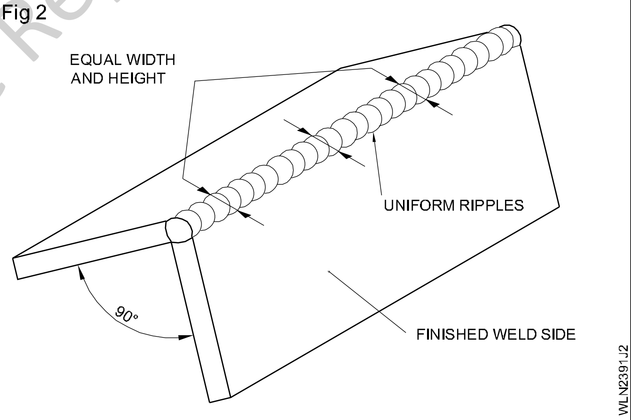


Hold the sheet on to the backing bar with steel strap. Fig.2

– correct alignment and uniformity of bead with correct penetration after cleaning the welded joint thoroughly.

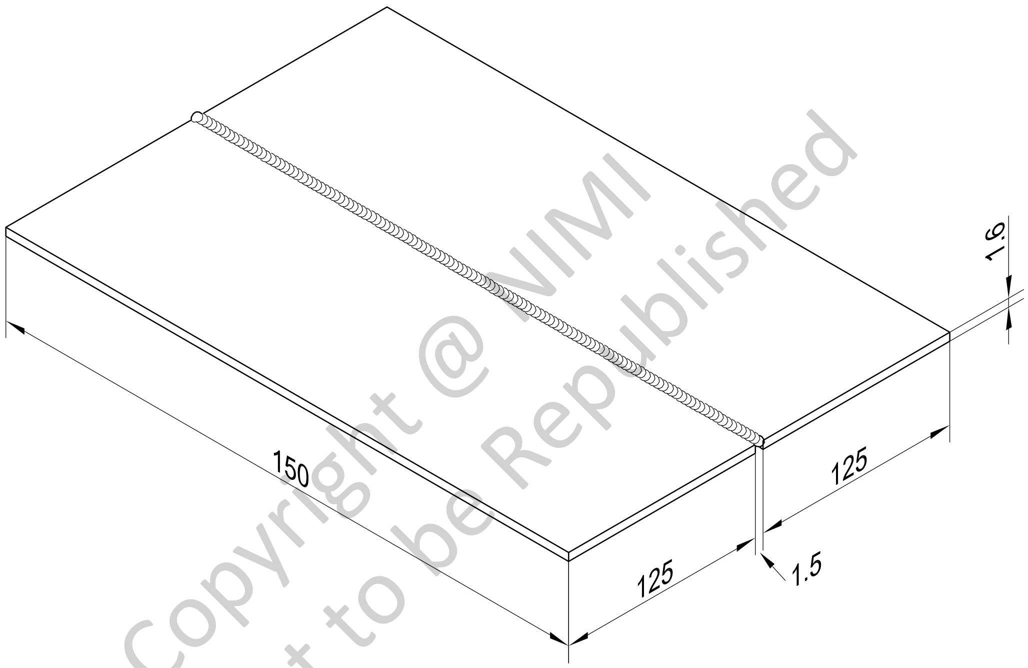
– uniform ripples with equal width and height of bead (Fig.3).

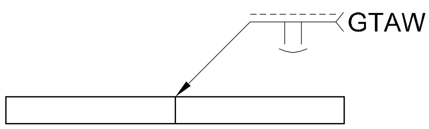
Fig 2

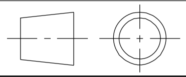


Butt weld square butt joint on stainless steel 1.6mm thick flat with purging Gas (1G)

Objective: At the end of this exercise you shall be able to
- **weld square butt joint on stainless steel sheet-1.6mm thick flat position.**





2	125 x 3.15 - 150	- -	X 04 Cr 19 Ni 9	- -	- -	GTAW- 03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO. 92
SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON STAINLESS STEEL SHEET 3.15mm - POSITION FLAT WITH PURGING GAS (1G)				TOLERANCE ±1	TIME 25 hrs
					CODE NO. WLN2392E1	

Job Sequence

1 Clean the base metal surface with the S.S wire brush.

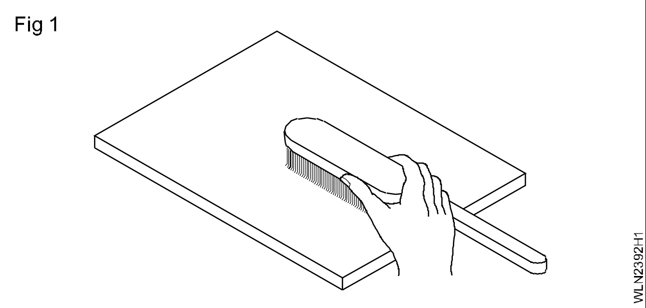
2 Clean the base metal surface with alcohol.

3 Adjust the current to about 80 to 90A.

4 Adjust the gas flow rate to 6-8 LPM.

5 Set the root gap to 1.5mm.

Fig 1



6 Fix the base metal with the jig.

7 Flow the back shielding gas by 4LPM.

8 Tack weld at 10mm inside from both ends of the joint.

9 Stop the back shielding gas.

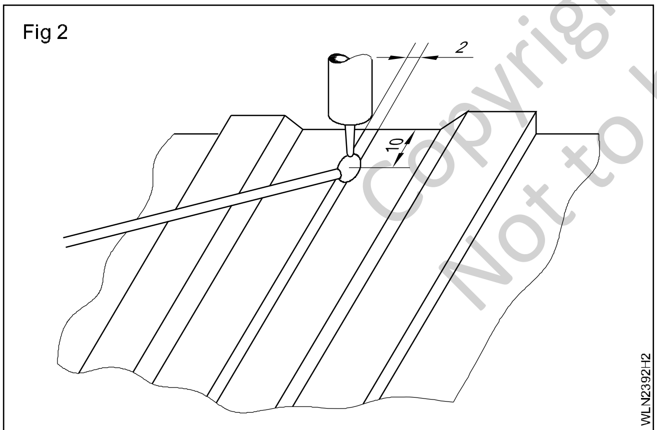
10 Remove the base metal from the jig.

11 Check if the joint has good alignment.

12 Fasten the base metal securely to the jig.

13 Polish the base metal with the ss wire brush.

Fig 2



14 Adjust the current to about 80 to 90A.

15 Adjust the shielding gas to 6.8LPM.

Fig 3

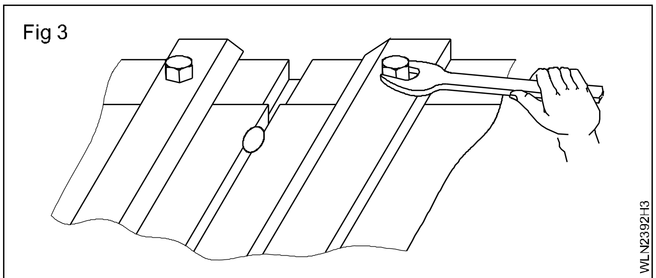
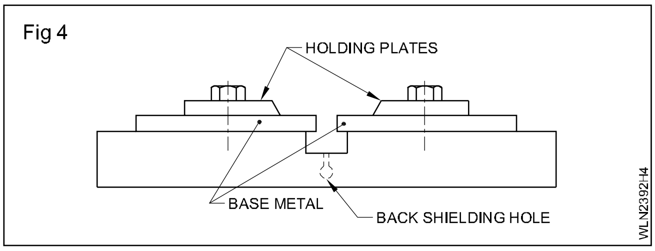


Fig 4



16 Adjust the back shielding gas to 4 LPM.

17 Generate an arc at the tack welding position.

18 Return to the start end.

19 Hold the torch to about 70 to 80° against the welding direction and 90° against the base metal surface.

20 Keep the arc length about 3 to 5mm.

Fig 5

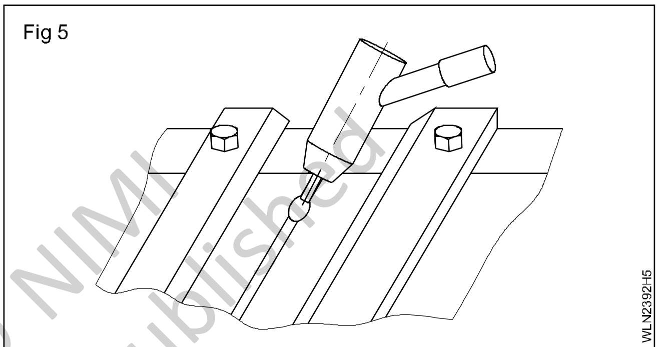


Fig 6

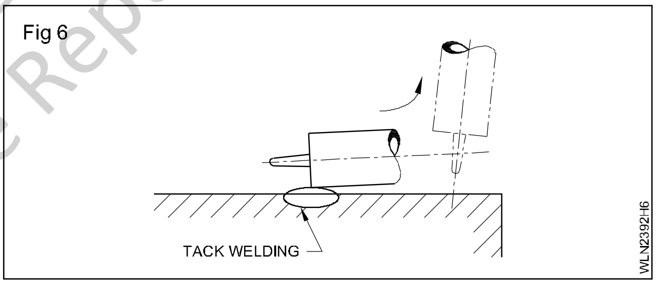
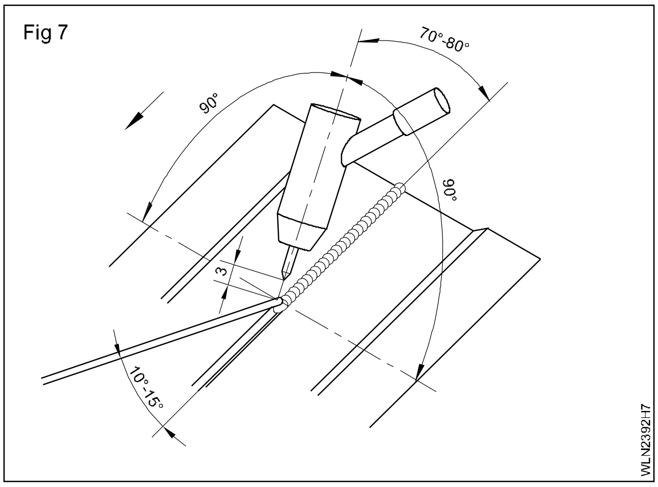


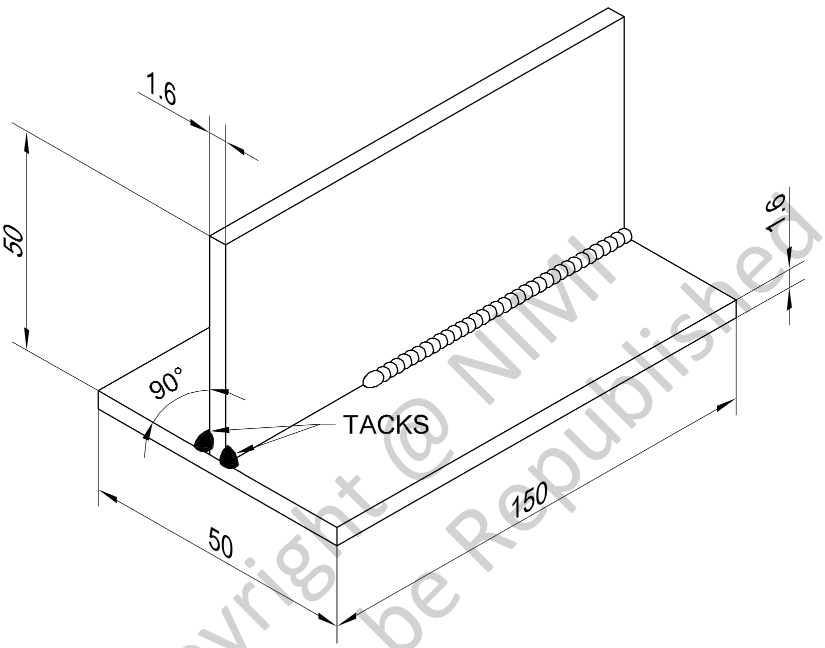
Fig 7

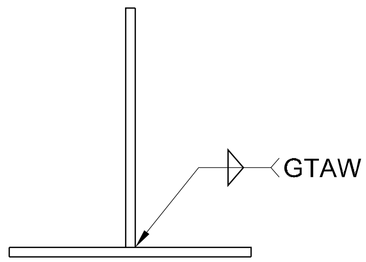


Fillet weld Tee joint on stainless steel sheet 1.6mm - position flat 1F

Objective: At the end of this exercise you shall be able to

- **weld fillet weld-Tee joint on stainless steel sheet 3mm thickness in flat position.**





2	50 x 1.6 - 150	- -	X 04 Cr 19 Ni 9	- -	- -	GTAW-03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.93

SCALE NTS	**FILLET WELD TEE JOINT ON STAINLESS STEEL SHEET 1.6mm - IN FLAT POSITION**	TOLERANCE ±1	TIME 25 hrs
		CODE NO. WLN2393E1	

Job Sequence

1 Prepare the sheets as per drawing and clean the edges.

2 Clean the surfaces using the stainless steel wire brush.

3 Set the sheets in the form of a 'Tee' joint on the welding table.

Wear safety equipments.

4 Set the GTA welding plant with argon gas.

5 Select the 1.6 mmf electrode and 2mmf filler wire and electrode tip be grinded for DC.

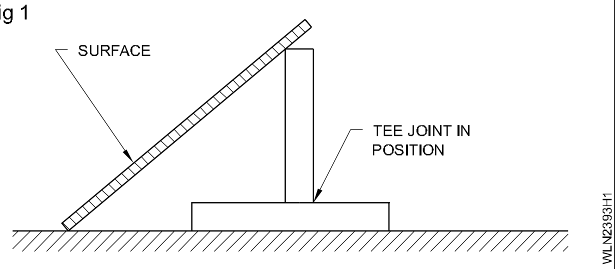
6 Set the current 60 amps to 90 amps.

7 Setting and tacking the job pieces

8 Place the pieces on the welding table as Tee joint.

9 Hold the pieces in position using support. (Fig.1)

Fig 1

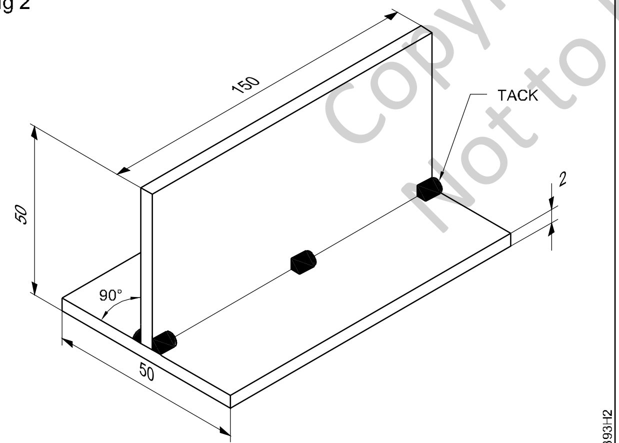


10 Ensure the vertical piece is perpendicular to the horizontal place without gap.

11 Check with a try square.

12 Tack-weld the joint at both ends and also in the centre. (Fig.2)

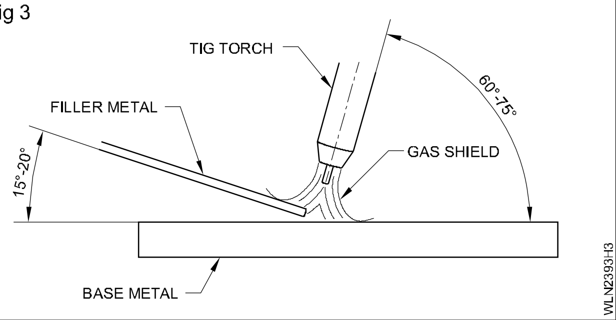
Fig 2



ASSEMBLING A TEE JOINT

13 Hold the torch perpendicular to the joint and pointing at an angle of about 30^0 toward the direction of travel. Fig.3.

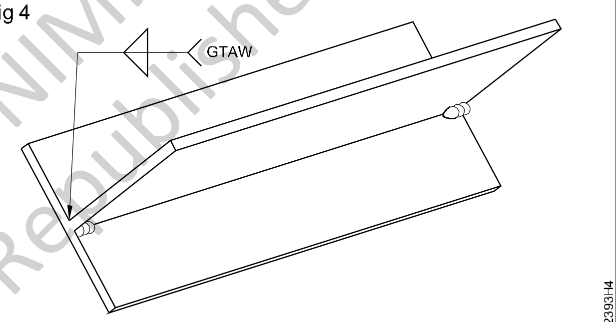
Fig 3



14 Strike an arc and establish a puddle. Make sure the side walls melt down to the root of the 'T' joint.

Because the side walls are nearer to the electrode than the root of joint, the arc will go to the sidewalls and cause them to melt before the root of the joint does. (Fig 4)

Fig 4



TACKING PROCEDURE AND WELD POSITION FOR A FLAT TEE JOINT

10 Add the filler wire in a dabbing motion, advancing the torch when you withdraw the filler metal.

11 Remember, when with drawing the wire, keep the wire in the protective gas shield.

12 Complete the bead, cool the assembly.

13 Reposition the 'T' base and weld the otherside as you did first, using the same procedure.

Skill Sequence

In 'T' joint - filler metal is necessary regardless of the thickness of the metal.

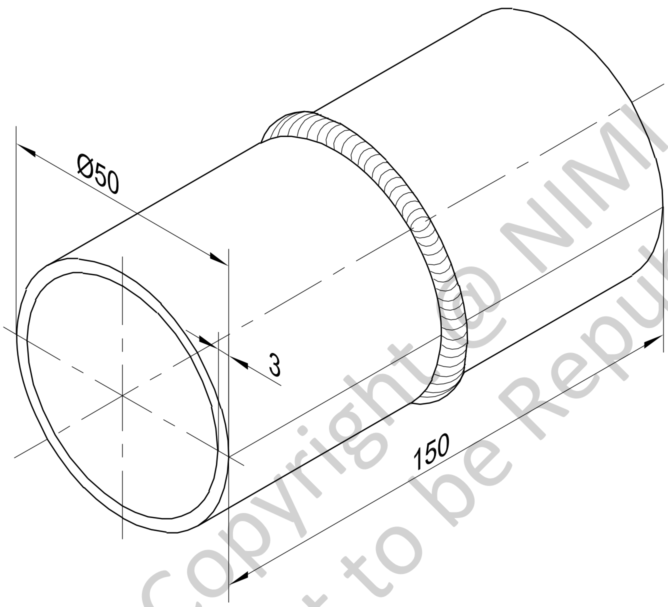
As a rule, a weld should be made on both sides of the fillet joints.

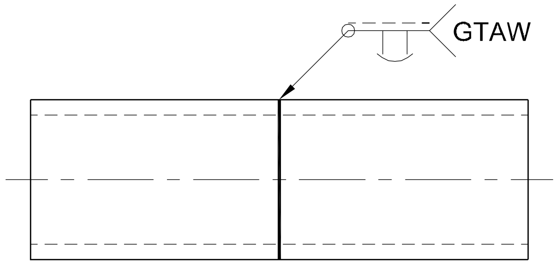
The number of passes over the seam will depend on the thickness of the material and the size of the weld to be made in this process.

Follow the recommendations for the correct gas flow, otherwise the shielding gas will not be effective.

Pipe butt joint on aluminium pipe φ50mmx3mm WT in flat position 1G

Objective: At the end of this exercise you shall be able to
- **weld square butt joint in aluminium pipe wall thickness 3mm and 50mmφ in flat position using TIG welding process.**





2	Ø50 x 3 - 76	- -	Aluminium	- -	- -	GTAW-03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.94

SCALE NTS	**PIPE BUTT JOINT ON ALUMINIUM PIPE Ø50mm x 3mm WT IN FLAT POSITION**	TOLERANCE ±1	TIME 25 hrs
		CODE NO. WLN2394E1	

Job Sequence

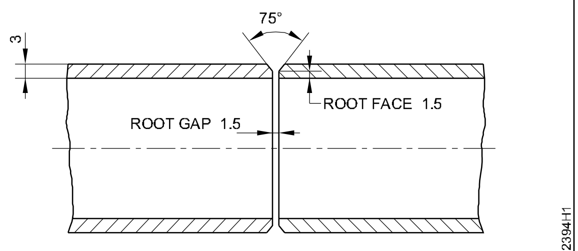
1 Cut and prepare the aluminium pipe as per the dimensions given.

2 Align the pipes in flat position (butt) for tack weld with the help of a Vee Block-angle iron.

3 Tack the joints at 120^0 by rotation and complete the tacking.

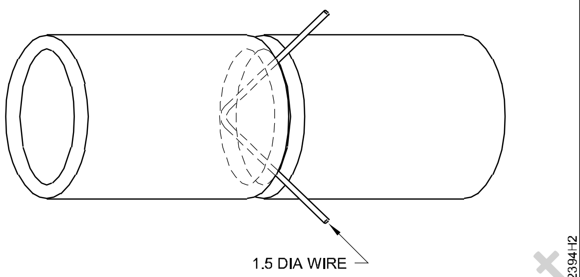
4 Use the roller stand to maintain the downward welding position.

Fig 1



EDGE PREPARATION AND SETTING PIPE FOR BUTT WELD

Fig 2



USE OF BENT WIRE OR SUITABLE SPACER TO SET ROOT GAP

5 Rotate the pipe at uniform speed for good weld result. Fig.3.

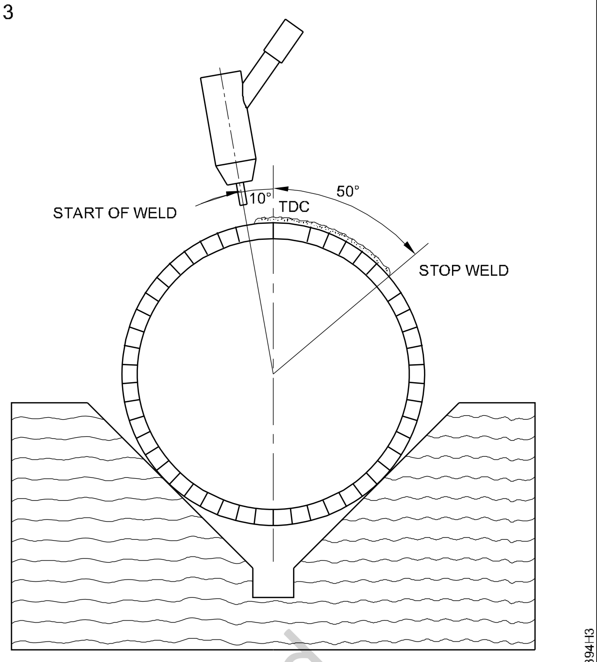
6 Further welding is done by rotating the pipe as shown in Fig.4 to the next segment and completed.

7 Repeat the above procedure till the joint is completely welded.

8 Remove the workpiece from the rotating fixture.

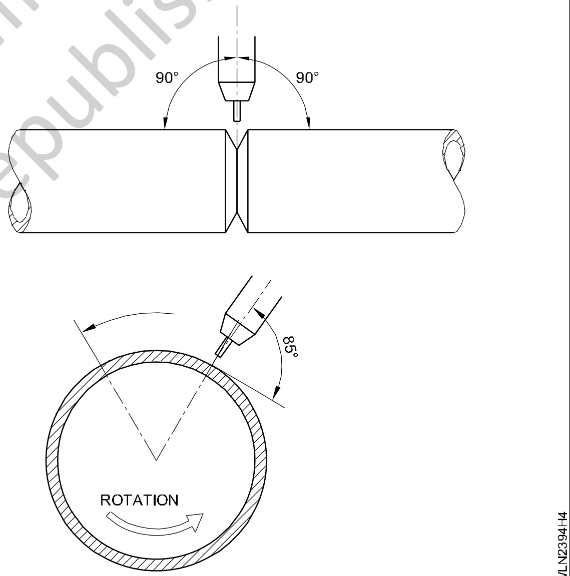
9 Clean the weld bead and inspect.

Fig 3



WELDING FIRST SEGMENT

Fig 4



Skill Sequence

Pipe welding is a highly skilled welding operation, which involves correct alignment and good penetration by equally melted edges of the pipes.

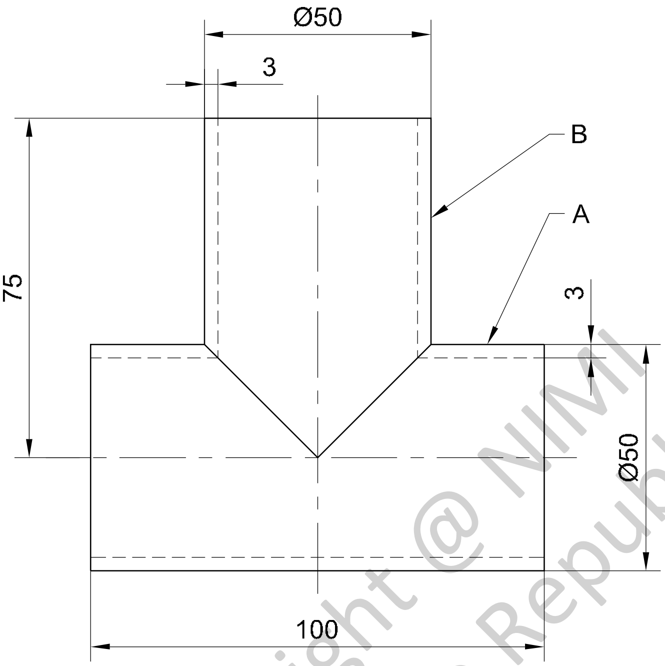
Select the rotating fixture according to the diameter of the pipe.

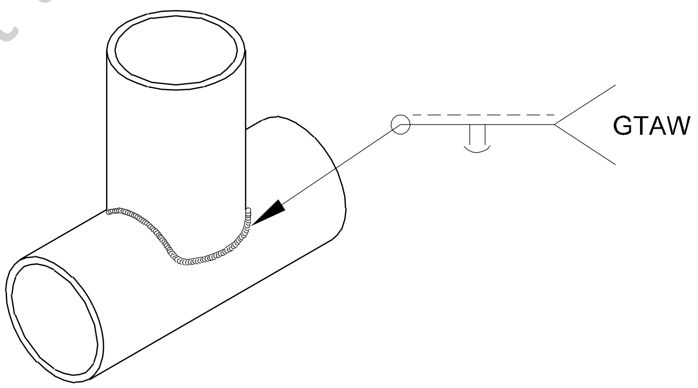
Place the tacked pipes on the rotating fixture and check the freeness of rotation.

Ensure proper melting of tacks for good penetration and surface appearance.

Tee joint on MS pipe φ50mm OD x 3mm WT position flat 1F

Objective: At the end of this exercise you shall be able to
- **weld fillet Tee joint on MS pipe 50mm ODx3mm WT in IG/rolling position.**





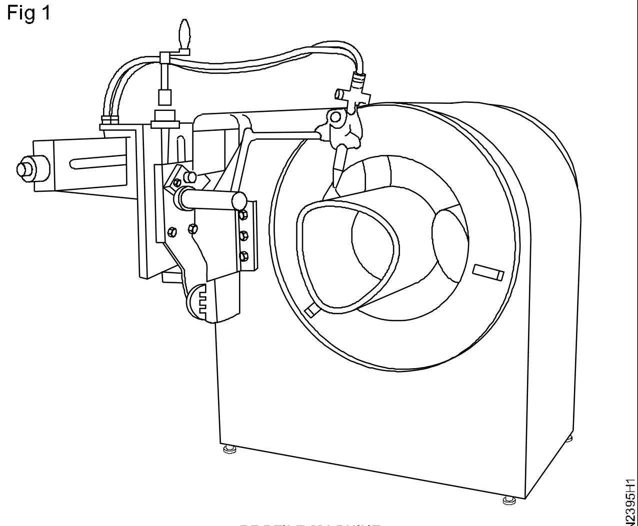
1	Ø50 x 3 - 180	- -	Fe 310	- -	A & B	GTAW-03
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.95

SCALE NTS	FILLET TEE JOINT ON M.S. PIPE Ø50mm OD x 3mm WT POSITION FLAT	TOLERANCE ±1	TIME 15h
		CODE NO. WLN2395E1	

Job Sequence

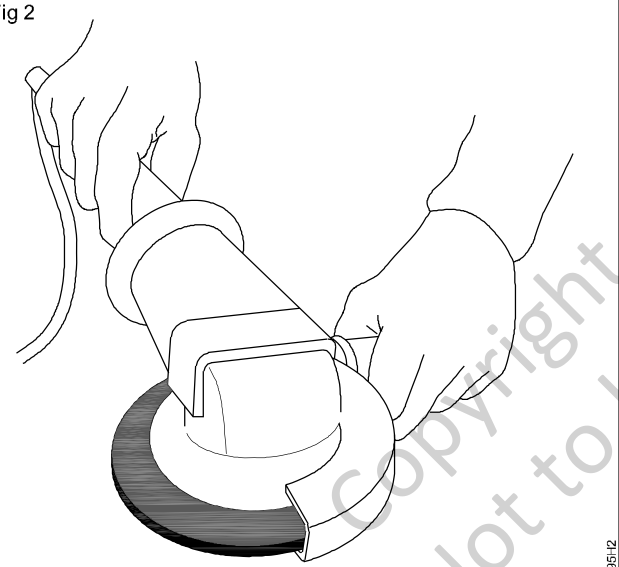
1 Cut the pipes to the given size.

Fig 1



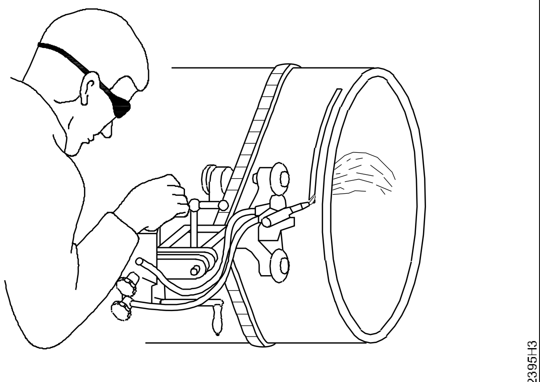
PROFILE MACHINE

Fig 2



HAND GRINDER

Fig 3



ROTATED PIPE-CUTTING HEAD

Cutting of branch components in mild steel

2 Branch pipes in mild steel may be cut on a special oxy-fuel gas profiling machine. Where such equipment is not available, the branch can be produced by marking the outline using a templete figure as shown in Fig 4 and scriber or pointed chalk followed by centre punching. The branch can then be produced by cutting to the marked outline, using manually operated oxy-fuel gas cutting equipment.

3 Branch holes may be cut by any of the following methods, depending on the equipment available:

a Oxy-fuel gas profiling machines, which cut the hole and produce the required angle for weld preparation.

b Cutting manually using the oxy-fuel gas process, the cut edge being dressed smooth by using a hand grinder or file. With this method, care must be taken to ensure that the cut sections are removed from inside the pipe.

4 Cut large diameter pipe by

a Power saw

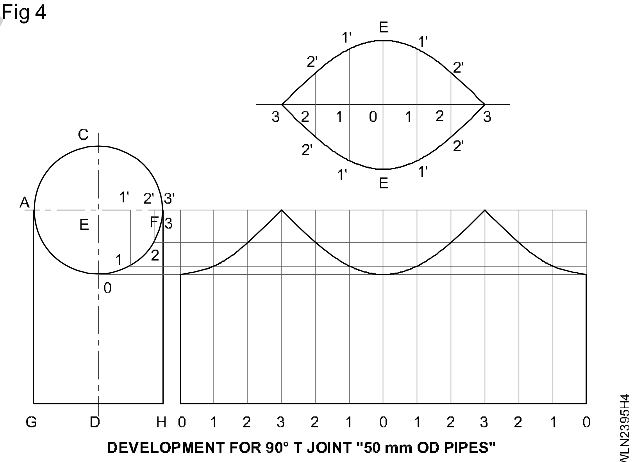
b Portable oxy-fuel gas cutting machine, either mechanically or electrically driven.

5 After cutting to length, remove any burrs on the inside of the pipe by reaming or filing.

6 Ensure the correct size of pipes.

7 Prepare development for 90^0 Tee. (Fig 4)

Fig 4



DEVELOPMENT FOR 90° T JOINT "50 mm OD PIPES"

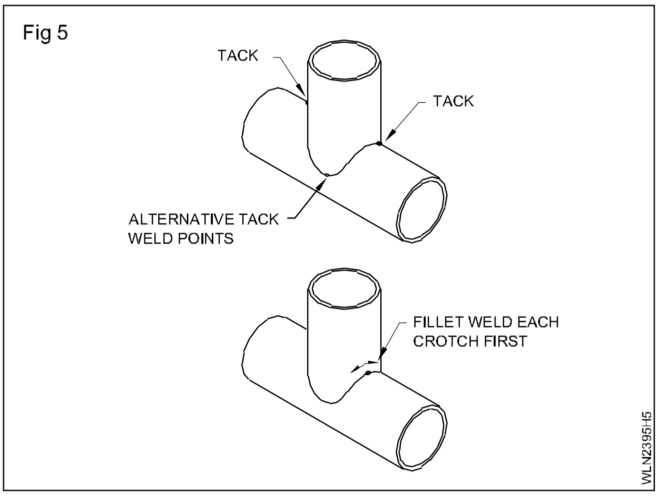
8 Mark the development on the pipe and cut accordingly.

9 Deburr the cutting edges and file the edges.

10 Clean the surface of the pipe if any oxide is found.

12 Set and align the branch pipe with the main pipe at an angle of 90^0. (Fig 5)

13 Tack-weld the joint with a 2mm root gap to control distortion and to obtain penetration.(Fig.5)

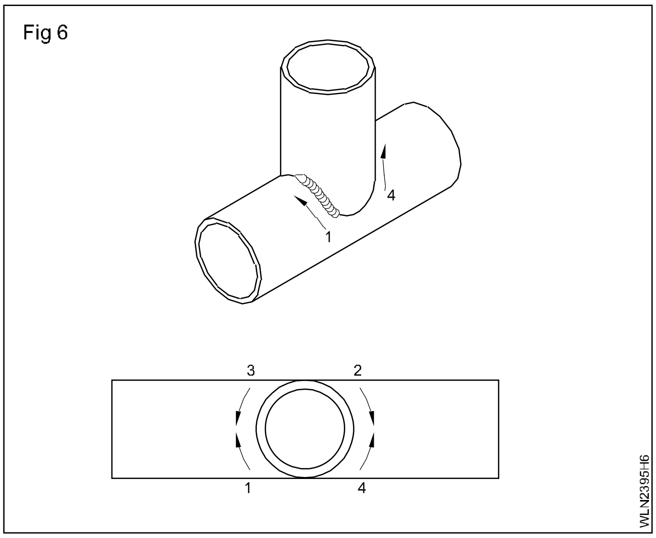


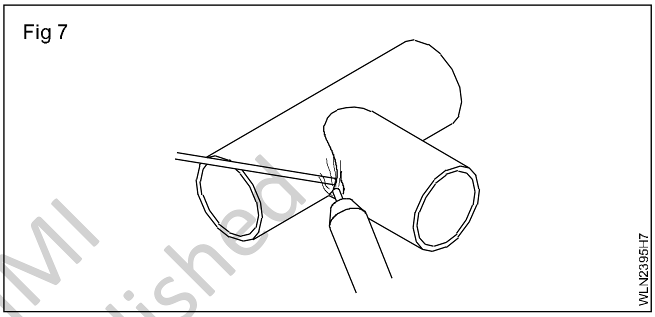
14 On T joints, angle joints and cluster joints, use a sequence welding technique. This prevents weld metal contraction from pulling the pipe out of line. Fig.6 illustrates one satisfactory sequence for a T-pipe assembly. Whenever possible, do all the welding in a downhand position. As in all pipe welding, the weld metal must be well fused into the base metal. There must be good penetration and no undercutting.

15 Manipulation of the torch and filler wire during welding the 'Tee' joint should be correctly followed.(Fig.7)

16 Weld and complete the joint-clean it.

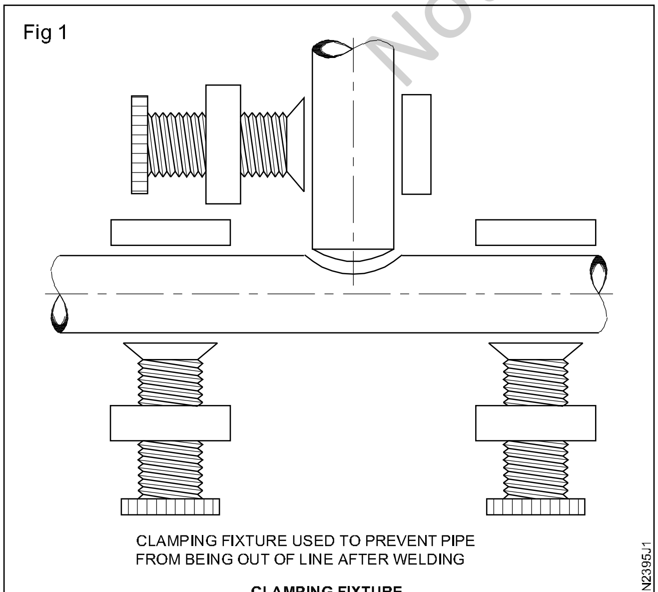
17 Inspect for surface defects.



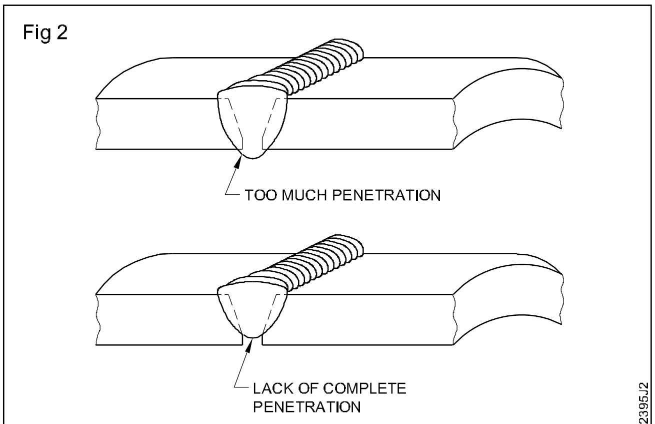


Skill Sequence

One difficulty encountered with all pipe and tube welding is the distortion or misalignment of the pipes/tubes after welding is completed. One, very frequently used method to prevent or reduce distortion is to clamp the pipes or tubes in a fixture while welding and allow it to cool before removing the clamps.



CLAMPING FIXTURE



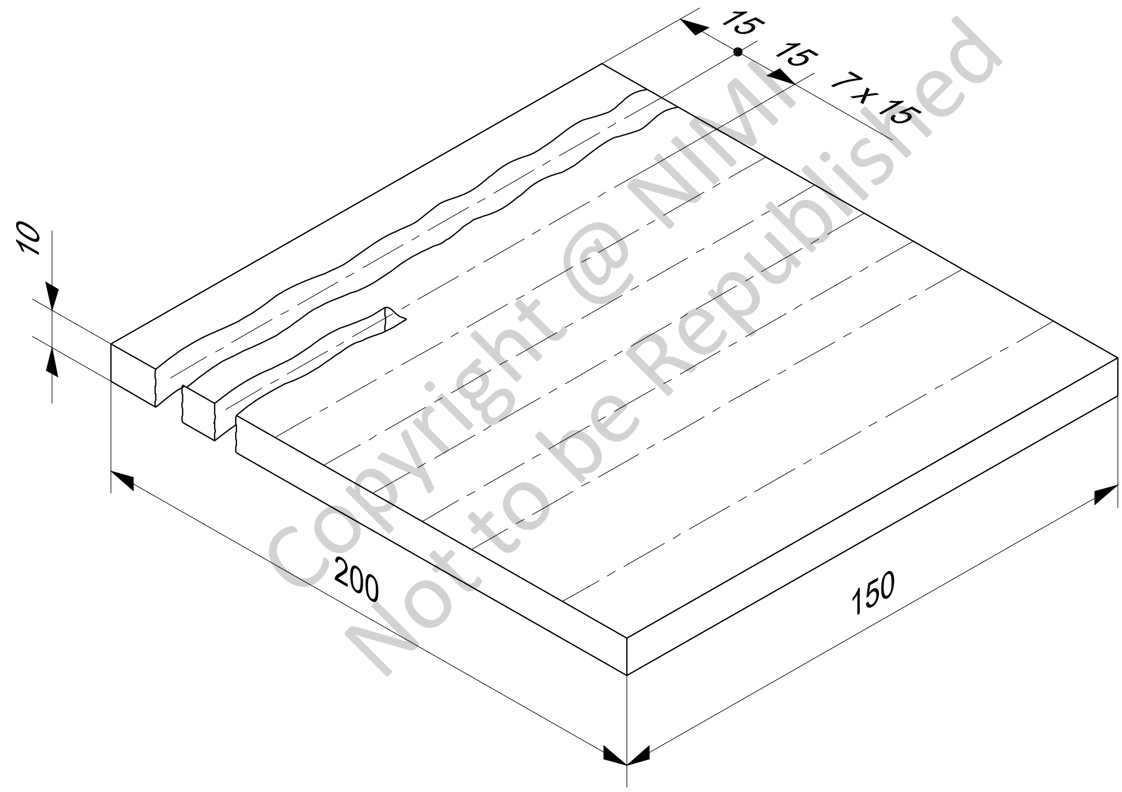
TUBE JOINT WELD SHOWING TWO COMMON PENETRATION DEFECTS

Tube welding is similar to thin sheet metal welding except the weld joint is a three dimensional curve, as in pipe welding. Also, since the root of the weld is not accessible and because the inner surface is in contact with flowing fluides, the penetration standards are high.Two common tube welding faults are too much penetration and lack of penetration. These faults must be repaired before the tubing can be used.

In pipe welding other than butt joint - it is very essential to get a development and prepare the template for the appropriate joints.

Plasma straight cutting on ferrous and non-ferrous metal

Objectives: At the end of this exercise you shall be able to
- **mark cutting lines on the plate (job) by keeping proper cutting allowance**
- **set the job for straight cutting**
- **clean the edges and inspect for defects.**



1	150 ISF 10 - 200		Fe 310 - W			PAC-04
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.96

SCALE NTS	PLASMA STRAIGHT CUTTING ON FERROUS AND NON-FERROUS METAL	TOLERANCE ±1	TIME 10 Hrs
		WLN2496E1	

Job Sequence

1 Begin cutting by placing the torch as close as possible to the edge of the base metal.

2 Pull the trigger to ignite the pilot arc.

3 Move the torch near the workpiece to ignite the cutting arc

4 Wait for the arc to penetrate through the bottom of the workpiece.

5 Start moving the torch slowly, perpendicular to the workpiece. Watch sparks leaving the bottom of the workpiece to judge your speed. If the sparks are not visible at the bottom of the plate, you have not penetrated the metal. This is because your travel speed is too fast or you have insufficient output amperage.

6 At the end of a cut, angle the torch slightly or pause briefly to competely finish the cut systems.

7 Provide a post-flow circuit, the post-flow air will continue for a short period of time after the trigger is releases to cool the torch and consumable parts. However, cutting can be resumed immediately.

8 To maximize cutting speeds, it is recommended to turn your power source to full output for all material thicknesses.

Proper safety procedures

Safety procedures must be closely followed in any application of a plasma cutter.

1 Be aware of potential hazards involved with the process, including high voltages, noise, temperatures, flammable materials, fumes, ultravioltradiation, and molten metal.

2 Proper welding clothing should be worn, as well as shaded eye protection, as specified by the manufacturer.

3 As with all industrial products, read the owner's manual for proper safety procedures.

Skill Sequence

1 Plasma cutters use either "high frequency start" or "contact start" technology to initiate the pilot arc. If you plan to use a plasma cutter near telephones, computers, CNC machines or other electronic equipment, be aware that high frequency (HF) often interferes with electronic controls.

2 To avoid potential HF problems, all machines feature contact start design that does not cause interference. Even better the contact start method creates a visible pilot arc that helps you better position the torch.

Pre-cut checklist

A few final words of advice before cutting:

3 Follow proper safety procedures and wear personal safety equipment - read the Owner's Manual!

4 Inspect the torch tip, electrode and shield cup and replace worn items. The expence is well worth avoiding the poor cutting performance (and operator frustration) caused by worn parts.

5 Check gas/air pressure at the compressor or bottle gauge.

6 Turn on the plasma machine.

7 Set the amperage control (generally to maximum) and check the air pressure.

8 Grind off rust or paint where you plan to secure the ground clamp. This step is critical with 12-amp machines; they just don't have the power to drive through rust and paint like larger units do.

9 Place the ground clamp as close to the cut as possible, and place the clamp on the work piece itself when possible. Check for any loose connections between the work cable and the clamp.

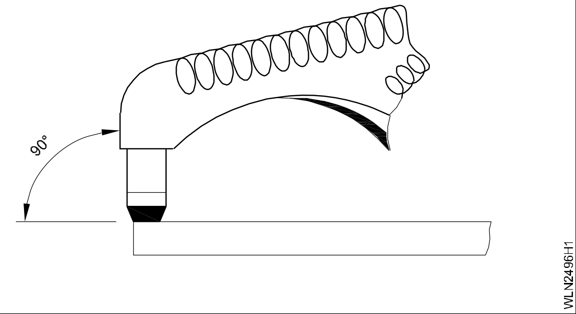
10 Relax-don't hold the torch too firmly or your hand will shake more

11 Begin cutting.

Cutting technique

Step 1: Place the drag shield on the edge of the base metal, or hold the correct standoff distance (typically 1/8 in.). Dircet the arc straight down. (Dragging the tip will reduce tip life).

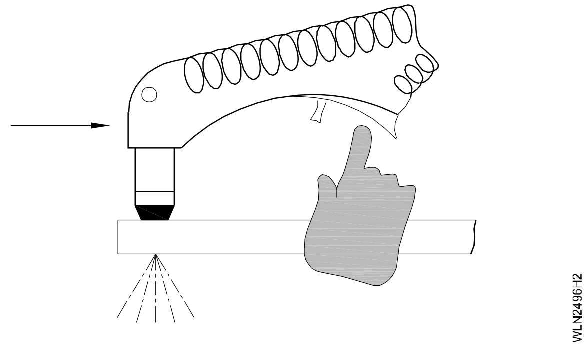
Fig 1



The arc starts immediately when trigger is pressed.

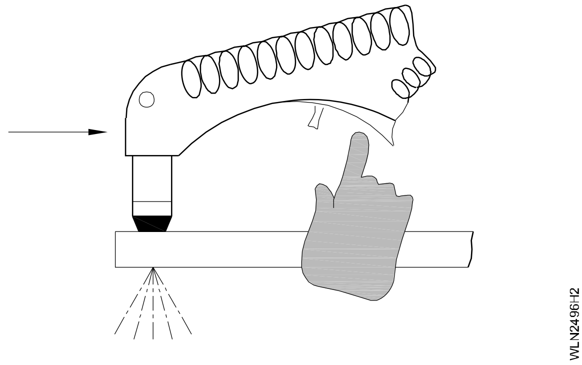
Step 2: Raise the trigger lock, press the trigger and the pilot arc starts immediately.

Fig 2



Step 3: Once the cutting arc starts, begin to slowly move the torch across the metal.

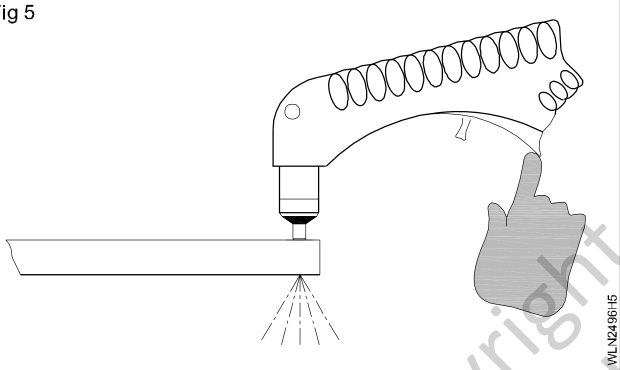
Fig 2



Step 4: Adjust your speed so sparks go through metal and out bottom of cut.

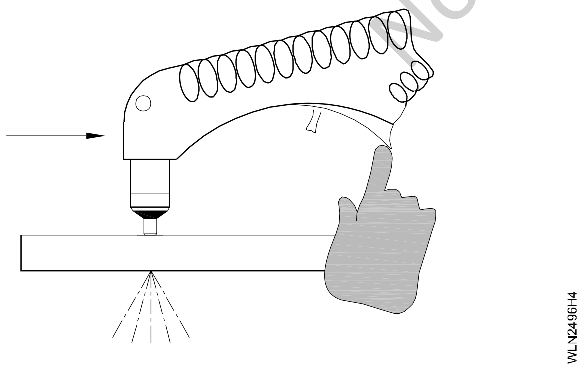
If the sparks are not visible at the bottom of the plate, the arc is not penetrating the metal. This can be caused by moving the torch too quickly, insufficient amperage or directing the plasma steam at an angle (not straight down). Insignificant grounding can also cause this problem.

Fig 5



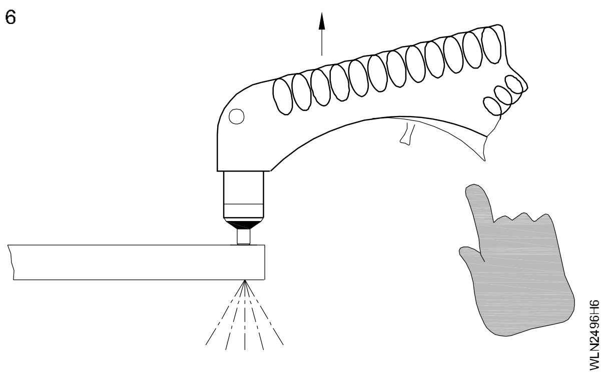
Step 5: At the end of a cut, angle the torch slightly towards the final edge or pause briefly before releasing trigger to completely sever the metal.

Fig 4



Step 6: To cool torch, post-flow air continues for 20-30 seconds after releasing the trigger; pressing the trigger during post-flow instantly restart the arc.

Fig 6



Travelling at the right speed produces a very clean cut with less dross on the bottom of the cut, as well as little or no distortion to the metal. If the travel speed is too slow, the material you are cutting may become hot and accumulate more dross. To minimize dross, increase travel speed or reduce amperage (for a rated cut). Dross also accumulates when you push a machine to its maximum thickness. The only cure for this is a bigger machine.

Gouging techniques

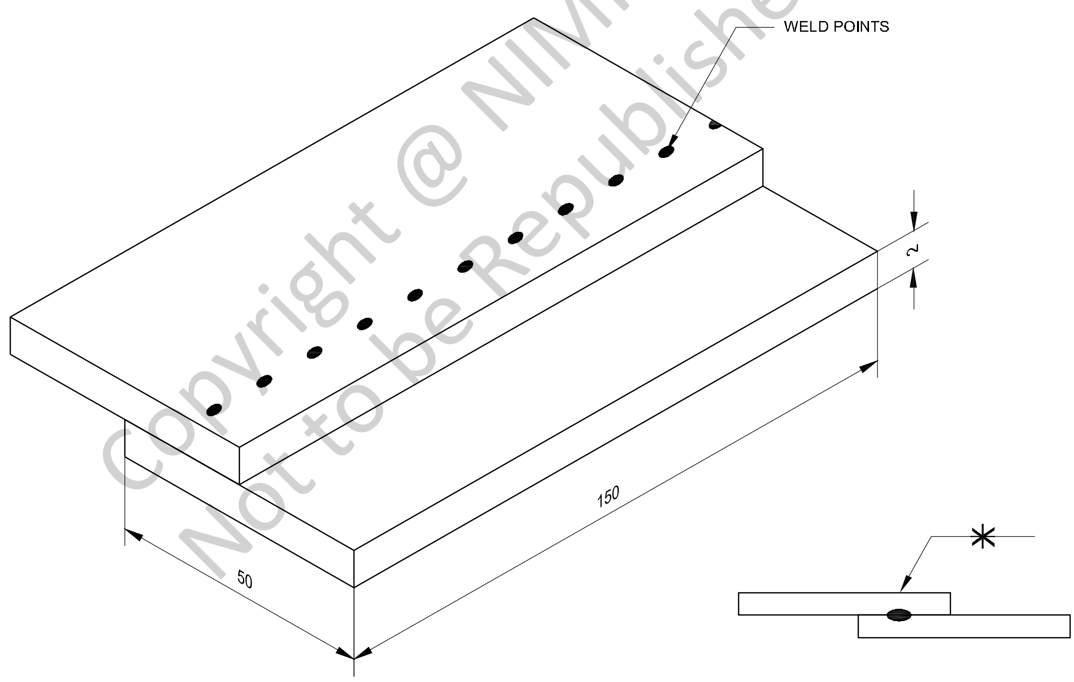
To gouge - to remove old welds or imperfetions - hold the torch at a 40 to 45º angle to the base metal. Establish an arc lengh of 1 to 1-1/2 in. and move the torch across the metal, adjusting torch speed, arc length and angle as needed. Dirct sparks away from the torch, and do not gouge too deeply on one pass. Make multiple passes if needed.

To pierce metal - creating a hole, such as to start coping or insert a valve - place the torch at a 40 to 45º angle to the work piece. Press the trigger. After the machine initiates the cutting arc, bring the torch tip to a 90º angle and the arc will pierce the base metal. Generally, a machine can pierce metal up to one-half of its maximum cutting thickness. Powerful machines pierce 1/4 in. steel within a second or two.

If you select the appropriate plasma cutter and service it properly, you can experience years of trouble-free performance. In fact, most "problems" with plasma cutting relate to oter systems(air, consumables), not the machine itself. Most importantly, almost every person who cuts with a plasma cutting gets hooked on the technolgy. They couldn't ba paid to go back other cutting methods.

Lap joint on stainless steel sheet by resistance spot welding

Objectives: At the end of this exercise you shall be able to
- **prepare sheets by shearing and grinding**
- **set plates as lap joint**
- **operate the spot welding machine**
- **complete the spot welding by applying pressure**
- **clean and inspect the weld job.**



2	150 x 50 x 2		X04 Cr19Ni9			RW-04
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.97

SCALE NTS	LAP JOINT ON STAINLESS STEEL SHEET BY RESISTANCE SPOT WELDING	TOLERANCE ±1	TIME 10 Hrs
		WLN2497E1	

Job Sequence

1 Cut the sheet by hand shearing as per drawing.

2 File the edges to square.

3 Remove the burrs and clean the surfaces by wire brush.

4 Set the pieces in the form of lap joint as per drawing.

Wear hand gloves.

5 Weld at two ends with spot welding machine.

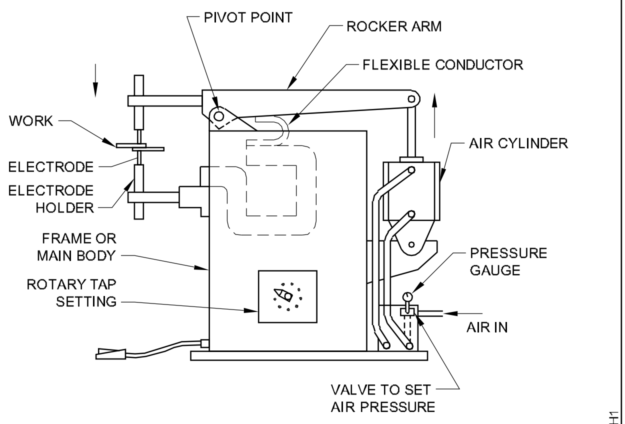
6 Complete the joint by spots.

Skill Sequence

1 Set the pieces in the form of lap joint.

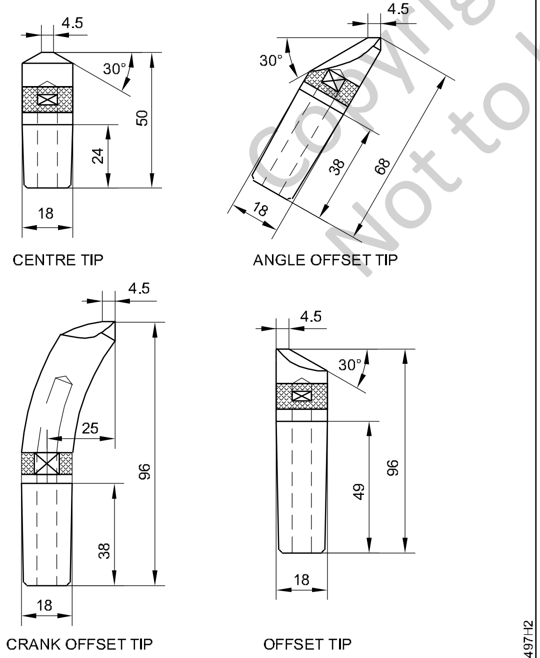
2 Select proper spot welding machine as Fig 1.

Fig 1



ROCKER ARM TYPE RESISTANCE WELDING MACHINE

Fig 2



FOUR STANDARD TYPES OF ELECTRODES

3 Select centre tip type copper electrodes

4 Set current flow time, contact period time.

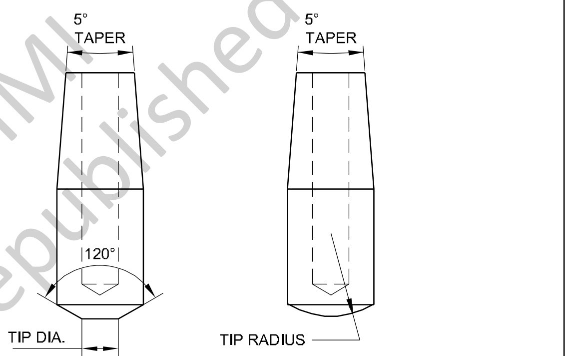
5 Check the water cooling system

6 Tack at both ends of job by applying the pressure with spot welding machine

7 Complete the welding(Wled nugget) carefully.

8 Clean and inspect the defects.

Fig 3



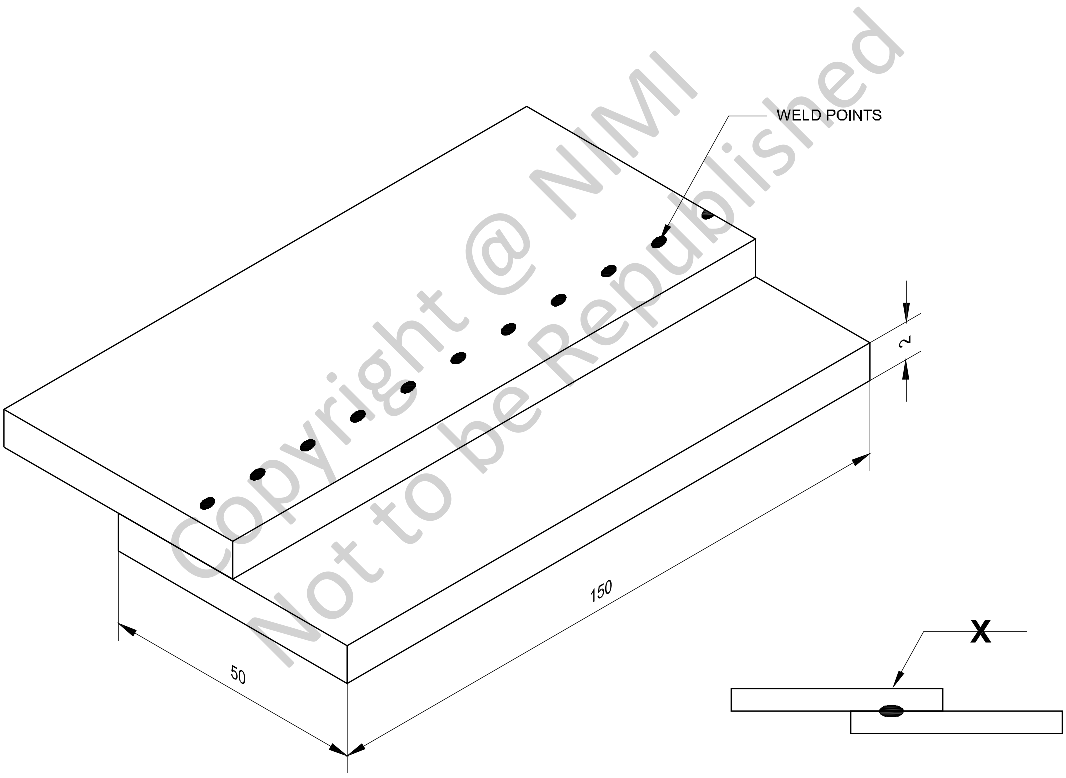
THE RADIUS OF THE DOMED TIP (RIGHT) VARIES FROM 25mm FOR WELDING 26 S.W.G. MATERIAL, UPTO 150mm FOR 3 S.W.G. THE DIAMETER OF FLAT PART OF THE OTHER ELECTRODE VARIES FROM 4mm TO 12mm FOR SIMILAR MATERIAL THICKNESS.

TWO STANDARD TYPES OF CENTER TIP ELECTRODE

Lap joint on M.S resistance spot welding

Objectives: At the end of this exercise you shall be able to

- **prepare sheets by shearing and grinding**
- **set plates as lap joint**
- **operate the spot welding machine**
- **complete the spot welding by applying pressure**
- **clean and inspect the weld job.**



2	150 x 50 x 2		Fe310-W			RW-04
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.98
SCALE NTS	LAP JOINT ON M.S. SHEET BY RESISTANCE SPOT WELDING				TOLERANCE ±1	TIME 15 Hrs
					WLN2498E1	

Job Sequence

1 Cut the sheet by hand shearing as per drawing

2 Grind the edges to square

3 Remove the burrs and clean the surfaces by wire brush.

4 Set the pieces in the form of lap joint as per drawing.

Wear hand gloves.

5 Weld at two ends with spot welding machine.

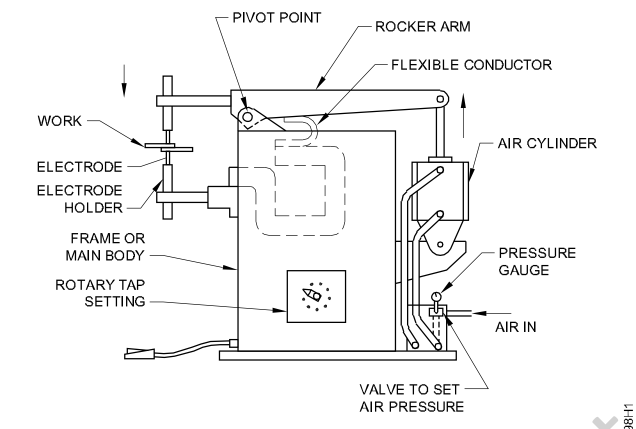
6 Complete the joint by spots.

Skill Sequence

1 Set the pieces in the form of lap joint.

2 Select proper spot welding machine as Fig 1.

Fig 1



ROCKER ARM TYPE RESISTANCE WELDING MACHINE

3 Select centre tip type copper electrodes.

4 Set current flow time, contact period time.

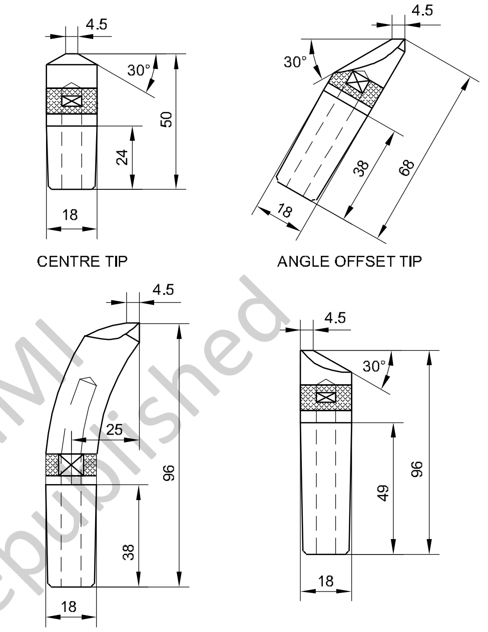
5 Check the water cooling system

6 Tack at both ends of job by applying the pressure with spot welding machine

7 Complete the welding(Wled nugget) carefully as per fig 2 b.

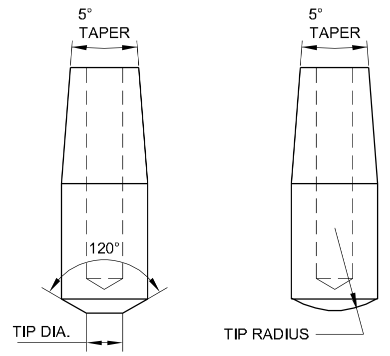
8 Clean and inspect the defects.

Fig 2



FOUR STANDARD TYPES OF ELECTRODES

Fig 3

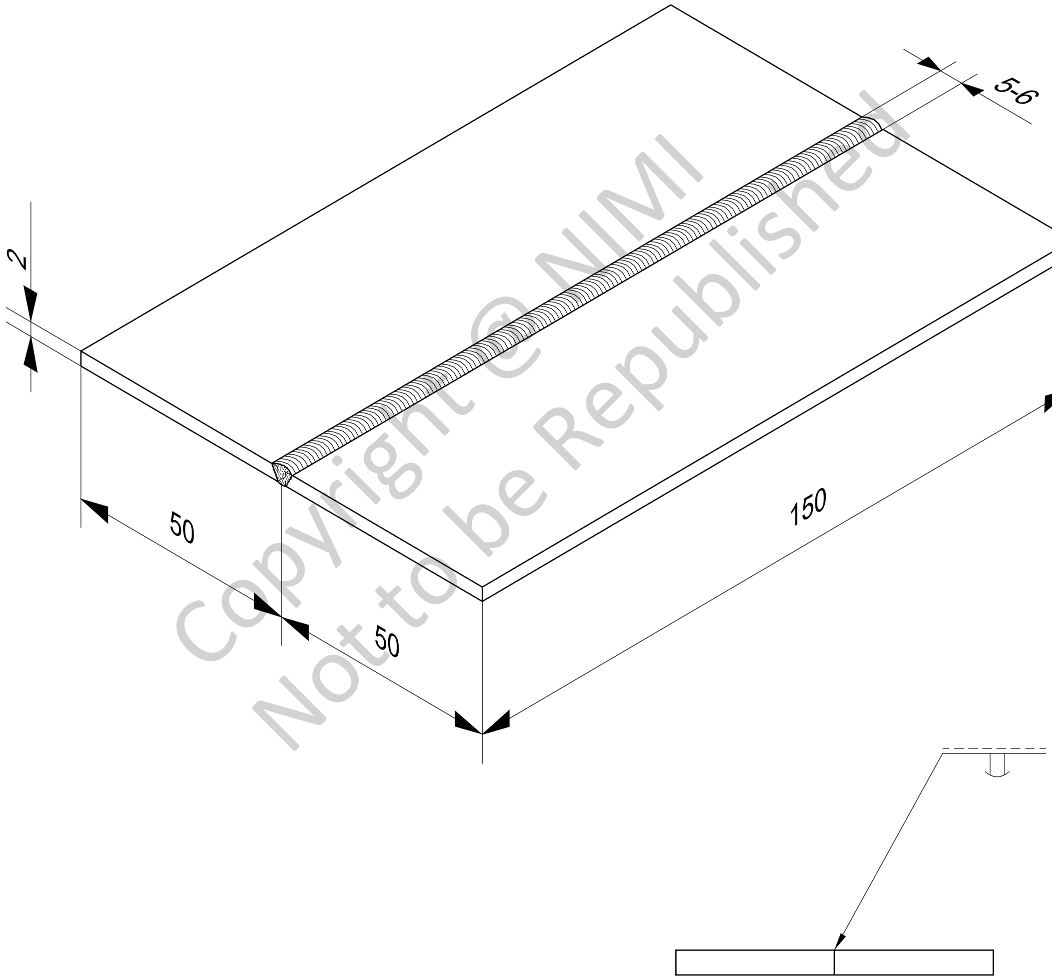


THE RADIUS OF THE DOMED TIP (RIGHT) VARIES FROM 25mm FOR WELDING 26 S.W.G. MATERIAL, UPTO 150mm FOR 3 S.W.G. THE DIAMETER OF FLAT PART OF THE OTHER ELECTRODE VARIES FROM 4mm TO 12mm FOR SIMILAR MATERIAL THICKNESS.

TWO STANDARD TYPES OF CENTER TIP ELECTRODE

Square butt joint on copper sheet 2mm thick in flat position (1 G)

Objectives: At the end of this exercise you shall be able to
- **select correct nozzle size and filler rod (composition and size), gas pressures and flux**
- **apply flux on the joint and filler rod**
- **preheat and post heat the job**
- **manipulate the blowpipe and filler rod in an appropriate way during welding**
- **clean the joint and remove any flux residue**
- **check the weldment for surface defects and bead size, profile.**



2	150 CU 50 x 2		CuDPA-IS: 2378			OAW-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.99

SCALE NTS	**FUSION WELDING OF COPPER - BUTT JOINT COPPER SHEET 150 x 150 x 20mm IN FLAT POSITION**	TOLERANCE ±1	TIME 10 Hrs
		WLN2599E1	

Job Sequence

1 Remove the oxides from the surfaces of the deoxidised copper sheet.

2 Clean the joint from other impurities using solvent/ pickling.

3 If pickling/solvent is used for cleaning, then thorougly wash and dry the joint before tack welding.

4 Prepare square edges of the pieces by filing.

Do not use grinding to prepare the edges of non-ferrous metals.

5 Select the nozzle No.10 and 0.15kg/cm^2 pressure for both the gases.

6 Select a 3.15 mm copper silver alloy filler rod.

7 Select copper/silver alloy flux.

8 Follow necessary safety precautions.

9 Set the job with a proper root gap or with diverging allowance.

Do not tack weld.

10 Apply the flux in the form of paste on both sides of the plate and on the filler rod.

11 Preheat the base metal.

12 Deposit the weld metal in the groove in one run.

13 Post-heat the weldment and cool the joint slowly.

14 Clean the flux residue on the weldment and the penetrated portion.

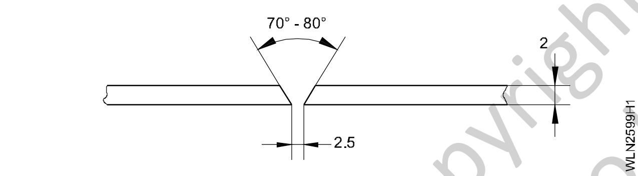
15 Inspect the weld for defects.

Skill Sequence

Clean the surface of the workpiece by using emery sheet or a wire brush to remove the oxides thoroughly and other impurities.

File the edges to the required form. (Fig 1)

Fig 1



Select nozzle No.5-7.

A nozzle one size larger should be used as compared with the M.S. sheet welding because of high conductivity and quick dissipation of heat.

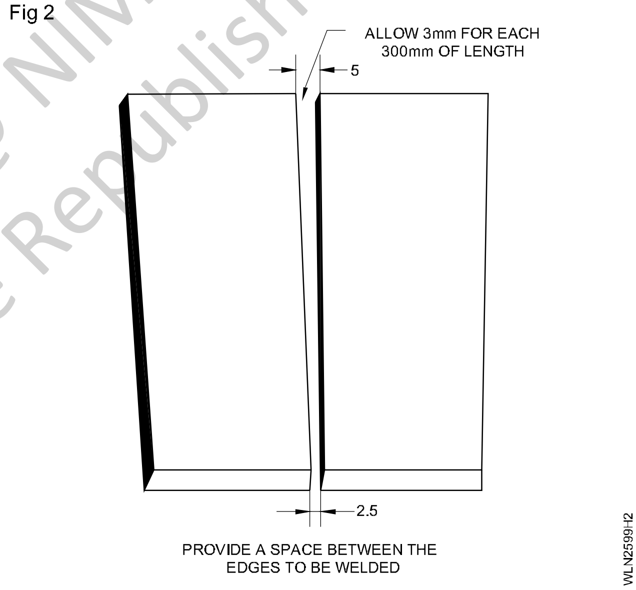
Select a 2.00 mm ø copper-silver alloy filler rod.

Select copper-silver alloy flux.

Set the job with a proper root gap or with a diverging allowance. (Fig.2) Do not tack weld.

Copper has a high coefficient of expansion and it is necessary to set the plates diverging at the rate of 3-4 mm per 300 mm. run, because they come together and the root gap gets closed so much on being welded.

Fig 2



Set a strictly neutral flame.

Preheat the base metal up to 'peacock neck' colour (350^{0}C) and commence welding.

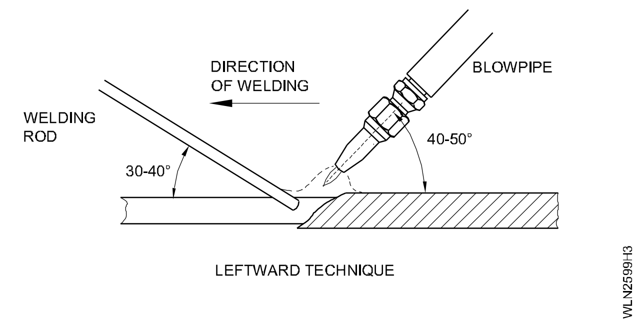
Apply the flux as paste on the filler rod and at the joints.

Deposit the metal in the groove in one run with sufficient reinforcement on the joint using the leftward technique.

The blow pipe angle should be 60^0 - 80^0 and the filler rod angle 25^0 - 30^0 to the line of weld. Fig.3.

Always keep the molten pool and the tip of the filler rod under the shadow of the outer envelope.

Fig 3



Maintain the temperature of the job throughout the welding operation.

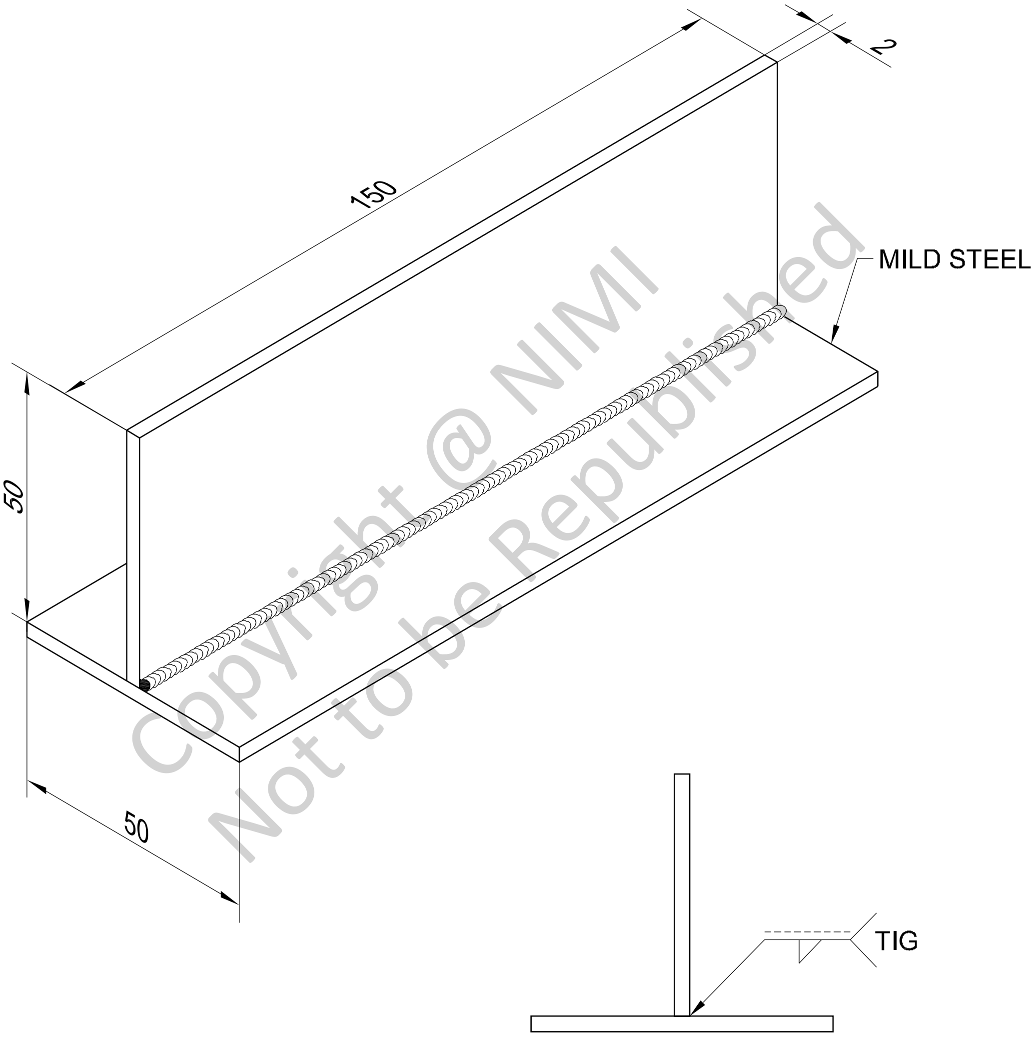
It is always better to keep a helper to continuously heat the job using another blow pipe as you are welding a copper joint. Otherwise the joint will begin to crack from the starting point as you proceed to weld further.

Post-heat the job to 300^0C and allow to cool slowly. Clean the bead and remove the flux residue on both sides of the joint.

Inspect the joint for external defects and bead size and profile.

'T' joint on copper to M.S sheet 2mm thick in flat position by brazing 1F

Objectives: At the end of this exercise you shall be able to
- **set and tack the plates to form Tee fillet joint and mainpulate the blow pipe and filler rod properly**
- **braze a Tee joint using recommended filler rod, flame and nozzle size**
- **clean and inspect the brazed joint for defects.**



2	150 x 50 x 2	- -	CNDPA-IS:2372	- -	- -	OAW-05
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.100

SCALE NTS	'T' JOINT ON COPPER TO M.S. SHEET 2mm THICK IN FLAT POSITION BY BRAZING (1F)	TOLERANCE ±1	TIME 10h
		CODE NO. WLN25100E1	

Job Sequence

1 Prepare the sheets (M.S. and copper) by using shearing filing.

2 Prepare the egdes to right angles by filing

3 Clean the base metal by steel wire brush.

4 Set the sheets as Tee joint on welding table

5 Wear all protective clothings.

6 Open the Cylinder values (Both O_2 and C_2H_2) slowly and set the working pressure.

7 Select nozzle one or two size bigger size than the sheet thickness.

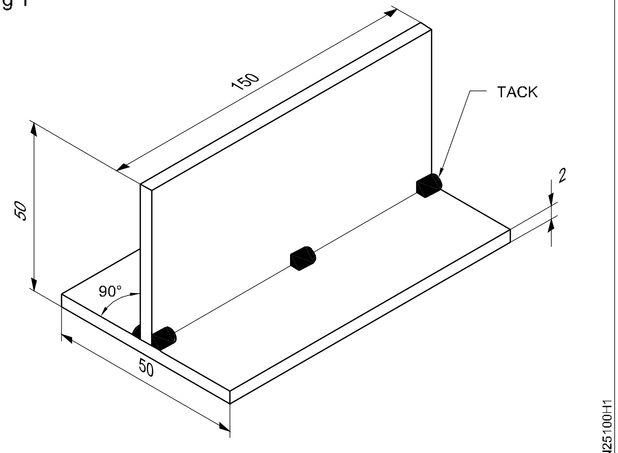
8 Select 1.6mm ø brass filler rod with suitable flux (Borax).

9 Ignite the flame by spark lighter.

10 Set slightly oxidising flame.

11 Tack the job as per the fig shown below.

Fig 1



ASSEMBLING A TEE JOINT

12 Set the job on welding table.

13 Deposit filler metal to complete the joint.

Skill Sequence

1 While tacking sheets the angle between them to be kept at 90º.

2 Clean the base metal surface along the root.

3 Set oxidising flame to avoid zinc evaporation.

4 Pre heat the copper sheet and then start to braze.

5 Concentrate the flame to wards copper sheet to reduce heat loss during brazing.

6 Apply the filler rod at perticular temperature to the joint.

7 Complete the joint with out defect.

8 Cool the job slowly.

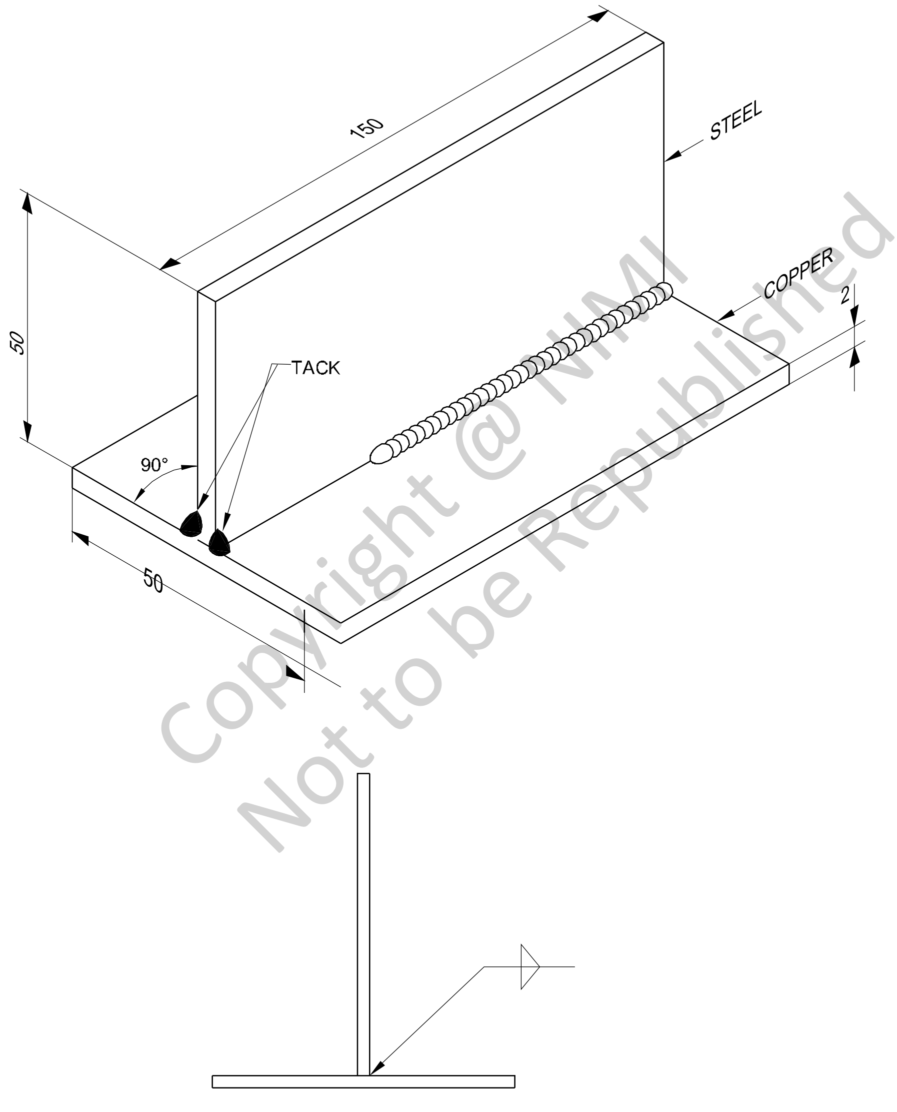
9 Clean the job by hot water to remove burnt flux (Slag).

10 Brush the job by wire brush

11 Observe the defects carefully.

Silver brazing on S.S. sheet with copper sheet 'T' joint

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack joint the plates in alignment as 'T' joint as per drawing**
- **set the 'T' joint in flat position for brazing**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the bead appearance.**



2	ISST 50 x 2 - 150		SS-CU.			OAW-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.101

SCALE NTS	TEE JOINT ON S.S SHEET WITH COPPER SHEET IN FLAT POSITION BY BRAZING	TOLERANCE ±0.5	TIME 10 Hrs
		WLN25101E1	

Job Sequence

1 Prepare the sheets (S.S. and copper) by using shearing, grinding & filing.

2 Clean the base metal by steel wire brush.

3 Set the sheets as 'T' joint on welding table

4 Wear all protective clothings.

5 Open the Cylinder values (Both O_2 and C_2H_2) slowly and let the working pressure.

6 Select nozzle one or two size bigger size than the sheet thickness.

7 Select 1.6mm ø filler rod with 40 to 50% silver and 25-15% zinc remaining copper.

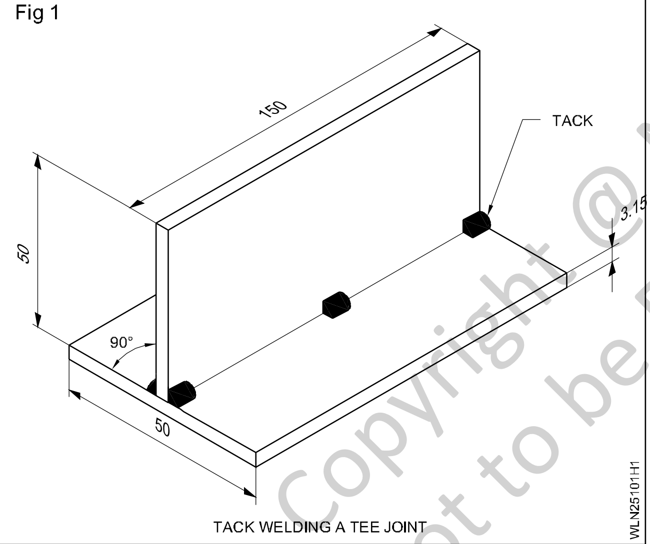
8 Ignite the flame by spark lighter.

9 Set slightly oxidising flame.

10 Tack the job as per the fig shown below. (Fig 1)

11 Complete the joint.

Fig 1



TACK WELDING A TEE JOINT

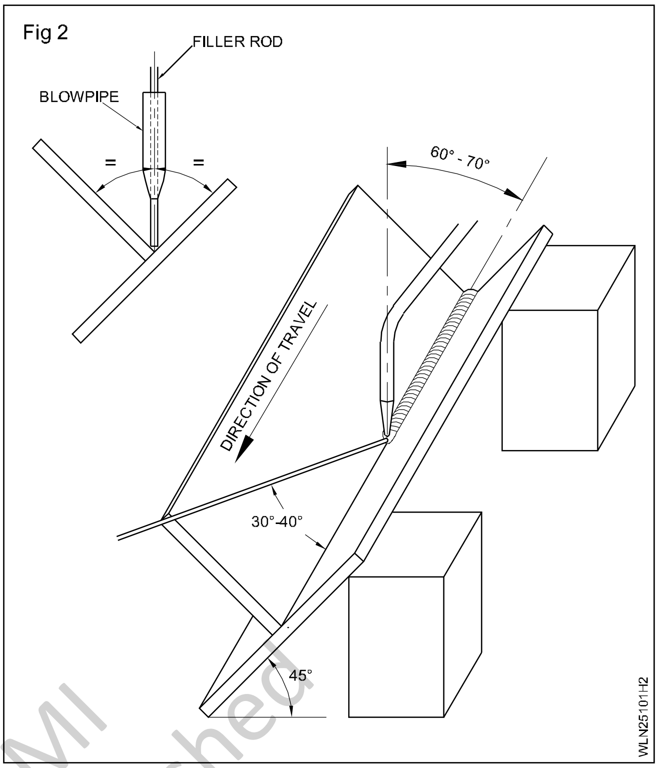
Silver Brazing of (Fig 2)

Place the tacked joint in flat position by tilting and supporting it.(Fig 2)

Start Brazing at the right hand end of the joint by fusing the tack-weld. Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 45^0 between the 2 surfaces of the joint. This will ensure root penetration. Watch the molten metal closely to make sure that both pieces are joined by brazing. When the molten pool is formed add the filler rod in the centre of molten pool. Give slight side-to-side movement to the flame (blowpipe) and a piston like motion to the filler rod.

Adjust the rate of travel of the blowpipe and the filler rod to secure even penetration at the root and into both sheets, and to produce a fillet weld of equal leg length.

Fig 2



Visual inspection (Fig 3)

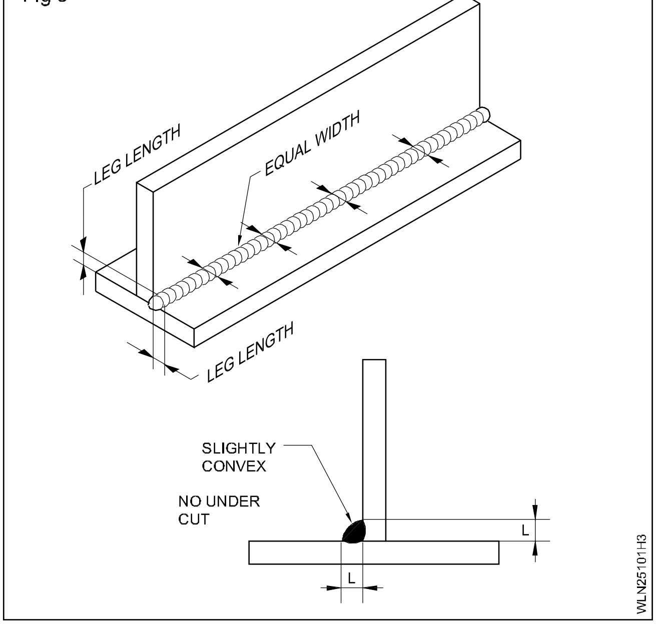
Clean the weldment and inspect for:

– uniform weld size and shape of bead (reinforcement and contour slightly concex)

– equal leg length.

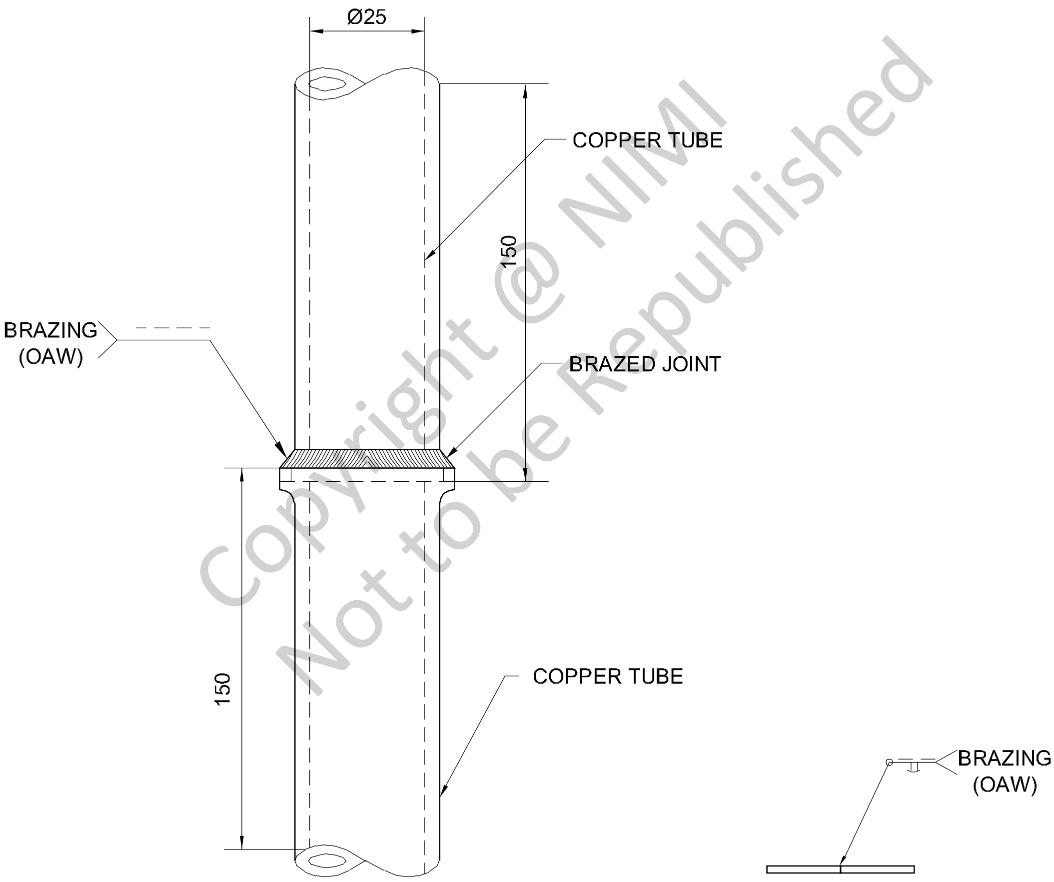
– no porosity, overlap.

Fig 3



Welder - Repair and maintenance Exercise 2.5.102

Objectives: At the end of this exercise you shall be able to
- **prepare a bell mouth by heating the tip of the pipe and by using a mandrel**
- **remove the surface oxide and other impurities with wire wool**
- **select nozzle, filler rod, flux and flame for brazing**
- **tack the bell mouth joint and position it for welding**
- **braze the joint using pipe welding technique**
- **clean the joint and inspect for surface defects.**



2	Ø25 x 2 - 150		CuDPA - IS: 2378			OAW-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.102

SCALE NTS	SILVER BRAZING ON COPPER TUBE TO TUBE	TOLERANCE ±1	TIME 15 Hrs
		WLN25102E1	

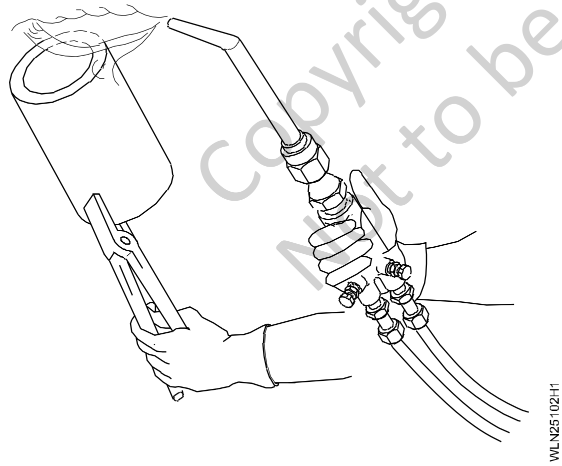
Job Sequence

1 Prepare a copper tube as per dimension.
2 Expand the copper pipe to form as a bell mouth.
3 Clean and remove the surface oxides by wire wool.
4 Select the nozzle No.5 and 1.6mmø phosphorus bronze or 2% Ag to 35% Ag filler rod.
5 Apply flux to the filler rod.
6 Set the oxidising flame.
7 Insert the copper tube into the bell mouth of copper tube and tack at 3 places.
8 Keep the tack welded pipes with their axes vertical.
9 Start Brazing at the mid point of two tack welds and end the first fun after brazing half the circumference of the pipe.
10 Braze the other half of the circumference of the pipe as second run.
11 Manipulate the blowpipe and filler rod with flux applied on it using proper angles to fill the bell mouthed groove.
12 Clean and remove the flux residue.
13 Inspect for external weld defects.

Brazing of copper to copper tube

Soften the end of copper tube to be bell-mouthed by heating. (Fig 1)

Fig 1



Dip the heated end in water and remove the oxides.(Fig.2)

Use a mandrel to form the bell mouth.(Fig.3)

Insert the mandrel and drive into the softened end of the tube by hammering.(Fig.3)

Remove any unevenness of the bell mouth.(Fig.4)

Insert the other tube into the bell mouth and tack it at 3 points.(Fig.5)

Fig 2

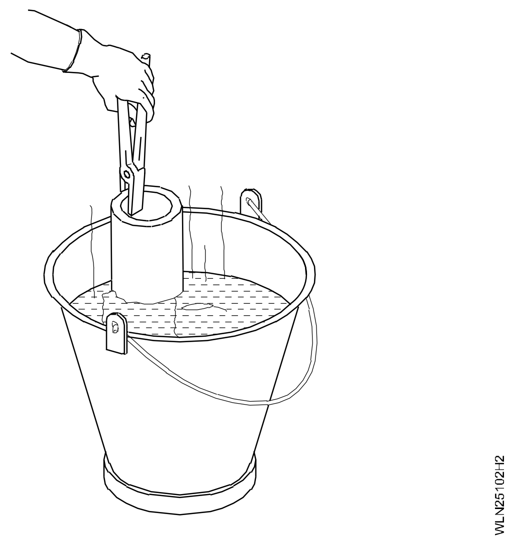


Fig 3

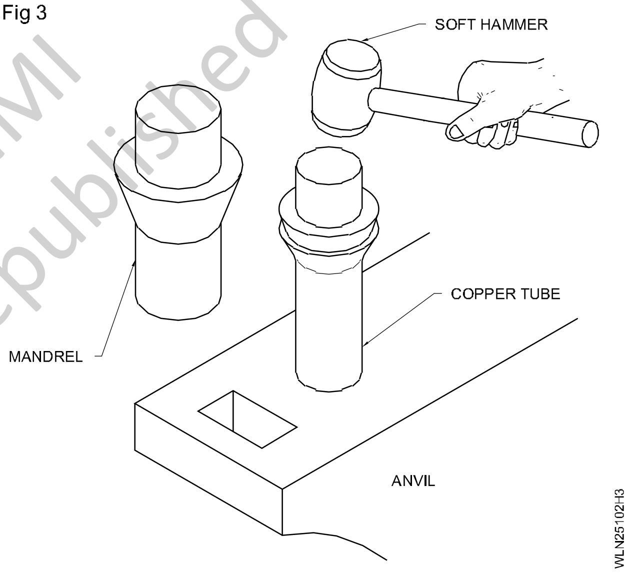
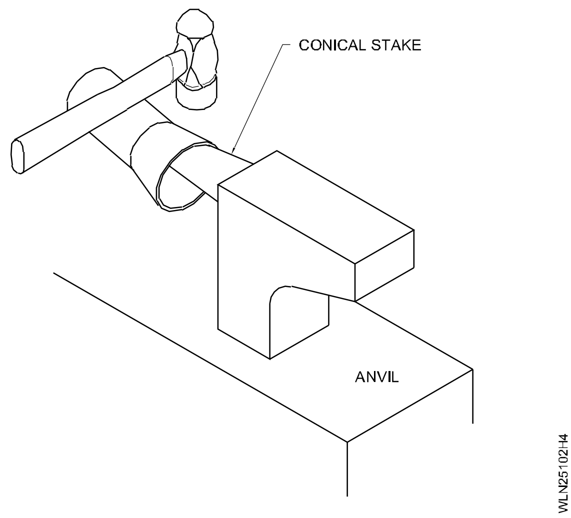
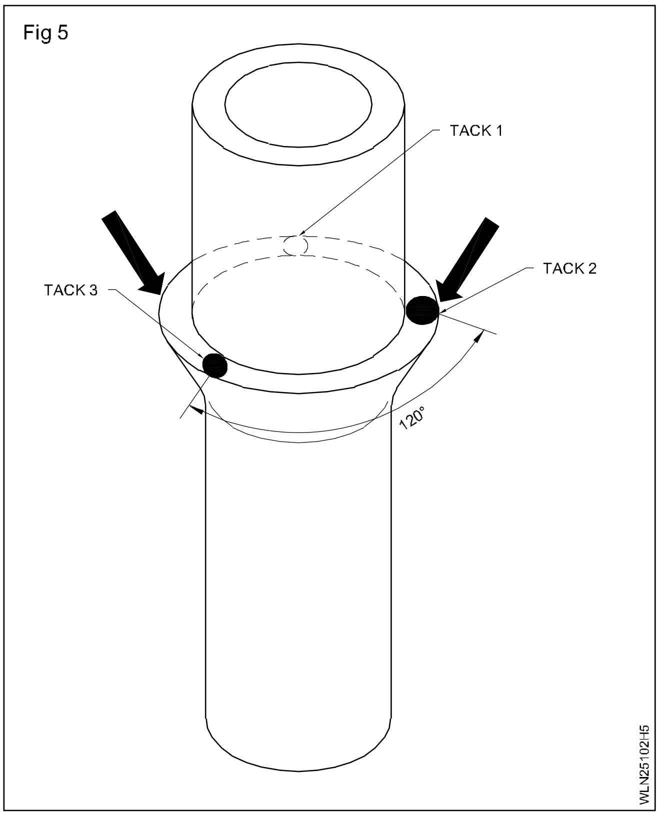


Fig 4





Keep the tack welded pipe assembly vertically and heat it until the colour of the tube starts changing.

Make a thin run on the line formed by the outer circumference at the bottom end of the tube and the inner circumference at the bottom of the bell mouth of copper tube (i.e tip of the bell mouth).

Make the first deposit starting from the tack weld 1 and ending at the midpoint of the tack welds 2 and 3 covering half the circumference of the bell mouth. (Fig.6)

Clean the deposit.

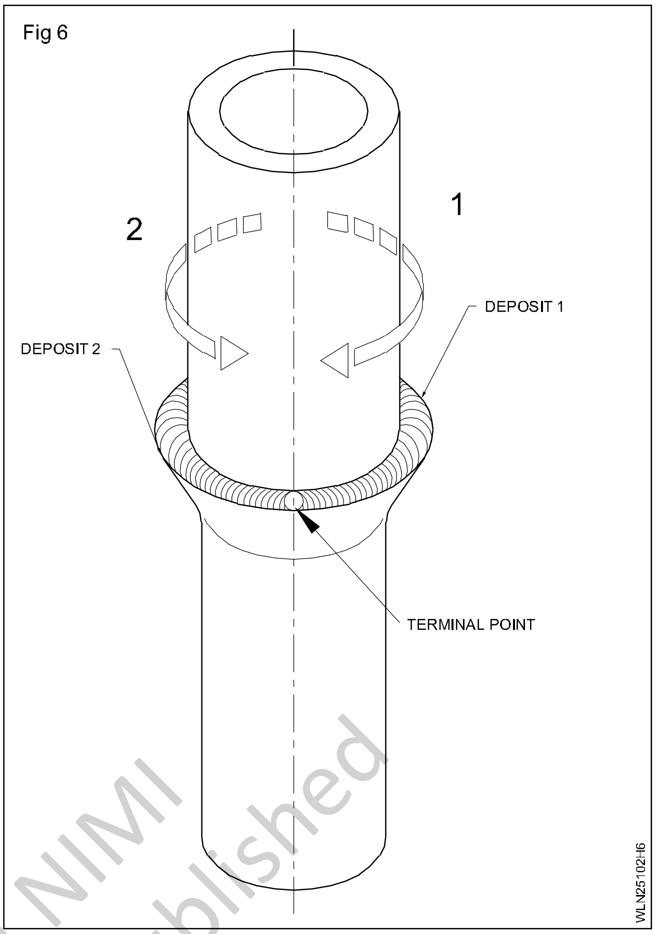
Make the second deposit starting from the commencement point of deposit 1 and ending at the finishing point of the deposit 1 which will cover the remaining half circumference of the bell mouth.

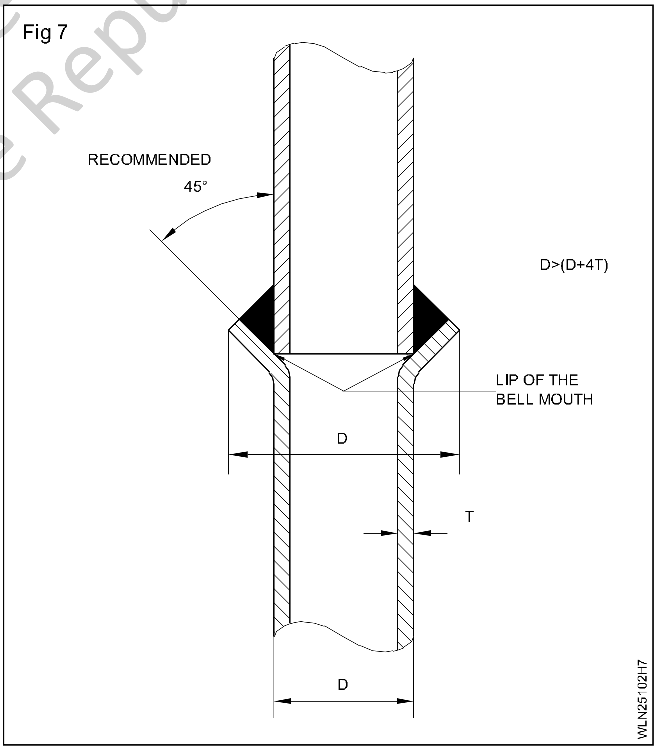
Ensure the deposit 2 merges with the deposit 1 at both ends (i.e. terminal points) properly by withdrawing the filler rod and manipulating the flame over these merging points.(Fig.6)

Ensure that the weld deposit is of the correct profile and it completely covers and bonds (without over spilling the outer edge of the bell contour. (Fig.7)

Clean the bead and the joint and remove the flux residue thoroughly.

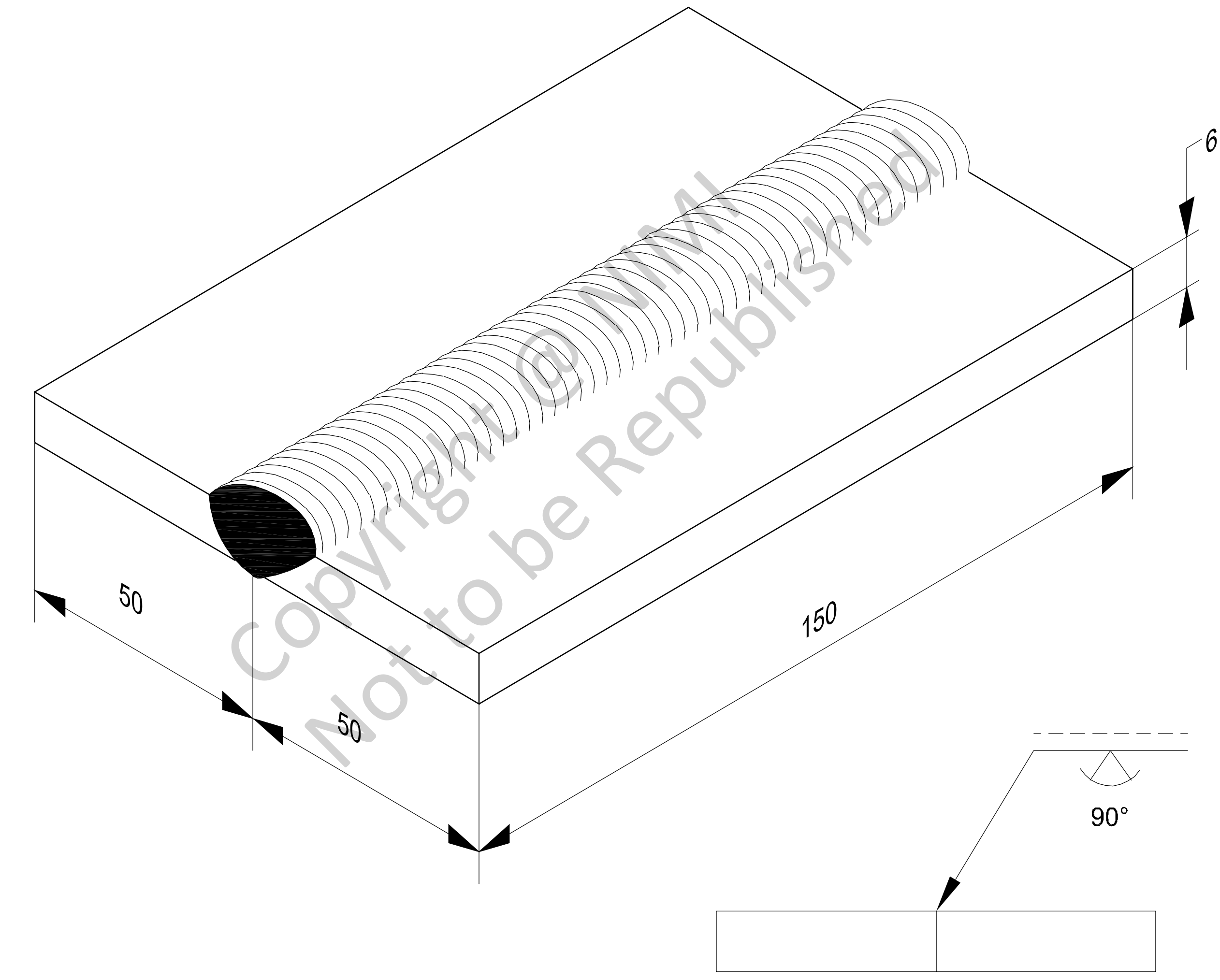
Inspect the braze deposit for uniform size and braze defects like porosity, etc.





Bronze welding of cast iron. Single "V" butt joint on cast iron plate 6mm thick

Objectives: At the end of this exercise you shall be able to
- **clean the job pieces from oil grease, etc and remove oxides from the surface of the parent metal**
- **select the correct nozzle size and filler rod (composition and size)**
- **set a slightly oxidised flame**
- **select and identify the correct type of flux and method of application of flux**
- **manipulate the blowpipe and filler rod in appropriate procedure during welding**
- **clean and check for defects on the weldment.**



2	150 x 50 x 6		FG15			GAW-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.103

SCALE NTS	BRONZE WELDING OF CAST IRON. SINGLE 'V' BUTT JOINTON 6 mm THICK CAST IRON PLATE IN FLAT POSITION.	TOLERANCE ±1	TIME 10 Hrs
		WLN25103E1	

Job Sequence

- Clean the surface of the workpiece from oil, grease, dirt and remove oxides if any by filing/grinding.
- Grind the edges of the plate to (no feather edge) form a single Vee of included angle of 90^0. Round off all sharp edges.
- Select nozzle No.10.
- Select a silicon bronze filler rod of 3mmø for the root run and 5mmø for the 2nd run.
- Select bronze flux and 0.15 kgf/cm^2 pressure for both gases.
- Ensure all safety precautions before lighting the torch.
- Set a soft oxidising flame.
- Apply flux in powder form by dipping hot filler rod. Then tack weld on both ends of the joint with a uniform root gap of 2.5mm.
- Weld the root run using leftward technique and 3mmø filler rod keeping the job at 30^0 slope.
- Ensure wetting of weld faces by the filler metal before building up the bead.
- Heat the weld faces only to dull red colour by giving circular motion to the blow pipe.

It is not necessary to melt the base metal for bronze welding of cast iron.

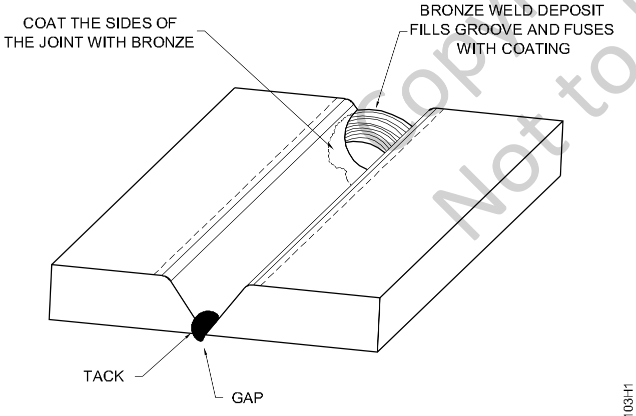
- Clean the root run and deposit the 2nd run using 5mm filler rod after applying flux.
- Fill the joint by filler metal to get a maximum of 1.5mm reinforcement, good ripple formation.
- Clean the joint removing any flux residue and inspect for defects.
- Heat control is important. If the heat is insufficient the bronze metal will not wet the surface or flow properly.
- Excess heat will cause the bronze metal to flow more freely and not allow it to build up.

Skill Sequence

Set the job with 30^0 inclination. Keep the angle of the filler rod at 30^0 to 40^0 and give a rubbing action to the filler rod on the vee.

Maintain the angle of the blowpipe at 60^0 to 70^0 and give a circular motion to the blowpipe. (Fig 2)

Fig 1

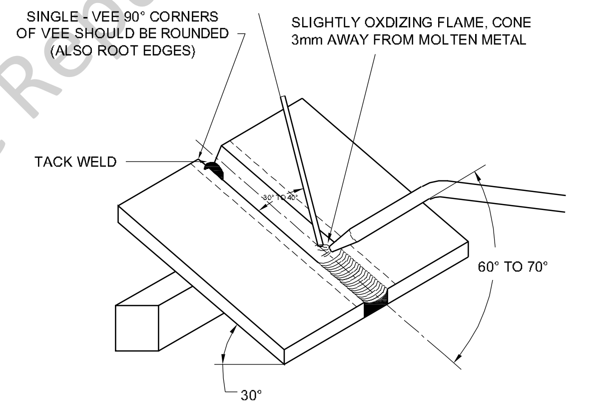


BRONZE WELDING CAST IRON MAKING THE COATING AND DEPOSIT

Deposit a root run with a 3mmø filler rod and the finishing run with a 5mmø filler rod. Dip the hot filler rod end into the powdered bronze flux frequently.

In bronze welding of cast iron the base is only heated to 650^0C and it is not melted. So while depositing the root run the surfaces of the joint is coated with a layer of filler metal for about 20mm along the joint, ensuring that it is correctly bonded. Fig 1.

Fig 2



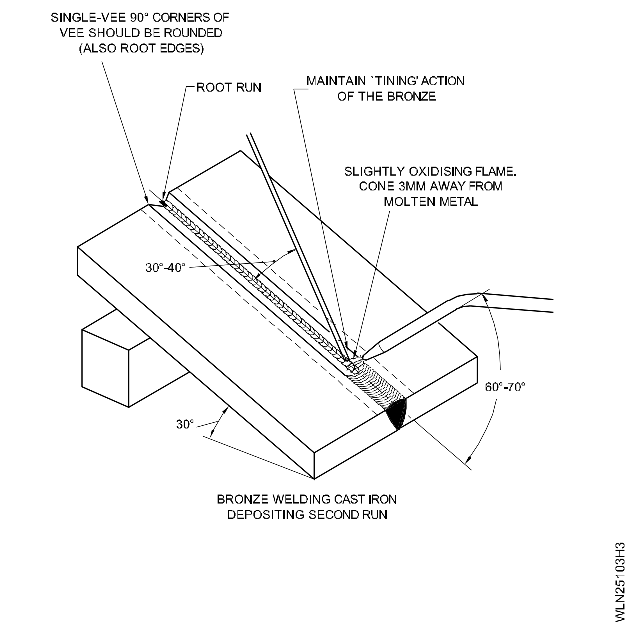
ANGLES OF ROD AND BLOWPIPE FOR BRONZE WELDING

BRONZE WELDING CAST IRON (ROOT RUN)

Then return to the starting point and add sufficient filler metal to produce a satisfactory weld. This method is repeated continuously until the root run is completed. Fig 2 Ensure root penetration by the filler metal and fusion between consecutive bronze filler metal deposits.

Weld similarly the 2^{nd} run by using 5mmø filler rod dipped in flux with a soft oxidising flame and get 1.5mm reinforcement and good bead up to the end of the joint. Fig.3.

Fig 3

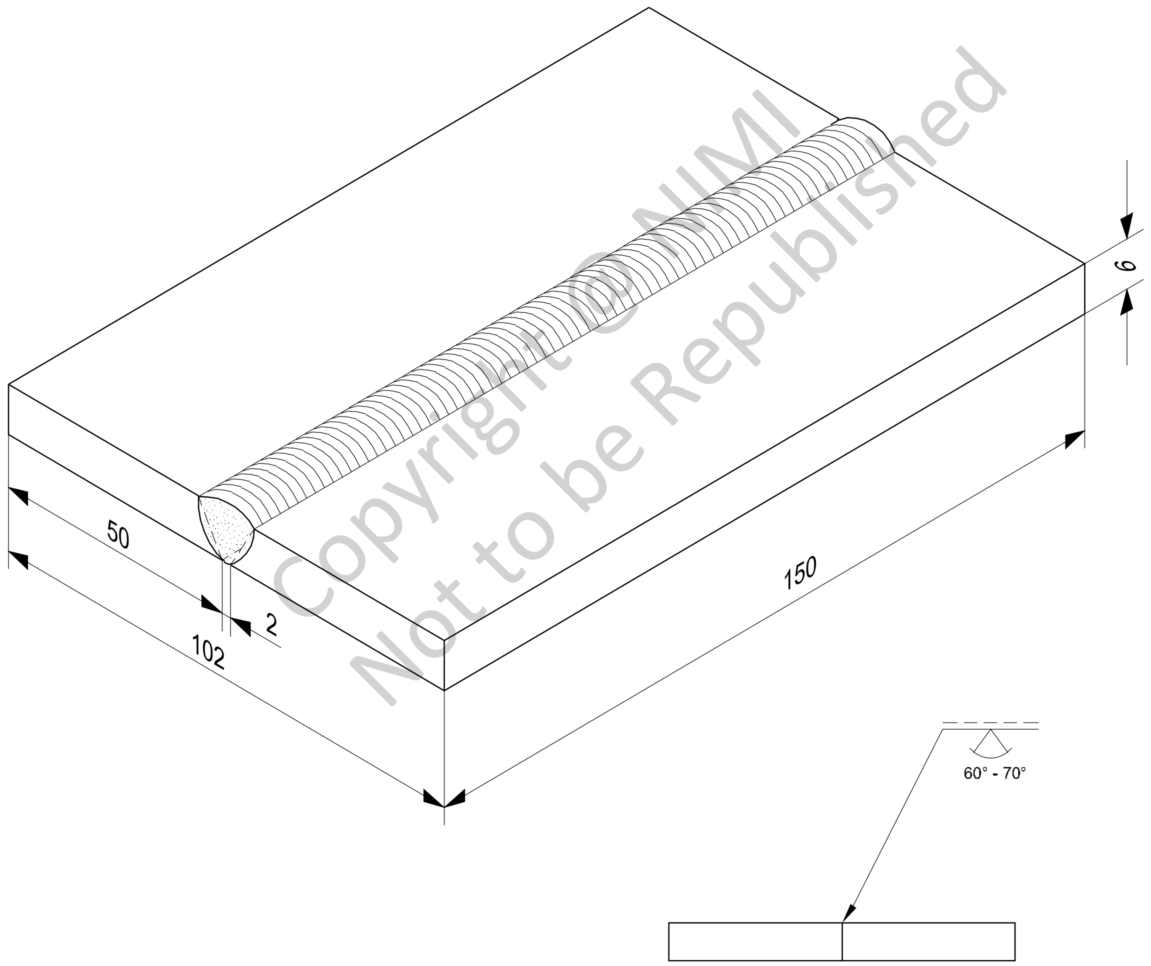


Clean the bead and remove the flux residue on both sides of the joint.

Inspect the joint for weld defects like porosity, incomplete penetration etc.

SMAW welding of cast iron plate 6mm thick in flat position flat

Objectives: At the end of this exercise you shall be able to
- **prepare the edges, set the cast iron plates and tack weld**
- **preheat the plates and post heat the joint**
- **select the electrode and set the current**
- **deposit root run, second and third runs without crack**
- **relieve the stresses from the joint by peening the bead**
- **inspect the joint for defects.**



2	150 x 50 x 6		FG 15			SMAW-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.104

SCALE NTS	WELDING OF CAST IRON PLATE 6mm THICK IN FLAT POSITION BY SMAW	TOLERANCE ±1	TIME 08 Hrs
		WLN25104E1	

Job Sequence

1 Bevel the edges to 30^0 angle by grinding (or) filing maintain root face to 1.5mm.

2 Keep the plates in alignment in flat position maintain a root gap of 2.50mm.

3 Select cast iron electrode Nickel based (ENI-1 or ENI-2) 3.15mm size and connect the electrode cable to the -ve terminal of the machine.

4 Follow necessary safety precautions.

5 Preheat the job to 300^0C using a oxy-acetylene torch and check the temperature using a thermo chalk and tack weld on both ends using low hydrogen electrode.

6 Keep the tack welded joint in flat position.

7 Deposit the root run using ø3.15mm cast iron nickel based electrode ensuring root penetration.

8 Clean the root run. Deposit 2^{nd} run using slight weaving and digging motion.

9 Maintain minimum interpass temp 200^0C throughout and also peen the weld bead by ball pein hammer to remove internal stress concentration for every run.

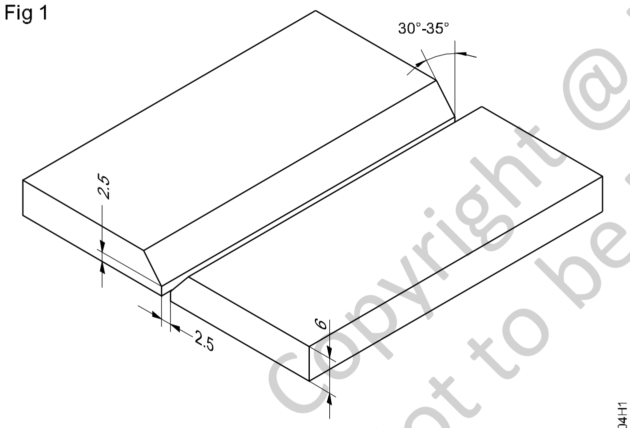
10 Post heat the job if required and cover it in dry sand or ash to allow to cool slowly.

11 Clean the weld and inspect it for cracks, proper fusion and other surface defects.

Skill Sequence

Bevel the edges: Bevel the edges to 30° angle by machining or filing. Maintain the root face 2 - 2.5 mm (Fig 1) avoid sharp edges as it may get chipped off if not handled properly.

Fig 1



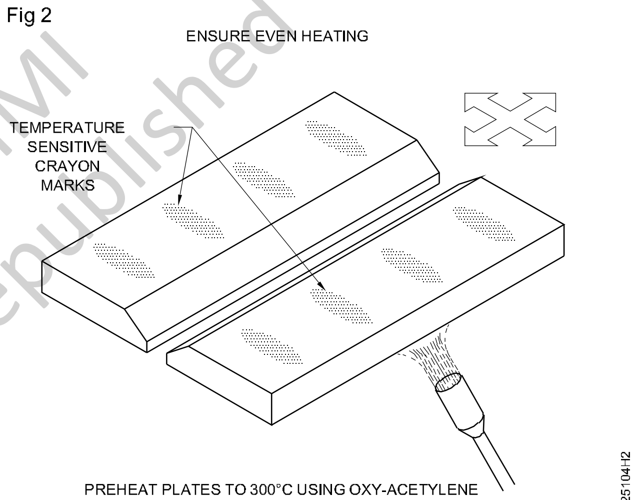
PREPARE EDGES BY FILING, GRINDING OR MACHINING AND SET PARALLEL 2.5mm APART

Set and tack weld: Keep the job parallel in flat position and maintain the root gap 2.5 mm.

Preheat the job: Preheat the job at 300°C by using an oxy-acetylene flame. (Fig 2) Check the temperature by using a thermochalk. (Figs 3a & 3b) Tack-weld on both ends. (Fig 4)

Deposition of runs: Select a M.S. electrode (low hydrogen) 3.15 mm dia. and set the current at 90-110 amps with DCEN. (Electrode +ve) Deposit root run with electrode angle of 80° to the line of weld with medium arc length. AVOID SHORT ARC.

Fig 2



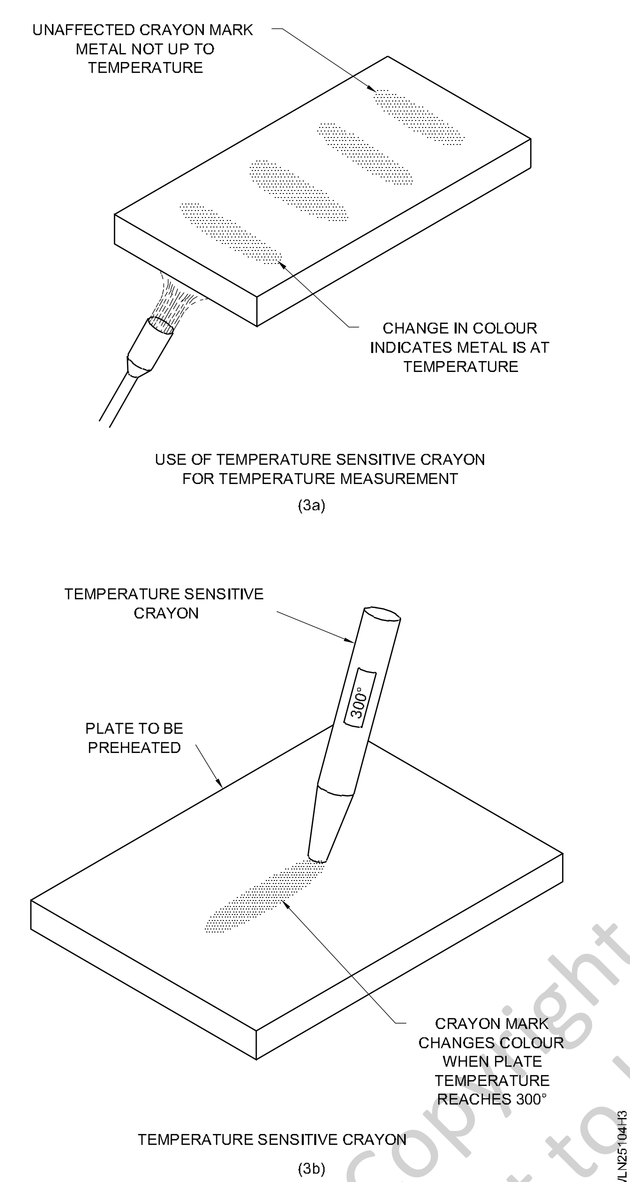
PREHEAT PLATES TO 300°C USING OXY-ACETYLENE TORCH OR FURNACE

Clean the root run by a wire brush. Deposit the second run by using a 3.15 mm dia. electrode with slightly weaving motion and keep the electrode angle 80° to the line of weld. Move the electrode with a digging action. since fluidity of cast iron is less, to make the molten metal to flow into the joint easily the electrode has to be given a digging action.

Clean the second run by a wire brush.

Peen the welded bead by a ball pein hammer to remove internal stresses. Post heat the job to preheating temperature. Keep the job under dry sand or ash and allow to COOL SLOWLY. Clean the weldment by using a wire brush.

Fig 3



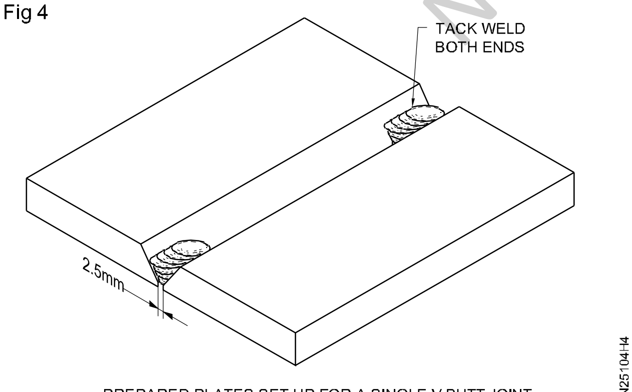
USE OF TEMPERATURE SENSITIVE CRAYON FOR TEMPERATURE MEASUREMENT

(3a)

TEMPERATURE SENSITIVE CRAYON

(3b)

Fig 4



PREPARED PLATES SET UP FOR A SINGLE-V BUTT JOINT

The use of cast iron nickel based electrode and the preheating, post heating, peening and slow cooling are essential to avoid cracks in the cast iron joint.

Inspect the welds: Inspect the welds for proper fusion, cracks and other surface defects.

Advantages

Low equipment cost.

Surfacing can be done in almost any position or location.

Submerged arc welding

The equipment used for this is identical to that employed for welding. The electrode is in the form of a continuous wire, either solid or tubular or solid strip.

Advantages

High quality of weld metal.

High deposition rates.

No spatter.

Open arc welding: It is a semi-automatic consumable electrode process. The continuously fed electrode is trubular and contains de-oxidizers alloying elements and flux. Open arc welding process is simple and involves low cost equipment.

M.I.G. welding: The equipment required for this is the same as that used for gas metal arc welding.

No flux is used but the arc and molten metal are shielded by an inert gas which may be argon, helium, carbon dioxide or a mixture of gases which depends upon the metal to be deposited.

T.I.G. welding: The equipment required for surfacing is the same as that used for T.I.G. welding. This process is used for surfacing drill pipe joints, valve gates etc.

Plasma welding: In this process the filler material in powder fom along with the plasma jet is forced through a constricting orifice and accelerated to sonic velocity with intense heat to form a bond with the base metal. A very thin layer with smooth finish is possible and generally no further maching is required.

Repairing of broken cast iron parts by using low heat input electrodes

Objectives: At the end of this exercise you shall be able to
- **explain the principle of low heat input method**
- **explain the low heat input electrodes and welding technique**
- **describe the advantages of this process**
- **state the applications of this process.**

Principle: Standard electrodes are used for most general types of welding. With these electrodes fusion is achieved by changing the solid state of metal into a molten state, which combines with the metal deposit of the electrode to form a permanent bond. However, metals often undergo an unfavourable change when subjected to high heat, and precautions must, therefore, be taken to avoid stress, distortion, wrapage and other metallurgical and structural changes.

A wide range of low heat input electrodes are available for welding where high heat is not desirable. These electrodes designed for a strong joint can be made without heating the parent metal to its full melting point.

Such welding is done with considerably lower current values without necessarily sacrificing the strength of the joint. For example, a 3 mm φ low heat input electrode may be used for cold weld casting with an arc gap of only 1.6 mm instead of the conventional 3 mm arc gap.

Low heat input electrodes may be used to weld all kinds of ferrous and non-ferrous metals.

Types of electrodes

- Silicon bronze electrode
- Phosphor-bronze electrode
- Aluminium bronze electrode
- Cupro-nickel electrode

If in arc welding, copper zinc alloys are used, zinc would evaportate and cause excessive weld porosity. Hence silicon bronze and phosphor bronze alloys are preferred.

These alloys may be classified into 3 types, thin flowing, bead forming and electrode forming alloys.

Thin flowing: Those alloys which flow by capillary action and can be used in sq. butt joints, lap joints, and other close fittings are classified as thin flowing alloys. These alloys may be used with oxy-acetylene flames, furnaces and induction heating units.

Bead forming: Those alloys which form beads and can be used in bevelled groove joints are known as bead forming alloys. Their use should be restricted to oxy- acetylene, oxy-hydrogen and carbon arc methods.

Electrode forming alloys: These alloys are used in the metal arc process. These are all coated electrodes. The specially designed flux coating permits application without deep fusion of the parent metal.

Welding technique: The low heat electrode requires the same technique as for welding conventional electrodes, with one notable exception; amperages are lower than those the operator is generally accustomed to using.

Preheating is not necessary as a rule, although in some cases it improves the performance of the elecrodes, cuts down rod loss, avoids excessive spatters and induces a neat, flatter and smoother deposit.

- Monel cored electrodes
- 45/55 iron-nickel cored electrodes
- Bronze electrodes

These electrodes have a copper-nickel or pure nickle core. These electrodes are used to repair all kinds of broken casting, correcting for machining errors, filling up defects or to weld cast iron to steel.

The deposited metal is soft enough; so it can be readily machined.

Non-machinable electrodes: Mild steel-cored low hydrogen electrodes with a special coating should be used.

The non-machinable electrodes have a mild steel core covered with or without special coating. These electrodes will have a very hard deposit and are used only when the welded section is not be machined afterwards.

These electrodes produce tight and waterproof weld and are ideal for repairing motor blocks, pulley wheels, pump parts, mover wheels and other similar structures.

Fusion welding method of C.I. welding: Prepare the edges as per drawing and clean them.

Select the electrode size according to the metal thickness, machinable or non-nchinable as per the applications. Set the current using DCRP (electrode = ve).

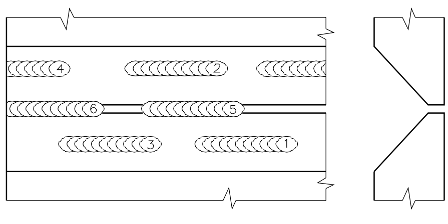
Form the joints as per the requirements and tack-weld.

Preheat the entire section by an oxy-acetylene flame. The tempearature should be between 100° and 300° C.

This preheating prevents cracking due to sudden heating and increases the fluidity of the weld metal.

Deposit short beads with 50 to 75 mm length. (Fig 5) Peen the weld and clean. Continue the same technique till there is complete deposition of the joint.

Fig 5



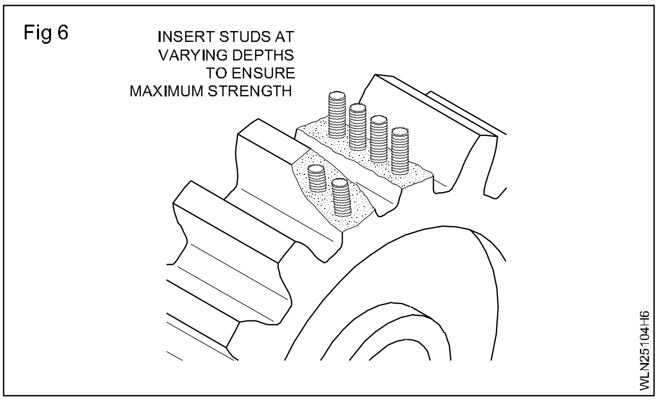
A SEQUENCE OF SHORT WELD BEADS WILL HELP AVOID EXCESSIVE CUMULATIVE STRESSES. WHEN COOL, BEADS IN LINE SHOULD BE JOINED BY WELDING IN SAME DIRECTION, ENDING THE CONNECTING BEAD ON TOP OF THE START OF A PREVIOUS BEAD

Post heat the job to the preheating temperature.

Cover the job with ash or dry sand to prevent rapid cooling, and allow it to cool slowly.

Study welding of cast iron: When a casting is 35mm or more in thickness and is subjected to heavy stresses, use steel studs to strenght the joint. (Fig 6)

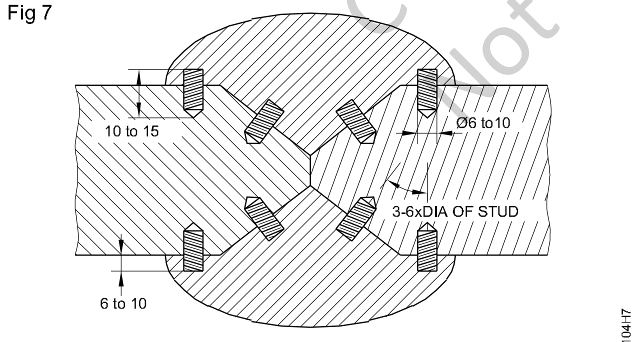
Fig 6



Studding is not advisable on casting lighter than 35 mm because it tends to weaken the joint.

Procedure: Bevel the cracked metal edges to 45°. Drill and tap 6 mm or 10 mm holes in the castings at right angles to the surface of the bevel. The No. of studs can be such that their area ia about 1/5th to 1/4th of the area of the weld. Space the holes, so that the centre-to-centre distance is equal to three to six times the diameter of the stud. Screw the studs into the holes. The threaded end of the studs should be about 10 to 15 mm in lenght and the stud should project approximately 6 mm to 10 mm above the castings. Choose the DCEP according to the metals and electrodes (non-machinable). Keep the pieces in parallel and tackweld on both ends. Deposit beads around the base of the studs, welding them thoroughly to the casting. Remove the slag and deposit additional layers of beads to fill the Vee as in Fig 7.

Fig 7



SECTION OF WELD PARTS ON THE STUDS ARE SHOWN.

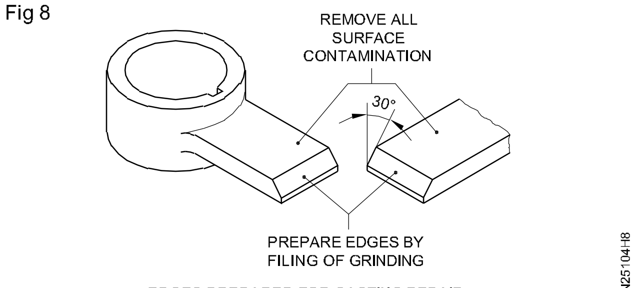
Clean the job and allow to cool slowly.

Method of repairing cracked C.I. by welding: The following procedures are adopted to repair the cracked C.I by welding.

Drill holes of 3 mm dia. beyond each end of the crack. These holes prevent the crack from extending. (Figs 8a) Bevel the crack at angle of 30° and 3 to 5 mm deep with a diamond-point chisel or by grinding. If the thickness is less than 5 mm, make the 'Vee' groove only half the thickness. (Fig 9) Select the electrodes according to the uses or conditions whether machinable or non-machinable. Use the DCEP. Set the current as per the requirements according to the size of the electrodes.

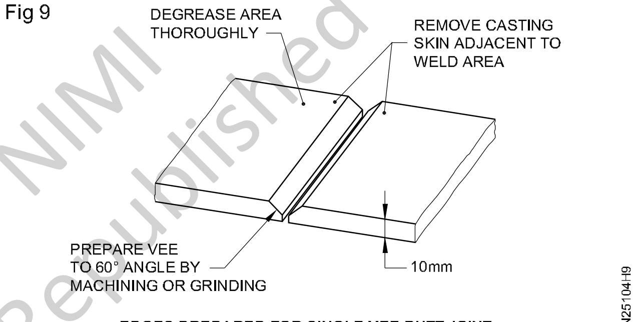
Before castings can be successfully welded, they must be properly prepared by 'veeing' and thoroughly de-greasing the welding area. Even slight traces of oil or grease below the weld surface will boil out because of the welding heat and cause porosity in the weld. (Figs 8, 9, 10, 11 & 12)

Fig 8



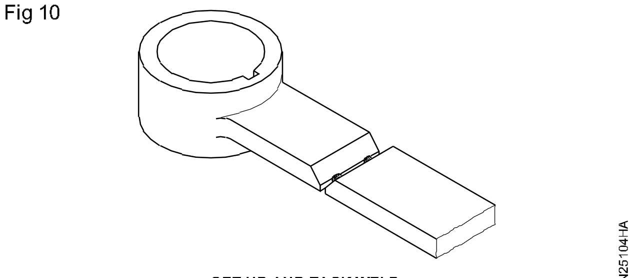
EDGES PREPARED FOR CASTING REPAIR

Fig 9



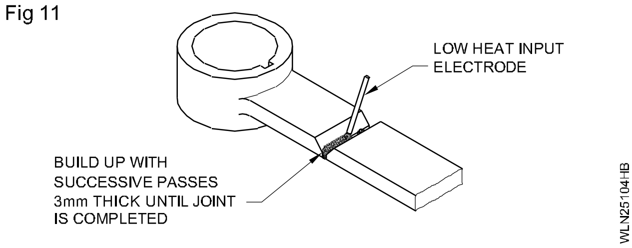
EDGES PREPARED FOR SINGLE VEE BUTT JOINT

Fig 10



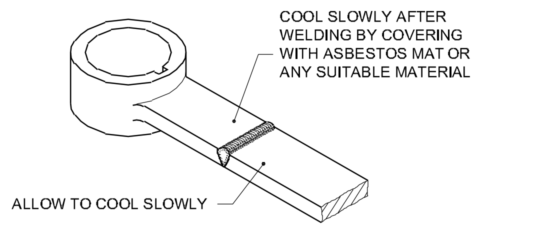
SET UP AND TACK WELD

Fig 11



Advantages: These electrodes can be used at very low currents and high travel speeds, resulting in minimum distrotion and least fusion zone cracking due to the fact that they are less hard and brittle.

Fig 12



ANNEALING REQUIRED TO PREVENT HARDNESS IN HEAT AFFECTED ZONE

The deposit can provide good bearing and corrosion resistant surfaces. These properties are an advantage in joining new, higher strength cast iron successfully.

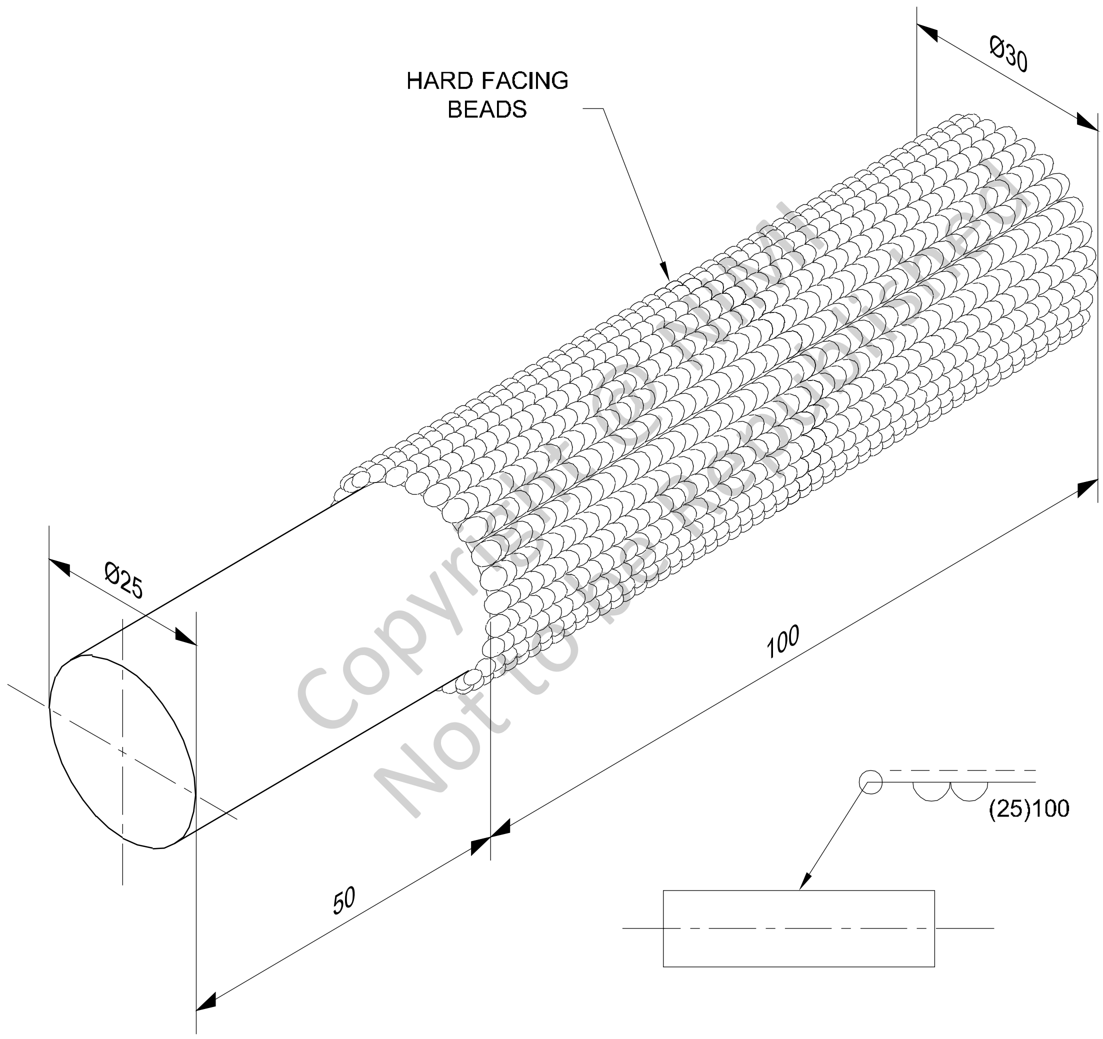
The advantages of low heat input welding are:

- produces stronger bond with the base metal than with conventional brazing alloys
- weld metal properties and colours are similar to those of the parent metal
- since welding is done at a low temperature, heat input, distortion and warpage is less
- fewer changes in metallurgical structure
- higher welding speed
- lower residual stresses
- lower rejections and failures.

Application: The process is well suited for the reclamation of worn out or mis-machined parts. Inaddition, it can also be widely used for providing wear-free, corrosion and heat resistant deposits on critical areas of vital machinary components for their improved performance, longer part life and recycling.

Hard facing practice on MS round rod φ25mm - by using hard facing electrode in flat position

Objectives: At the end of this exercise you shall be able to
- **prepare the surface to be hardened**
- **do the marking and setting**
- **select the electrode and set the current and polarity**
- **deposit beads using the sequence method**
- **give the after treatment**
- **give the aftertreatment defects.**



1	Ø25 x 150		Fe310 - W			SMAW-05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.105

SCALE NTS	**HARD FACING PRACTICE ON M.S. ROUND ROD Ø25mBY USING HARD FACING ELECTRODES IN FLAT POSITION**	TOLERANCE ±1	TIME 07 Hrs
		WLN25105E1	

Job Sequence

1 Clean the surface of the job.

2 Divide the M.S. round circumference into four points.

3 Draw and punch the lines from the four points.

4 Place the punched M.S. round bar horizontally on the Vee blocks at both ends.

5 Select a 3.15mm hard facing electrode and set 90-120 amps current.

6 Follow necessary safety precautions.

7 Deposit the first short bead along one side parallel to the axis from point 1.

8 Rotate the bar and deposit the 2nd short bead from point 2.

9 Rotate the bar and deposit the 3rd bead from point 3.

10 Rotate the bar and deposit the 4th bead from point 4.

11 Rotate the bar, chip the slag and clean thoroughly and deposit bead No.5 adjacent to 1.

12 Complete the job by depositing symmetrically as shown in Fig 2 under Skill Sequence.

13 Cool slowly in sand, slaked lime or ash.

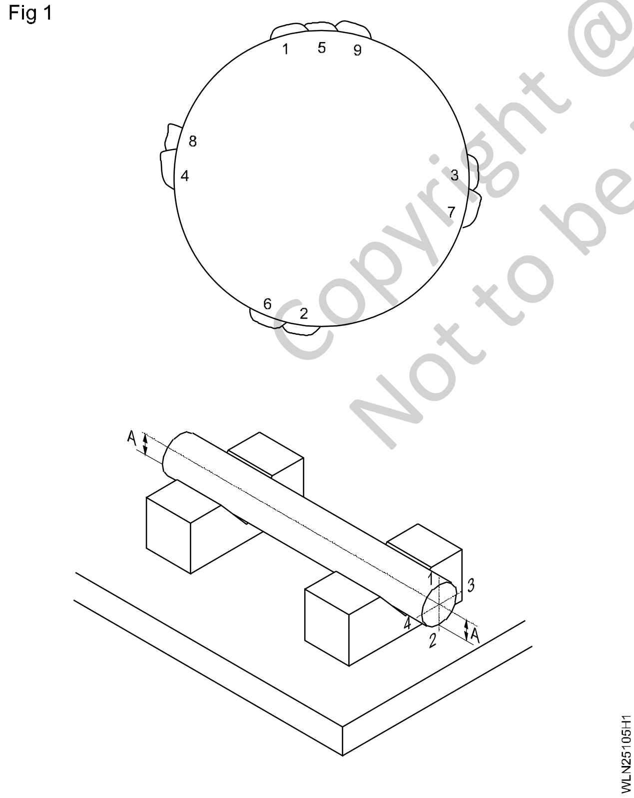
14 Clean the weld and inspect for surface defects.

Skill Sequence

Preparation: Clean a surface of 25mm ø thoroughly by grinding/emergy sheet. The surface must be free from oil, scale, paint, dirt etc.

Marking: Divide the circumference into four parts. Draw four lines parallel to the axis and punch. Place the workpiece over the two Vee blocks. (Fig 1)

Fig 1



Selection of electrode: Select a hard facing electrode of 3.15mm ø depending upon the hardness required. Set the current at 90-120 amps.

Use a low current to prevent 'pick-up' of the deposit by the base metal.

Welding: Deposit 100mm long beads along one side parallel to the axis.

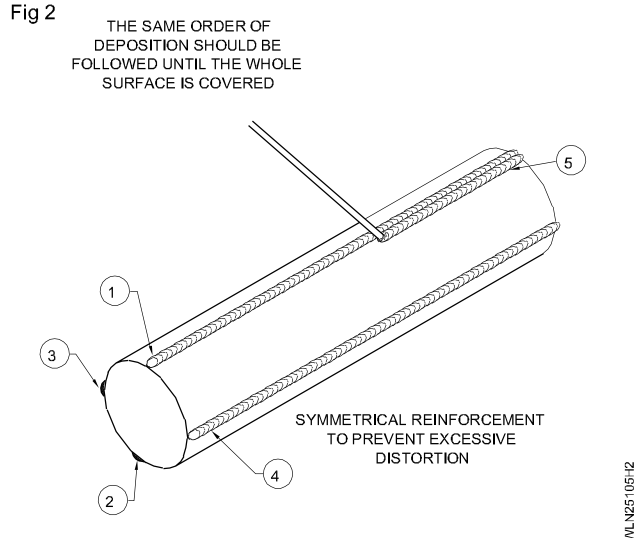
Use medium arc with stringer beads. The angle of the electrode should be 70° to 80° to the direction of travel.

A long run would cause permanent distortion.

Rotate and make a similar run on the opposite side to equalize the stress as shown in Fig 1.

Complete the job by depositing symmetrically as shown in Fig 2.

Fig 2



Inspection of weld: Remove slag from the weld and inspect for:

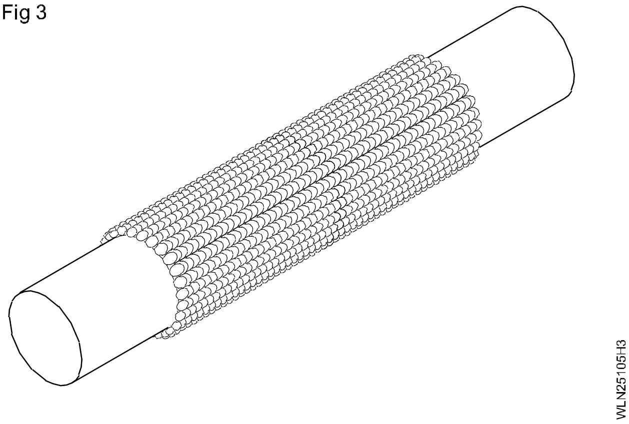
– diameter of the hard faced surface

– uniform starts and stops

– absence of depressions and high spots

– absence of spatters. (Fig 3)

Fig 3



After treatment: Cooling of the job after hard facing should be slow and uniform.

The usual method is to cover it with dry insulating powder so that slow cooling is ensured. The insulating materials commonly used are slaked lime, ash, sand, mica dust, asbestos powder, etc. The slow cooling can be done by using asbestos mat also.